ON-FARM EVALUATION OF THE DRUM AND DRIP MICRO-IRRIGATION SYSTEM FOR VEGETABLE PRODUCTION IN HOME GARDENS

by

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NOVEMBER 2003
DECLARATION BY CANDIDATE

‘I hereby declare that the dissertation submitted for the degree M Tech: Agriculture, at Technikon Pretoria, is my original work and has not previously been submitted at any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references’.

T. B. Khosa
ABSTRACT

This study was initiated to evaluate, on-farm, the suitability of the Drum and Drip micro-irrigation system for vegetable production in rural home gardens. This technology was introduced to address the problem of child malnutrition ascribed, at least in part, to lack of vegetables in the diet of children. To describe the context in which this food security intervention occurred, and to link the study to the societal problem of chronic malnutrition, a household survey was conducted. It investigated the demographics, sources of income and expenditure, and agricultural production by households, and the food they obtained by means of purchasing and dryland agriculture.

The survey results showed that livelihoods in Sekuruwe and Ga-Molekane, Limpopo, were based mainly on income generated outside the two settlements, and that poverty was widespread in the two villages, with 77% households living below the poverty line. On-farm evaluation of the Drum and Drip micro-irrigation system identified constraints, which affected vegetable production. These included the lack and poor quality of water, inadequate crop protection, low nutrient supply, and a lack of basic knowledge of vegetable production among participants. Clogging of the drippers, and rusting of drums causing leaks, were technical weaknesses that affected the suitability of the system. Children’s dislike of eating vegetables reduced the positive impact of the intervention on the problem of chronic malnutrition among them. Generally, the analysis of nutrient intake revealed that purchased food and food produced by means of dryland agriculture supplied households with adequate vitamin C, but insufficient vitamin A and iron. Adding the food obtained from the irrigated gardens addressed
the shortage of vitamin A, but failed to address the inadequacy of iron. The analysis also revealed that nutrient supply by the three sources of food was unevenly distributed, with periods of plenty and periods of scarcity following one another. Periods of low nutrient availability occurred when households relied on purchased food only. Based on the results of the study, several needs were identified. The most important were the need to address the problem of lack and poor quality of water, and the chronic shortage of iron. There was also a need to devise a cropping calendar and a production system that would even out the supply of produce over the different seasons in the study area. Lastly, the study identified a need for the provision of a comprehensive training package on vegetable production by means of the Drum and Drip micro-irrigation system.
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CHAPTER 1
INTRODUCTION

1.1 STATEMENT OF THE DEVELOPMENTAL PROBLEM

South Africa is facing a serious problem of child malnutrition (Schmidt, Jurgens & Jordan, 2002). In 1999 the Department of Health’s Integrated Nutrition Programme conducted a survey, which showed that 22% of all South African children between the ages of one and nine years old were stunted (Labadarios & Nel, 2000). Kleynhans & Albertse (2000) reported that 19% of a sample of 168 children aged between one and two years old living in Sekuruwe and Ga-Molekane, two rural settlements in Limpopo Province, were stunted. An investigation of the diets of the children in these two villages revealed a general lack of calcium, iron, vitamin A and vitamin C (Amissah, 2000:206-210). A lack of fruit and vegetables in the diets of the children was identified as the probable cause (Amissah, 2000:218). Low household incomes limited the ability of households to purchase fruit and vegetables (Amissah, 2000:214). Dry conditions and a lack of water for irrigation prevented local households from growing their own vegetables.

1.2 MOTIVATION FOR THE STUDY

Re-using or recycling domestic water may help to solve the lack of irrigation water in semi-arid and arid areas (Buechler, Hertog & Van Veenhuizen, 2002). Consequently, using grey water to grow irrigated vegetables may help to address the malnutrition problem encountered in Sekuruwe and Ga-Molekane. Albertse (2000) identified the Drum and Drip
micro-irrigation system as a potentially suitable technology for the production of irrigated vegetables using recycled water. Micro-irrigation is known to be very efficient (Du Plessis & Van Der Stoep 2001:1). Albertse (2000) postulated that by handing the micro-irrigation system to women for use in their home gardens, the vegetables being produced would be used for home consumption, thereby benefiting the whole family including the children.

1.3 STATEMENT OF THE KNOWLEDGE PROBLEM

No information was available on the acceptability of grey water as a source of irrigation water among people in the study area. There was also no information on how women would handle irrigated vegetable gardening using the Drum and Drip micro-irrigation system, and how they would allocate the produce of their gardens to home consumption, sales and donations to others.

1.4 OBJECTIVES OF THE STUDY

The main objective of this study was to evaluate the suitability of the Drum and Drip micro-irrigation system technology for production of vegetables in home gardens in Sekuruwe and Ga-Molekane. A secondary objective was to estimate the contribution of food produced in the irrigated vegetable gardens to the nutrient intake of households in the two villages. To describe the context in which this food security intervention occurred, the livelihoods and food security strategies of local people were investigated.
2.1 INTRODUCTION

In this Chapter, literature dealing with concepts important to this study is reviewed. Concepts that are explored include malnutrition, poverty, rural livelihoods, farming systems of African people in South Africa, irrigation, micro-irrigation, and on-farm experimentation. The section that deals with malnutrition was written jointly with Ms Johannah Maswikaneng (Maswikaneng, 2003).

2.2 MALNUTRITION

2.2.1 What is malnutrition?

Malnutrition is a nutritional disorder caused by eating too little (undernutrition) or too much (over-nutrition) of one or more nutrients (Crystal, 1999:532, King & Burgess, 2000:209 and South Africa, Department of Health, 2002). The societal problem with which this study is concerned is undernutrition. According to Burgess, Maina, Harris and Harris (1998:13), young children are most at risk of malnutrition, but malnutrition commonly also occurs among school-age children and pregnant and breastfeeding women. Severe malnutrition in adults is usually associated with debilitating diseases, such as HIV/AIDS, or with acute starvation in famine conditions (Young, 2001). Undernourished children typically lack energy, protein and other nutrients. When extremely deprived they may develop protein-energy malnutrition (PEM) (King & Burgess, 2000:209). The signs
of PEM in children are failure to grow or being underweight (King & Burgess, 2000:222; Young, 2001). In severe cases, the children may look thin, badly wasted (marasmus) and oedematous (kwashiorkor). An undernourished child has little energy to do things and to learn, and also has little resistance and immunity against infections (Burgess et al., 1998:13). Signs of malnutrition in pregnant women include thinness, a low weight gain during pregnancy, and a baby’s birth weight of less than 2.5 kg (Burgess et al., 1998:13).

2.2.2 Malnutrition in the world

Undernutrition is one of the world’s most widespread and serious health development problems (Burgess et al., 1998:1). Protein–energy malnutrition (PEM), nutritional anaemia, iodine deficiency disorders, and vitamin A deficiency are four major clinical forms of malnutrition in developing countries (Young, 2001). The United Nation Children’s Fund (1998) reported that over 200 million children under the age of five years were affected by malnutrition. This contributed to more than 50% of the 12 million deaths of children younger than five years old in developing countries. According to Sasson (1990:38), the incidence of malnutrition is highest in developing countries. Nearly all undernourished children live in Asia (70%) and Africa (26%) (World Health Organization, 2000).

In most regions of the developing world, malnutrition rates have been falling during the last two decades of the 20th century, but sub-Saharan was the exception (UNICEF, 1998). Here malnutrition rates increased in most countries during the early 1990s, following the regional economic decline that started during the late 1980s (UNICEF, 1998).
2.2.3 Malnutrition in South Africa

The most common type of malnutrition affecting South Africa’s children is undernutrition (Labadarios & Nel, 2000). In 1994, the South African Vitamin A Consultative Group (1995) found that 660,000 children aged between six months and six years old were identifiably malnourished, and 1,520,000 were stunted because of long-term malnutrition. This meant that in 1994 one in every four children living in South Africa was stunted, and one in ten was underweight (Theron, 2000). The National Food Consumption Survey of 1999 reported that the mean rate of stunting among South African children aged 1-9 years old was 22% (Labadarios & Nel, 2000). Figure 2.1 presents the stunting rates of South African children aged 1 to 9 years old by province as determined during the National Food Consumption Survey in 1999.

![Stunting rates among South African children aged 1-9 years](image)

**FIGURE 2.1:** Stunting rates among South African children aged 1-9 years (after Labadarios & Nel, 2000)
The prevalence of stunting was highest in the Northern Cape (30%), the Free State (30%) and Mpumalanga (26%). The least affected provinces were Western Cape (14%) and KwaZulu-Natal (18%). According to Labadarios and Nel (2000), the most affected were children living on commercial farms and in rural areas. Children living in urban areas were least affected.

2.2.4 Causes of malnutrition

Many factors contribute to the development of malnutrition. Poverty has been recognized as the overriding factor (Young, 2001). Poor families lack the economic, environmental, or social resources to purchase or produce enough food. In rural areas, land scarcity and degradation, water salinity due to over-irrigation, soil erosion, droughts and floods can all undermine a family’s ability to grow enough food. In urban areas, low wages, lack of work, underemployment, and rapid changes in food prices often place food out of the reach of poor households (World Resource Institute, 1998). The causes of malnutrition were outlined in a conceptual framework by UNICEF (1998), which is reproduced in Figure 2.2. This conceptual framework was developed as part of the UNICEF nutrition strategy (UNICEF, 1998). The causes of malnutrition in the framework are classified as immediate, underlying, and basic, whereby factors at one level influence those at other levels. The two immediate factors are poor food intake and high disease rate. They are affected by the underlying causes usually operating at the household level. These include household food insecurity, a lack of basic health services, and a poor health environment and maternal and childcare. The basic causes of malnutrition operating at higher administrative levels are influenced by several factors. These include a lack of potential
resources, economic and political structures, and ideological superstructures (Young, 2001).

**FIGURE 2.2: A conceptual framework of the causes of malnutrition (UNICEF, 1998)**
2.2.5 Solution to malnutrition

According to Burgess et al. (1998:19), it is usually difficult for communities to address the basic causes of malnutrition at community level. This implies that the basic causes of malnutrition should be dealt with by the national government. Burgess et al. (1998:19) identified several initiatives and programmes likely to be successful in addressing the underlying causes of malnutrition. Household food insecurity can be addressed by encouraging people to produce their own food (agriculture), by introducing feeding programmes, and by initiating income-generating activities. Care of women and children can be improved by reducing women’s workload, and by improving services for women and care practices for children. Lack of adequate home environments and health care can be addressed by improving water supply and sanitation, child immunization, food safety and hygiene practices.

2.3 RURAL LIVELIHOODS OF AFRICAN PEOPLE IN SOUTH AFRICA

2.3.1 Characteristics of rural livelihoods

Swift and Hamilton (2001) define livelihood as “the capabilities, assets (including both material and social resources) and activities required for a means of living”. Lipton, cited by May (1996) assigned a minimum requirement to livelihoods, in terms of time and reward. He defined livelihood quantitatively as “approximately 200 days per year of work, receiving a reward that is at least sufficient to prevent household poverty”. Consequently, activities occupying less than 200 days of work or producing rewards insufficient to
prevent household poverty have to be considered as partial livelihoods. Smith (2000) emphasises the historical dimension of livelihoods. He sees livelihoods as complex and specific reactions of the domestic group to a history of external and internal influences of economic, political and climatic nature. These induce or are related to changes in the organization, role division, and perceptions of the domestic group and its members as these evolve over time. Therefore, a domestic group may hold a wide array of perceptions and strategies that differ per member, gender and age group (Smith, 2000).

Swift and Hamilton (2001) distinguished four main categories of livelihood strategies that may be constructed by households in the African rural context:

(i) Livelihood *intensification*, where the value of output per hectare of land or per animal is increased by the application of more labour, capital or technology;

(ii) Livelihood *extensification*, where more land or animals are brought into production at the same levels of labour, capital and technology;

(iii) Livelihood *diversification*, where households diversify their economic activities away from reliance on the primary enterprise (animal or crop production), typically seeking a wider range of on-farm and off-farm sources of income; and

(iv) *Migration*, where people move away from their initial source of livelihood, and seek a living in another livelihood system.

When agriculture fails to provide for an adequate livelihood, households add other non-farming activities to agricultural production (diversification). Households that fail to
generate successful livelihoods in rural settings often move to seek better livelihoods in other areas. Migration may involve certain members of households only. It becomes the task of the migrant members to move to places of work, generate income, and remit at least part of it to members of the rural household (Swift & Hamilton, 2001).

Within South Africa, a rural livelihood is somewhat of a special case. For example, in some areas social grants enable households to live in rural areas without engaging in any substantial agricultural activity or other local economic activity (Van Averbeke, Bediako, Langeveld & Barrett, 1998). Migration has been another important livelihood strategy used by rural households in South Africa. Migration of black people in South Africa was organised in response to the demand for labour by white-owned industries, particularly in mining and farming from about 1910 (Yawitch: 1982:5). These industries were assisted by the State, through legislation that forced black people to earn a living off-farm for at least part of the year (Bundy, 1988). This legislation included various forms of taxes and also restrictions that prevented black people from accessing adequate land to make a living from farming. According to Yawitch (1982:6), it was mainly men who migrated to the cities, leaving women and children at home. Yawitch (1982:6) argued that male migration affected the traditional organization of African households, and in turn its productive capacity, especially in agriculture. For example, when men returned from work in cities, they saw themselves as ‘resting’ and did not participate in the productive affairs of their households, such as agriculture, to the same extent as before (Yawitch, 1982:6). Male migration remained important until the end of the 1980’s. Thereafter, another form of migration emerged in South Africa. This involved migration of entire households. While effectively becoming urban, these households often maintained their rural residence, which they returned to weekly, monthly or annually (Van Averbeke et al., 1998).
Recent studies (May, 1996; Baber, 1996; Van Averbeke et al., 1998 and Hebinck 2000) show that rural livelihoods in South Africa are mainly based on ways of generating income outside of the rural place of residence. These involve making claims against the State and against kin, and the seeking of paid work, mainly in urban areas, which often involves migration of part or all of the household. Attempts to maximize agricultural production (livelihood intensification and extensification) are rare, but sporadically they do occur (Van Averbeke et al., 1998 and Monde, 2003).

2.3.2 Poverty and rural livelihoods

According to May (1998) poverty is defined as “the inability to attain a minimal standard of living, measured in terms of basic consumption needs or the income required to satisfy them”. According to Woolard and Leibbrandt (2002), there are two approaches for measuring poverty using a poverty line, i.e. the use of an absolute poverty line, and the use of a relative poverty line. An absolute poverty line corresponds to some bare minimum subsistence level below which survival is not possible in the long term (Woolard & Leibbrandt, 2002). A relative poverty line reflects that people can be poor even when they live above the minimum subsistence level, because they fall below what is regarded by society as the minimum level of command over goods and services needed in order to be a fully integrated member of that society. People living in that state are said to suffer from relative deprivation (Woolard & Leibbrandt, 2002).

Carter and May (1999) used 1993 data supplied by a national living standards survey undertaken by the Project for Statistics on Living Standards and Development to study livelihood generation and class in rural South Africa. They found that 52.1% of all South
African households in rural areas were poor, because their scaled per-capita expenditure fell below the poverty line of R237 per adult equivalent per month. Carter and May (1997) also found that poor households tended to be larger than wealthy households. The implication was that 70% of all rural African individuals lived in households with incomes below the poverty line. May (1998) established that most poor people in South Africa live in rural areas. He estimated the poverty rate in rural areas of South Africa to be 71% in 1995. He estimated that at that time the national poverty gap, which is the amount of money needed to lift poor households above the poverty line by means of a perfectly-targeted transfer of money, and which measures how deep or intense poverty is, to be about R28 billion. He found that 71% of the national poverty gap was accounted for by rural areas.

In May and June 2002, the Children’s Budget Unit (CBU) conducted research on the extent and depth of child poverty in South Africa’s nine provinces (Streak, 2002). The CBU used the data sets of the 1995 and 1999 October Household Survey by Statistics South Africa to predict the 2002 provincial poverty rates among children between the ages of zero and 17 years old. Two absolute poverty lines were established with reference to 1999, namely R400 (poor) and R200 (ultra poor) per person per month. Using the Consumer Price Index, these two poverty lines were adjusted to R490 and R245 for 2002. The predicted child poverty rates in 2002 are presented in Table 2.1.
As evident from Table 2.1, the national poverty rate among children in South Africa in 2002 was estimated to be 76 % and the ultra poverty rate 58 %. Poverty was estimated to affect more than 70 % of children in seven of the nine provinces of South Africa. The two provinces estimated to have the lowest child poverty rates were Western Cape (47 %) and Gauteng (55 %). The rates of ultra poverty were high in the Eastern Cape, Limpopo and KwaZulu Natal provinces, which are predominantly rural.

The persistence of poverty in the rural areas of South Africa is due to ‘poverty traps’ (May, 1998). Poverty traps refer to a lack of complementary assets and services resulting in
‘poverty opportunity’, whereby individuals are unable to take full advantage of the assets
to which they have access (May, 1998). Carter and May (1999) ascribe rural poverty to
limited access to endowments, highly constrained options for the use of endowments, and
poor returns being generated by the use of these endowments. Carter and May (1999)
revealed three dimensions of the rural poverty problem. These are:

(i) Returns to uneducated labour are so low that claims on other economic or social
    assets are necessary to lift the family above the poverty line;
(ii) Financial constraints limit poor people’s ability to effectively utilize the
     productive assets and endowments such as land, which they do have; and
(iii) The burden of fetching water and firewood in rural South Africa creates ‘time
     poverty’ which further constrains the ability of households to effectively
     employ those resources to which they have access for the generation of
     livelihoods.

In order to address poverty, Carter and May (1999) suggest a policy that focuses on lifting
the constraints that limit the effectiveness with which the rural poor are able to use the
limited assets and endowments they possess. Elements of such a policy could be the
promotion of local financial institutions, and the delivery of essential services such as
water and energy. May (1998) advised that reducing poverty and inequality in South
Africa required substantial changes in the distribution of incomes, wealth and economic
power. He pointed out that redistribution revolved around access to livelihoods, housing,
infrastructure, land, and water.
2.3.3 Agriculture and rural livelihoods

Many households in rural areas engage in agriculture as part of their livelihoods strategy. May (1998), reported that 26% of rural households in South Africa had access to a plot of land for crop production, 24% owned livestock, and 18% owned agricultural equipment. However, although rural households engage in agriculture, its contribution to the total household income is usually small (May, 1998). Table 2.3 shows the contribution of various sources to the total household income in four rural areas of South Africa.

<table>
<thead>
<tr>
<th>Source of income</th>
<th>Rural Mbashe Municipality (Eastern Cape) (%)</th>
<th>Koloni &amp; Guquka (Eastern Cape) (%)</th>
<th>Rural KwaZulu-Natal (%)</th>
<th>Momane &amp; Rantleke (Limpopo) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State grants</td>
<td>38.4</td>
<td>26.5</td>
<td>17.9</td>
<td>15.3</td>
</tr>
<tr>
<td>Remittances</td>
<td>10.7</td>
<td>10.5</td>
<td>16.4</td>
<td>51.6</td>
</tr>
<tr>
<td>Salaries and wages</td>
<td>30.0</td>
<td>33.3</td>
<td>53.6</td>
<td>7.6</td>
</tr>
<tr>
<td>Private pensions</td>
<td>2.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-agricultural activities</td>
<td>9.9</td>
<td>17.8</td>
<td>5.3</td>
<td>17.6</td>
</tr>
<tr>
<td>Agricultural activities</td>
<td>8.5</td>
<td>11.9</td>
<td>6.8</td>
<td>7.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

In all four cases, the contribution of agriculture to rural household income was small, ranging from 7% to 12%, on average. Depending on the case, state grants, remittances, or salaries and wages constituted the main source of income. Non-agricultural local economic activities, such as trade, provision of services, housing, housing industries, and retirement annuities made a contribution ranging from 5% to 18% of the total household income.
2.4 AFRICAN FARMING SYSTEMS

The first farming communities in South Africa were established by the end of the third century, and they were cultivating millet (Hammond-Tooke, 1993:50). By the seventeenth century they produced a wide range of crops, including millet, sorghum, maize, beans, pumpkins, melons, tobacco and dagga. According to Hammond-Tooke (1993:27), cattle production by black people in South Africa can be traced to AD 800.

The four main ethnic groups of black people found in South Africa, namely Nguni, Tsonga, Sotho, and Venda, varied considerably in terms of settlement patterns (Hammond-Tooke, 1993:47). The Nguni and Tsonga groups settled in the well-watered eastern part of South Africa. Each homestead owned a field and a cattle byre, and homesteads were scattered at varying distances from one another. The Nguni tended to build homesteads along the spurs and hills, often intersected by deep, bush-filled valleys, which provided fuel, building material and medicinal plants. The higher ground, typically grass-covered served as pasturage. This ensured that the cattle were never far away, and were herded nightly in the byres that formed the symbolic centre of each homestead (Hammond-Tooke, 1993:47). The Tsonga group settled in the lowveld bush, which was relatively flat, and had less surface water. The settlement of the Sotho and Venda in the west was typically nucleated, because of a lack of water (Hammond-Tooke, 1993:49). Shortage of water caused the homesteads to be closer together so that every household was close to the water source. The nucleated settlement pattern resulted in fields being far from the homesteads (Hammond-Tooke, 1993:49). Some family members resided temporarily on the arable land during the cropping season to tend the crops and to keep birds away (Hammond-
Tooke, 1993:49). Cattle were herded between permanent cattle posts situated near the grazing. Daily milk had to be transported back to the village.

Betterment schemes implemented during the 20\textsuperscript{th} century modified traditional settlement patterns of African people in South Africa. In the betterment schemes, the land was divided into residential, arable and grazing areas (Yawitch, 1982:48). Ownership of arable land was reduced to between 0.85 ha and 5.10 ha per household, and cattle ownership limited to 11 cattle per household. (Yawitch, 1982:41). Residential sites were less than 0.5 ha, getting smaller with time (Bembridge, 1984 and Mkile, 2001:43). To a large extent by implementing the village model throughout the country Betterment removed differences in settlement patterns that existed among the major groups of black people. Betterment appears to have encouraged crop production in the yards of residential sites, also called home gardens (Yawitch, 1982:49) and to have discouraged field cropping.

\textbf{2.4.1 Crop production on arable land}

As explained in section 2.4, Betterment schemes subdivided land into three categories. The parcels of arable land situated outside residential areas were referred to as fields, and were designated specifically to crop production. They ranged between 0.85 ha and 5.10 ha (Yawitch, 1982:41). According to May (1998), in 1995 about 26\% of rural African households held arable fields.

For a long time crop production on arable land played an important role in supplying farming households with food and additional income (Scogings, De Bruyn & Vetter, 1999 and Shackleton, Shackleton & Cousins, 2001). However, recent studies show that not all
households holding arable land cultivate their fields (Shackleton et al., 2001, ARDRI, 2002 and Van Averbeke, 2002). MacAllister (2000) as cited by Shackleton et al. (2001) reported that many households in Transkei were abandoning their arable fields and were investing all their agricultural efforts in home gardening. Table 2.3 shows rates of cultivation of arable land by rural African households holding arable land in three areas of South Africa. All the studies were conducted during the last decade of the 20th century.

TABLE 2.3: Rates of cultivation of arable land among rural African households in three areas of South Africa

<table>
<thead>
<tr>
<th>Rural area</th>
<th>Source</th>
<th>Period</th>
<th>Proportion of arable land under cultivation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mbhashe (E. Cape)</td>
<td>ARDRI (2002)</td>
<td>1996</td>
<td>32</td>
</tr>
<tr>
<td>Rantlekane and Mamone (Limpopo)</td>
<td>Baber (1996)</td>
<td>1993 &amp; 95</td>
<td>47</td>
</tr>
</tbody>
</table>

The results of the three case studies presented in Table 2.3 show that much of the arable land available to rural households is no longer cropped. Obviously this must have an effect on household food security in these areas. Lack of implements and money to hire implements for soil preparation, and lack of protection of crops against livestock and theft by people, are the main reasons for land holders to discontinue arable farming (Baber, 1996, Mbuti, 2000 and Shackleton et al., 2001).

2.4.2 Crop production on residential sites

According to the Environmental and Development Agency Trust (1995), agriculture currently practiced on residential sites includes production of crops and micro-livestock. The primary reason for practicing agriculture on residential sites is to produce food for
home consumption (Shackleton et al., 2001). Monde (2000) investigated the use of residential allotments for agricultural purposes in Koloni and Guquka in the Eastern Cape. She reported that 113 of 128 surveyed households in Guquka and Koloni had one or more plots allocated to food production on their residential sites. These plots ranged between 40 and 1500 m$^2$ in size. Households grew maize, potatoes, pumpkins, cabbages, tomatoes, carrots, beetroot, onions, butternuts, beans, peas and Swiss chard on these plots. The main reason for growing these was to supply their households with food. Households themselves consumed three quarter of the garden produce, and about 26% was sold or donated to friends and relatives. Although her study focused on crop production, Monde (2000) also reported that households used their residential sites for micro-livestock production, involving the rearing of pigs and poultry.

2.4.3 Animal production

Livestock production is a major component of many African farming systems (Bembridge, 1980, King, 1985:90, Scogings, De Bruyn & Vetter, 1999, Schwalbach, Groenewald & Marfo, 2001 and Shackleton, et al., 2001). According to Hatch (1996), and Schwalbach et al. (2001), livestock in the rural areas of South Africa are kept for a variety of reasons. These include generating income by selling, providing meat, milk, skin, manure, eggs, and draught power, as a means for social exchange, as a security against adverse conditions, or as an asset that may be liquidated. According to King (1985:90), the most important types of livestock kept by rural households in South Africa are cattle, sheep, goats, pigs and poultry. Table 2.4 shows the proportions of households owning livestock in Rantlekane and Mamone rural settlements in Limpopo Province and in the rural Mbashe area of the Eastern Cape Province, as reported by Baber (1996) and ARDRI (2002), respectively.
TABLE 2.4: Proportions of households owning livestock in two rural areas of South Africa

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Rural Mbashe, 2001 (ARDRI, 2002) (%)</th>
<th>Rantlekane &amp; Mamone, 1995 (Baber, 1996) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>60</td>
<td>54</td>
</tr>
<tr>
<td>Sheep</td>
<td>36</td>
<td>25</td>
</tr>
<tr>
<td>Goats</td>
<td>52</td>
<td>64</td>
</tr>
<tr>
<td>Pigs</td>
<td>73</td>
<td>8</td>
</tr>
<tr>
<td>Poultry</td>
<td>80</td>
<td>-</td>
</tr>
</tbody>
</table>

The proportions of households owning particular livestock in the rural areas of Rantlekane and Mamone were comparable to those in Mbashe except for pigs (Table 2.4). In both rural areas cattle and goats were owned by more than half of the resident households.

Schwalbach et al. (2001) reported the size of the average cattle herd of African livestock owners in South Africa to range between seven and 29 animals.

2.5 IRRIGATION

2.5.1 Irrigation and plant production

Houk as cited by Goldberg, Gornat, and Rimon (1976:xxii), defines irrigation as the controlled application of water to arable lands to supply crop water requirements not satisfied by rainfall. Technikon Pretoria (2000) defines irrigation as the application of water to the soil for one or the following reasons:
(i) To supply water to the plant in order to obtain optimal growth;

(ii) To create a cooler micro-climate for the crop, that will enhance crop growth and quality of produce;

(iii) To reduce frost hazard;

(iv) To leach out and dilute of salts; and

(v) To alleviate the mechanical resistance of dry soils in order to improve root growth.

Pair, Hinz, Reid and Frost (1983:106) pointed out that the primary purpose of irrigation is to provide a soil environment that will permit the germination of seeds, the emergence of young plants, the development of the root system of plants, and the supply of water to plant for consumptive use. For plant growth to proceed optimally, the soil water status must be maintained in a range that permits absorption of water by plant roots at a rate that matches transpiration losses (Pair et al., 1983:106). In addition, the soluble salt content in the root zone must not limit plant growth and water absorption. This implies that in addition to the water applied to satisfy crop requirements, water must also be applied to leach salts. These are the important factors that need to be considered when evaluating irrigation requirements. Other factors that should be considered include adequate aeration of the soil and the maintenance of favourable soil temperatures (Pair et al., 1983:106).

Crops have varying irrigation water requirements. The irrigation requirement of a crop is the amount of water that needs to be applied in addition to precipitation to maintain the desired soil water status and salinity level in the rooting zone during the cropping season (Pair et al., 1983:107). It is usually expressed in mm for a given period of time. The irrigation requirement is affected by evapotranspiration rate, which, in turn, is influenced
by a number of factors, including leaf area index, stage of growth of the crop, climate, and soil (Goldberg, Gornat, & Rimon, 1976:68-70 and Pair et al., 1983:107).

2.5.2 Smallholder irrigation in South Africa

In South Africa small-scale irrigated farming covers an area of about 100 000 ha of land (International Programme for Technology and Research in Irrigation and Drainage, 2000). The total irrigated area of South Africa covers about 13 million ha. According to De Lange (1994 2-10) and Du Plessis and Van Der Stoep (2001:iv), small-scale irrigation farmers can be classified into four categories in terms of their water supply:

(i) Independent farmers: These are farmers who grow crops on land that is not part of an irrigation scheme, but which usually does not belong to farmers either. They have their own source of irrigation water (dam, borehole, or river) and are responsible for the water supply and infrastructure (obtaining, installing and maintaining pumps, pipelines and irrigation systems). They are not subsidised by government, but may have loans. Farm size varies widely.

(ii) Scheme farmers: These are farmers growing and irrigating crops on an irrigation scheme where they share a water source, infrastructure and sometimes irrigation equipment. These schemes are usually subsidised by government or by a funding agency. Farm sizes range from 0.1 ha to 10 ha.

(iii) Vegetable garden (food plot) farmers: These are farmers who are usually found in community gardens, and who have very small plots (for example, 10 m x 10 m) and who share a water source and equipment.
Backyard farmers: These farmers utilize their residential sites for growing vegetables. They are working in a group. They have access to water for domestic purposes and allocate some of this to farming. This water is often municipal.

South Africa’s small-scale irrigators currently use a wide variety of irrigation technology, depending on the category to which they belong (De Lange, 1994:2-10). De Lange (1994:2-4) reported that farmers in irrigation schemes used flooding, sprinklers, centre pivots, and micro-irrigation. Garden farmers used buckets, hosepipes with a tap stand, and furrow-irrigation to irrigate their crops. According to Crosby, De Lange, Stimie and Van Der Stoep (2000:1.9-1.10), sprinkler-irrigation is used most commonly on “modern” irrigation schemes, while an indigenous system of short furrows is very popular and used widely on older schemes, in community gardens, and in backyards. The International Programme for Technology and Research in Irrigation and Drainage (2000) also reported that irrigation technology used by South African small-scale farmers was limited to sprinkler and furrow irrigation. An investigation by Crosby et al. (2000:1.9-1.10) found that the use of micro-irrigation was limited to the production of fruit trees by independent smallholders.

2.5.3 Micro-irrigation

According to Du Plessis, Van Averbeke and Van Der Stoep (2001:1), micro-irrigation is known to be an efficient way of applying water to crops. Consequently, it has been presented as a way to assist South Africa in meeting its future water requirements. According to Du Plessis et al. (2001:59), micro-irrigation is a collective term for irrigation
with drippers (drip-irrigation) and micro sprayers (micro-spray irrigation). In both cases, only part of the soil surface is normally wetted. Irrigation takes place regularly and short cycles are followed. The discharge of the emitters is relatively low compared to other types of irrigation. Micro-irrigation requires low operating pressures.

Drip-irrigation is the precise, slow application of water as discrete, continuous drops, through mechanical devices called emitters (drippers or applicators) located at selected points along water delivery lines (Merriam & Keller, 1979:8 and Pair et al., 1983:528). Emitters dissipate the pressure in the pipe distribution network by means of either a small diameter orifice or a long flow path. The low water pressure allows for low discharge rates.

In drip-irrigation, the objective is to frequently supply each plant with sufficient water to meet evapotranspiration demand (Pair et al., 1983:528). The advantages of drip-irrigation include improved application and distribution efficiency, improved water control, enhanced crop response, reduced weed growth, improved fertilizer application efficiency, potential usage of saline water, and reduced energy requirement. Possible disadvantages of the drip irrigation system are clogging, salinity build-up, and restricted soil water distribution (Pair et al., 1983:528).

2.5.4 The use of wastewater for irrigated crop production

Increasing volumes of domestic, hospital and industrial wastewater are being produced around the world (Buechler, Hertog & Van Veenhuizen, 2002). Part of this untreated wastewater is being used in the irrigation of crops. According to Buechler et al. (2002),
there are a variety of motives for using untreated wastewater for irrigation of crops. These are:

(i) In semi-arid and arid areas it is often the only source of water available and it is available throughout the year;
(ii) It is an inexpensive source of water; and
(iii) It often contains useful nutrients.

The sources of wastewater include rivers, city drainage canals, spouts from city sewage and drainage channels that drain onto the fields below, ponds, tanks, shallow wells, house drainage spouts and channels (Buechler et al., 2002). The composition of the wastewater varies according to its origin. There is storm and run-off wastewater, grey (domestic water from the kitchen and bathroom) and black (domestic water from the toilet, with urine and faeces) wastewater, industrial wastewater, hospital wastewater, and other institutional and commercial establishment wastewater. Industrial wastewater may contain pollutants, some of which are not acutely detrimental either for crops, the soil, or for the consumer, but over time may be damaging to either or all of these (Buechler et al., 2002). The current study is concerned with grey water only.

The use of untreated wastewater poses a serious health risk to consumers of wastewater-produced crops (Faruqui, 2002). According to Faruqui (2002) the health risk is related to microbiological water contamination from domestic water sources (not industrial pollution). Faruqui (2002) states that the main health risk arises when vegetable or salad crops, grown with untreated wastewater, are consumed raw. This practice is linked to cholera, typhoid, and faecal bacterial diseases, such as bacterial diarrhoea and dysentery among consumers of such food. There is further evidence that agricultural workers in
wastewater-irrigated fields and consumers of wastewater-irrigated produce are more likely to get intestinal helminths infections. These infections are due to *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), and *Ancylostoma duodenale* and *Nector americanus* (hookworms).

The International Water Management Institute (IWMI) in collaboration with the International Development Research Centre (IDRC) convened a meeting in Hyderabad, India in 2002 to review experiences with the widespread use of untreated wastewater in agriculture (Buechler et al., 2002). The focus was on the livelihoods of the poor, and health and environmental risks. The proceedings of this meeting led to the Hyderabad Declaration on Wastewater Use in Agriculture. The countries attending the Hyderabad meeting recognised that wastewater was a resource of increasing global importance in agriculture. With proper management, wastewater use was set to contribute significantly to sustaining livelihoods, food security and the quality of the environment. Without proper management, wastewater use posed a serious risk to human health and the environment. The signatories of the Hyderabad declaration declared that in order to enhance positive outcomes and minimise risks of wastewater use, feasible and sound measures needed to be applied. These included:

(i) Cost-effective and appropriate treatments suited to the end use of wastewater, supplemented by guidelines and their application.

(ii) Certain activities to take place where wastewater is insufficiently treated, and until treatment becomes feasible. These activities include the development and application of guidelines for untreated wastewater use that safeguard the livelihoods, public health and the environment; application of
appropriate irrigation, agricultural, post-harvest, and public practices that limit risks to farming communities, vendors, and consumers; and education, and awareness programmes for all stakeholders, including the public at large, to disseminate these measures.

(iii) Health, agriculture and environmental quality guidelines that are linked and implemented in a step wise approach.

(iv) Reduction of toxic contaminants in wastewater at source and improved management.

The signatories also declared that knowledge needs should be addressed through research to support the measures outlined above, and that institutional coordination and integration together with increased financial allocations were required (Buechler et al., 2002). The declaration strongly urged policy-makers and authorities in the fields of water, agriculture, aquaculture, health, environment and urban planning, as well as donors and private sector, to safeguard and strengthen livelihoods and food security, mitigate health and environment risks and conserve water resources by confronting the realities of wastewater use in agriculture, through the adoption of appropriate policies and the commitment of financial resources for policy implementation.

Figure 2.3 the depicts a decision-making process on locally appropriate health protection measures designed by Von Sperling and Fattal as cited by Drechsel et al. (2002).
Water treatment is possible

Alternative cropping areas and safe water sources can be allocated and are accepted (viable)

Yes

Microbiological water quality guidelines to be applied

Yes

Guiding treatment quality

In addition

Explore options for:
- On-farm water treatment
- Crop restriction
- Safer irrigation guidelines

No or in addition

Raise awareness on potential post-harvesting contamination among traders and authorities

Support clean water access in markets (vegetable refreshing) and appropriate sanitation facilities

No or in addition

Raise awareness on potential health risk among consumers

Farmer level

No or not Satisfying 2

Create awareness among farmers on potential health risks and explore with them viability and benefits of other protective measures

No

5

5a

Explore options for:
- On-farm water treatment
- Crop restriction
- Safer irrigation guidelines

6

No or in addition

5b

Improve protective clothing and reduce wastewater contact

No or in addition

Consumer level

6a

Teach safe food preparation at home

Increase consumers’ demand for safe food (crop certification)

6b

FIGURE 2.3: Flow diagram of a decision-making process aimed at reducing health hazards resulting from the use of wastewater for irrigation of crops (Von Sperling & Fattal cited by Drechsel et al., 2002)
The decision-making process in Figure 2.3 considered experiences in Ghana and elsewhere where wastewater is used directly or indirectly in the irrigation of crops, and where municipal wastewater treatment is not possible (Von Sperling & Fattal, cited by Drechsel et al., 2002). The elements influencing the decision-making process are summarised in Figure 2.3. The arrows in Figure 2.3 refer to the decisions themselves. The process is explained in what follows. For easy reference the decisions appearing in Figure 2.3 have been given a number.

Referring to Figure 2.3, where treatment of wastewater is possible, the microbiological guidelines must be applied (1). In addition to the microbiological guidelines, it is also critical to consider post-harvest contamination on markets (3). This can be avoided by the availability of clean water for vegetable handling, especially crop washing and “freshening up”, and general hygienic conditions for traders, such as the availability of sufficient sanitation facilities. Hygienic market conditions must be combined with education and awareness campaigns for traders and authorities. Established but often officially ignored informal vegetable markets, which often occur in upper class suburbs, must be considered also, and availability of clean water must be insisted on. After addressing the problem of post-harvest contamination on physical markets, risks to consumers should be reduced further by sensitising households about the health implications related to the use of polluted irrigation water and unhygienic produce handling (6). Recommendations need to consider local diets and food preparation behaviour and options. Improved vegetable washing and cooking can significantly reduce the risk of contamination through wastewater irrigation or post-harvest processes (6a). A related long-term target is to raise consumers’ demand and willingness to pay for safe food (6b). This could bring about awareness shifts among
traders, farmers and authorities also. Crop certification could become an option (Westcot cited by Drechsel et al., 2002).

Where the establishment or maintenance of a functional wastewater treatment facility is not a realistic option, the concerned authorities have several other options to reduce health risks to farmers and consumers (2). Allocation of alternative cropping areas or safer water from another source, such as groundwater, should be explored first. To enhance the likelihood of a successful search for alternatives, farmers should be involved in this exploration. If alternative land and safe water sources are available and acceptable to farmers, it might be possible to apply the microbiological guidelines (4), and the decisions applicable to when wastewater treatment is possible (decisions 3 and 6) as discussed earlier. If water quality cannot be guaranteed, awareness among farmers on the potential health risks and transfer of pathogens must be created. With them the viability and benefits of other protective measures that reduce the health hazard resulting from using wastewater (5) must be explored. There are two options to reduce the health hazard resulting from the use of wastewater. The first (5a) is to investigate the possibility for:

(a) Alternative irrigation technology and methods to reduce farmers’ exposure (e.g. during water fetching and application); crop contact (e.g. surface instead of overhead irrigation); and microbiological water contamination levels (e.g. through improved and better located wells).
(b) Crop selection and patterns taking market demand, cultural preferences and gender balance in cultivation or marketing into account; and
(c) On-farm water treatment options, such as simple sedimentation tanks, taking into account land-tenure arrangements, labour constraints and farmer’s interest and ability for on-site investments.
The alternative (5b) is to reduce the health hazard resulting from using water by improving protective clothing and reducing wastewater contact. After applying either of these two approaches it is still necessary to consider post-harvest contamination at market level (3) and other risks to consumers (6) as explained earlier.

Ouedraogo (2002) undertook a study in the city of Ouagadougou in Burkina Faso to determine the perceptions of market vegetable gardeners on wastewater with a specific focus on hygiene and disease. He found that wastewater was not perceived to be polluted or likely to cause illness. Gardeners believed that all foods could make one sick, depending on the “strength of the stomach” that received it. There was also another thinking that diseases depended on God, bad luck, and environmental change. The gardeners pointed out that there were no specific ailments for people that consumed vegetables irrigated with wastewater (Ouedraogo, 2002).

### 2.5.5 The Drum and Drip micro-irrigation system

The concept of the Drum and Drip micro-irrigation system was developed in 1994, in response to problems experienced by people living in arid areas, who could not grow vegetables because of a lack of irrigation water (Farming Systems Consulting Service, S.a.). This resulted in an investigation into the possibility of using recycled domestic water for irrigation. The results showed that recycled water had no detrimental effect on soil, and produced yields (Farming Systems Consulting Service, S.a.). To avoid contamination, recycled water has to be applied without making contact with the leaves of the vegetables. Drip-irrigation is a method that meets this requirement. According to the Farming Systems Consulting Services (S.a.) drip-irrigation prevents the possible spread of pathogens that might be contained in the recycled water to the...
leaves of the crops. The first model of the Drum and Drip micro-irrigation system was developed for use on a small circular parcel of land of about 110 m$^2$. It was constructed using a 210 l metal drum and 6 x 6 metre polyethylene pipes. The polyethylene pipes were perforated by means of a heated nail to construct drippers. A 1.5 mm braided nylon string was threaded through these perforations. A knot was made on both sides of the perforations to avoid that the string would slip out of the pipe. When the dripper was clogged, pulling the string from side to side unclogged the drippers (Farming Systems Consulting Services (S.a.). The ends of the dripper lines were folded back and tied off with wire. A stone-sand filter could be placed at the bottom of the drum to filter out coarse particles present in the recycled water, minimizing the problem of clogging of the drippers. This first model of the Drum and Drip micro-irrigation was called the Wagon Wheel Irrigation System (see Figure 2.4). The Wagon Wheel was modified to fit a rectangular shaped parcel of land (Fig 2.5). The size of plot under irrigation was reduced from 113 m$^2$ to 36 m$^2$.

![Diagram of the original (Wagon Wheel) version of the Drum and Drip micro-irrigation system](image)

**FIGURE 2.4:** The original (Wagon Wheel) version of the Drum and Drip micro-irrigation system
The Wagon Wheel system reportedly was able to produce up to 500 kg fresh vegetables per year using 600 l of water per week (Land Bank and Agricultural Research Council, S.a.). The potential of the rectangular system has not been determined yet.

Since their development, the two versions of the Drum and Drip micro-irrigation system have been introduced at several sites, including the Western Cape, the Northern Cape and the North West Province in South Africa, and also in Namibia, Zimbabwe, Ghana, Zambia, Kenya and Swaziland (Severin, 2000:6). In 1999, Severin (2000:4) evaluated 22 Wagon Wheel irrigation systems that were set up at various sites in the Western and Northern Cape between 1995 and 1999. The study looked into the durability of the systems and determined the impact of the use of the irrigation systems on the soils. He found that 15 out of the 22 systems were still in use in 1999. Of these
systems, nine had been installed in 1999 and six during the period 1995 to 1998. Severin (2000:45-46) reported that malfunction was the main reason for people to abandon their systems, but he did not indicate which components were problematic. Apart from malfunctioning of the systems, there were other reasons stated by participants who stopped using their systems (Severin, 2000:44-47). These were:

(i) Lack of irrigation water because grey water was available in quantities that were less than required; and
(ii) Users were no longer interested in vegetable production because of their historical background, which involved a tradition of livestock production.

On the impact of the irrigation system on the soil, Severin (2000:47) reported that the samples collected from planted rows of the Wagon Wheel (treatment) had higher organic carbon contents than samples collected from unplanted areas (control). The increase in organic carbon was attributed to the compost that was added by farmers during soil preparation and to the crop residues that were worked into the soil after harvesting (Severin, 2000:47). All farmers in the sample were aware of the importance of applying organic matter (Severin, 2000:47). Severin (2000:80) reported that salt accumulation did not occur in the cultivated soil, but pointed out that accumulation of salts over time was inevitable, since the water that was applied was too little to wash them out. Damage of crops by salts is said to be limited in drip irrigation, because salts have a tendency to move to the periphery of the wetted area (Barnstein & Francois as cited by Severin, 2000:38).
Tests of the uniformity of the flow rate of the emitters showed that the home-made emitters released water more rapidly than the commercial emitters when clean water was used, but the flow rate of the home-made emitters was much more variable. The variation in the flow rate of the home-made drippers was ascribed to the way these drippers were constructed. According to Severin (2000:73), it is very difficult to make holes of the same size using a heated nail. The variation in the sizes of the drippers has a negative impact on the distribution efficiency.

When using grey water, the commercial emitters retained the same rate of flow as with clean water but that of home-made emitters dropped to about 15 % of the rate measured when using clean water. No explanation for this phenomenon was provided. The American Society of Agricultural Engineers tolerates a maximum flow rate difference of 15 % (Polak, Nanes & Adhikari, cited by Severin, 2000:73). The difference in flow rate among home-made emitters was much higher than that.

2.6 ON-FARM EXPERIMENTATION

On-farm experimentation was established as part of the Farming Systems Research (FSR) approach to technology development (Swanson, 1993). The rationale was that if farmers could be involved in research they could contribute greatly to the design and development of appropriate solutions to their problems, and decide whether or not to adopt practices, because they stood to gain or lose most from the adoption process (Swanson, 1993).
According to Buhler et al. (2002:100) and Selener (1997:171-177), there are four types of on-farm experimentation. These include contractual, consultative, collaborative, and collegial on-farm experimentation.

In contractual on-farm experimentation researchers’ contract with farmers to provide land or labour. The aim of this type of on-farm research is to test and validate research findings obtained on research stations. According to Selener (1997:171), farmers do not actively participate in the research process of contractual on-farm experimentation. Instead, researchers generally design, implement, and evaluate the technology in the farmer’s fields, or they define the research agenda and design the trials, whilst farmers are allowed to comment on the outcomes of the experiments. The experimental designs used in this approach tend to be similar to those used on research stations. Because researchers bring technology from the experimental stations to the farm for testing and validation, farmers are not involved in technology generation (Selener, 1997:171).

In the consultative on-farm experimentation, researchers consult farmers about their problems. Researchers then develop solutions to these problems (Buhler et al., 2002 and Selener, 1997:172). Consultation of farmers at the beginning of the research process is primarily aimed at assisting the researchers in interpreting farmers’ circumstances, problems, or needs, and to arrive at experimental designs for trials, which often will not include active farmer participation in the initial stages of on-farm testing (Ashby as cited by Selener, 1997:172). The relationship between researcher and farmer is consultative. Researchers interview farmers about their problems and needs at the beginning of the process. Researchers make decisions as to appropriate solutions, design and implementing trials, and assume responsibility for all data
collection and analysis. According to Selener (1997:172), farmers may be allowed to participate in testing, validation and evaluation of the new technology developed on the experimental station, but on-farm experiments are conducted for the purpose of answering the scientific concerns of researchers about on-farm conditions. If farmers are allowed to evaluate the technology, this occurs after the outcomes of the on-farm tests are known. Consequently farmer responses tend to be well rehearsed and predictable to researchers and extension workers (Ashby as cited by Selener, 1997:172). Consultative on-farm experimentation is the last step in a research approach, which relies heavily on experimental station research, as on-farm trials are usually aimed at adapting a technology to farm conditions. Compared to contractual on-farm experimentation, where trials are solely controlled and conducted by researchers, this approach involves more interaction between researchers and farmers. However, researchers continue to control the research process and technology development. The farmers’ minimal involvement does not include making decisions on research agenda, trial implementation, or evaluation. Selener (1997:173) asserts that because farmers do not participate in the problem definition, the design of the experiments and the evaluation process, consultative on-farm experimentation is consistent with the transfer-of-technology model, and is therefore likely to result in agricultural practices and technologies that fail to meet farmers’ needs.

Collaborative on-farm experimentation involves the collaboration of farmers and researchers as partners (Buhler et al., 2002 & Selener, 1997:173). In this approach, they work together on problem definition, design, management, and implementation and evaluation of trials. In the early stages of the process, researchers and farmers discuss potential areas for collaborative research, and decide on joint decision-making and evaluation processes (Selener, 1997:173). By combining informal research by
farmers with formal testing procedures, indigenous knowledge and science-based knowledge are mixed to meet farmers’ needs. Ideally a collaborative relationship means balanced participation in, and control over the research process in order to achieve the objectives of farmers (Selener, 1997:174).

In the collegial approach, farmers are the main actors and decision-makers. They develop technology through a process that includes problem identification, trial design, the implementation of experiments, and the evaluation of results (Selener, 1997:174). The researchers’ role is to assure that the community’s local experimental capacity is fully utilized, and to link farmers to information and resources for which the community has expressed a need, but which are not available at local level (Buhler et al., 2002:100 & Selener, 1997:174). In the diagnostic phase, farmers identify the problems and needs they want to address. In the planning and design phase, they choose the technology, and decide how to test it. In the experimentation phase, they test and evaluate the technology. Finally, in the validation phase, farmers further test the technology that has been developed prior to dissemination.
CHAPTER 3
MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter provides an overview of the study area and reports on the materials and methods that were used to achieve the objectives of this study. The study employed two main research methods, namely a survey and on-farm experimentation. Ethical considerations pertaining to the study are dealt with in the final section of this chapter.

3.2 STUDY AREA

The study was conducted in the rural settlements of Sekuruwe and Ga-Molekane. These are situated in the Mokgalakwena Local Municipality, which is located in the Waterberg District Municipality of the Limpopo Province, formally known as Northern Province, of South Africa (see Figure 3.1). The two neighbouring settlements are located about 27 km north of the town of Mokopane, formally known as Potgietersrus, the main urban centre and administrative seat of Mokgalakwena Local Municipality.
FIGURE 3.1: Sekuruwe and Ga-Molekane form part of Mokgalakwena Local Municipality in the Limpopo Province (Map A) of South Africa (Map B)
The two villages are administered by ward councillors of the Mokgalakwena Local Municipality. In Ga-Molekane the tribal authority also operates. There is a headman (Ntuna) who reports to the Mapela Tribal Authority under chief Mapela.

In 2000, Sekuruwe and Ga-Molekane counted 767 and 459 residential sites, respectively. The majority of the people residing in the two settlements are Pedi, and they speak Northern Sotho. A small proportion consists of Shangaan and Ndebele.

Table 3.1 presents a selection of climatic variables applying to the Potgietersrus area, in which the two villages are found. The data in Table 3.1 are based on a record of 30 years that lasted from 1961 to 1990 (Weather Bureau, 1992).

The Potgietersrus area is best described as semi-arid. During the 30 years covered by climatic records the Potgietersrus area received a mean annual rainfall of 582 mm (Weather Bureau, 1992). Rainfall peaks during summer and is very low during the other seasons. The summer season tends to be cloudy, resulting in an average of about eight hours of sunshine per day, which is very low. Cloud conditions during summer limit evaporative demand. De Mey (2002) estimated the reference evapotranspiration in Potgietersrus to be lower during midsummer than during early and late summer.

The main limitation to irrigated vegetable production in the two villages is the lack of a reliable supply of surface water. At both sites there is a community borehole equipped with a diesel pump that transfers water into a communal reservoir, which supplies water to house taps or stand pipes. However, the diesel pumps do not operate on a regular basis because both communities fail to pay for operation and maintenance of
their pump. As a result, most of the time residents have to buy potable water from others who have private boreholes. In 2001, the price of 20 l of water was R0.50. Alternative water sources are springs, which are found at the two villages, the river at Ga-Molekane, and the harvesting of rainwater from roofs. Although the dry condition and the lack a reliable supply of domestic water in the two villages make year-round production of vegetables difficult, the temperature regime, which is moderate, is conducive for the production of various types of vegetables throughout the year. During the three decades covered by the records frost only occurred once, in June 1981 (Weather Bureau, 1992).
### TABLE 3.1: Climatic conditions at Potgierstersrus

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation (mm)</th>
<th>Daily temperature (°C)</th>
<th>Mean monthly relative humidity (%)</th>
<th>Mean monthly wind speed (km/day)</th>
<th>Mean monthly sunshine (hr/day)</th>
<th>Mean monthly radiation (MJ/m².day)</th>
<th>Mean monthly $E_t$ (mm/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>45 (29 yrs) 117</td>
<td>277 29.7 18.0 29.7 10.3 37.8</td>
<td>60.5</td>
<td>216.0</td>
<td>8.3</td>
<td>15.7</td>
<td>4.1</td>
</tr>
<tr>
<td>Feb</td>
<td>14 83 212</td>
<td>29.1 17.6 29.1 11.6 37.1</td>
<td>61.5</td>
<td>207.4</td>
<td>8.8</td>
<td>18.4</td>
<td>4.4</td>
</tr>
<tr>
<td>Mar</td>
<td>7 68 180</td>
<td>28.1 16.2 28.1 8.0 36.4</td>
<td>62.0</td>
<td>207.4</td>
<td>9.1</td>
<td>21.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Apr</td>
<td>1 35 76</td>
<td>25.9 13.2 25.9 5.3 35.0</td>
<td>60.5</td>
<td>216.0</td>
<td>9.4</td>
<td>23.5</td>
<td>5.1</td>
</tr>
<tr>
<td>May</td>
<td>0 9 48</td>
<td>23.7 9.1 23.7 2.1 32.6</td>
<td>57.5</td>
<td>207.4</td>
<td>11.1</td>
<td>26.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Jun</td>
<td>0 6 51</td>
<td>21.0 5.9 21.0 -1.3 28.2</td>
<td>56.5</td>
<td>198.7</td>
<td>11.1</td>
<td>26.5</td>
<td>4.9</td>
</tr>
<tr>
<td>Jul</td>
<td>0 2 27</td>
<td>21.4 6.0 21.4 0.6 28.0</td>
<td>54.0</td>
<td>207.4</td>
<td>11.6</td>
<td>27.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Aug</td>
<td>0 6 67</td>
<td>23.9 8.8 23.9 0.1 32.1</td>
<td>51.5</td>
<td>250.6</td>
<td>12.0</td>
<td>27.3</td>
<td>5.6</td>
</tr>
<tr>
<td>Sept</td>
<td>0 19 91</td>
<td>27.1 12.5 27.1 1.0 36.2</td>
<td>50.5</td>
<td>267.8</td>
<td>11.9</td>
<td>25.8</td>
<td>6.0</td>
</tr>
<tr>
<td>Oct</td>
<td>7 45 111</td>
<td>28.2 15.1 28.2 6.5 36.8</td>
<td>53.0</td>
<td>267.8</td>
<td>9.9</td>
<td>20.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Nov</td>
<td>17 88 183</td>
<td>28.3 16.4 28.3 7.5 38.5</td>
<td>57.5</td>
<td>267.8</td>
<td>8.4</td>
<td>16.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Dec</td>
<td>18 104 268</td>
<td>29.1 17.4 29.1 8.8 37.1</td>
<td>60.5</td>
<td>224.6</td>
<td>8.2</td>
<td>14.9</td>
<td>3.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>582</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Generally, the soils in the two villages are sandy and they have low organic matter content (see Table 3.2). This implies that irrigated vegetable production requires frequent irrigation, because sandy soils do not hold much water.

TABLE 3.2: Important chemical and physical properties of top soils in Sekuruwe and Ga-Molekane (after De Mey, 2002)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM (%)</td>
<td>0.94</td>
</tr>
<tr>
<td>CaCO$_3$ (%)</td>
<td>0.06</td>
</tr>
<tr>
<td>pH (H$_2$O)</td>
<td>5.7</td>
</tr>
<tr>
<td>pH (KCl)</td>
<td>4.9</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>8.8</td>
</tr>
<tr>
<td>Loam (%)</td>
<td>10.5</td>
</tr>
<tr>
<td>Sand (%)</td>
<td>80.7</td>
</tr>
</tbody>
</table>

According to Nyalungu (2002), Betterment Planning was implemented in Sekuruwe and Ga-Molekane during the late 1960s. New people arrived from elsewhere to occupy excess residential sites. At present, most households live in brick houses with corrugated iron roofs. Both villages are electrified.

Locally, employment is offered by the Potgietersrus Platinum Mine, at Ga-Molekane. Regionally, people may find work in the urban centres of Mokopane (Potgietersrus) and Polokwane (formerly known as Pietersburg). Some residents work in Gauteng Province, about 200 km south of Mokopane.
3.3 ON-FARM EVALUATION OF THE DRUM AND DRUM MICRO-IRRIGATION SYSTEM

This study employed consultative on-farm experimentation. In this approach, researchers interview farmers about their problems and needs at the beginning of the research process (Buhler et al., 2002 & Selener, 1997:172). Based on the analysis of the interviews, researchers design technologies in order to solve the problems that were identified. Selected technologies are then tested in farmers’ fields. During the process of technology testing researchers assume responsibility for implementation. Farmers’ participation, if any, tends to be inactive and follows on the instructions of researchers. The current study involved a larger degree of farmer participation than is usual in consultative on-farm research. During on-farm testing farmers were encouraged to make their own decisions on implementation and modification of the technology. A detailed explanation of the consultative on-farm experimentation appears in section 2.6 on page 35. The ensuing subsections (3.3.1 and 3.3.2) explain the consultative on-farm research approach as applied in the current study.

3.3.1 Problem identification, the search for a solution and its implementation

In 1997, Technikon Pretoria, Medunsa, University of the North, University of Venda, Technikon Northern Gauteng, and the Departments of Health and Welfare, and Education of the Limpopo Province established the Welfare, Health, and Education Consortium (WHEC). The aim of the WHEC was to carry out research and train communities in issues of health and welfare in the Limpopo Province (Albertse, 2003). In 1998, Technikon Pretoria’s Department of Food and Nutrition established the NutriGro research programme
to conduct research on nutrition problems experienced by rural and urban communities in South Africa. The NutriGro research programme proposed to conduct research on malnutrition in two rural settlements within the Limpopo Province. In consultation with the Department of Health and Welfare, (Sub-directorate of Nutrition) of the Limpopo Province, Sekuruwe and Ga-Molekane were selected as the study sites, because they met the population size requirements. NutriGro and the Sub-directorate of Nutrition obtained permission from residents of the two villages to conduct research, and employed ten local women (enumerators) to assist in data collection. These were selected from a group of women who had at least passed grade 12, and were 25 years or older. The selection criterion was the ability to read. The minimum age of 25 accommodated community norms, which consider people of this age or older to be old enough to discuss health issues with others.

In 1998, work started with an investigation into the rate of chronic malnutrition among or stunting children between the ages of one and two years old (Albertse, 2003). This investigation revealed that 19 % of the children aged 12 to 24 months old in the two villages were affected by stunting. The rate of children affected by stunting was higher in Sekuruwe (24 %) than in Ga-Molekane (14 %). According to Albertse (2003), the anthropometric study was followed by three case studies investigating the causes of stunting. These case studies investigated the care practices of children by their mothers or caregivers (Aryee, 2000), dietary intake of children and mothers (Amissah, 2000), and household food security (Erik & Albertse, 1999). After identifying the problems, and investigating the possible causes, the researchers started to search for ways to address the problem. The major factors related to stunting of children was found to be the lack of calcium, iron, and vitamins A and C, which could have been caused by the absence of fruit
and vegetables in their diets (section 1.1.1). The absence of vegetables was caused by dry conditions and lack of water for irrigation, preventing local households from growing their own vegetables, and by their limited ability to purchase fruit and vegetables because of poverty. This led to the formulation of a technological intervention consisting of vegetable production in home gardens by means of the Drum and Drip micro-irrigation system. The intervention was targeted at children, but women received it, because it was thought that their entire households, including the children, would consume the food produced by them in their home gardens. In a community meeting ten female volunteers were selected by the community to receive the intervention (Kellerman, 2003). The designer of the system, Mr. G. Albertse, installed the irrigation systems in the home gardens of the volunteers in August 2000. During installation, the participants were supplied with vegetable seedlings and chemical fertilizers to start their gardens. At the time of installation and planting, the designer advised participants on vegetable production and on the operation of the irrigation system. In addition to this advice, he presented two short follow-up training sessions in general vegetable production and propagation of vegetable seedlings.

The Drum and Drip micro-irrigation system that was installed in the gardens consisted of a 210 l drum, which was connected via a tap to a set of five polyethylene dripper lines with a length of 6 m. The drippers were constructed by perforating the polyethylene pipe with a hot nail. A piece of string was threaded through these perforations by means of a bag-needle. Knots on both ends of the string prevented it from slipping out. Regular pulling of the string from side to side helped to unclog the perforations. A stone-sand filter placed at the bottom of the drum filtered out the coarse particles present in the water, thus reducing clogging of the drippers. A detailed explanation on how the Drum and Drip
The irrigation systems were handed to participants on a loan basis. This was done to ensure that the irrigation system would be passed on to other interested women in cases where a recipient wished to terminate her participation. During the study, two of the original recipients terminated their participation and passed on their systems to other women. Finding a replacement was not difficult. In both cases participants knew people who had shown interest in the system, and who had inquired about where and how the system could be obtained. In Sekuruwe, a female recipient passed her irrigation system to a man before it was explained that participants were given the irrigation systems on a loan basis and that only women qualified. As a result the irrigation system could not be repossessed. Data obtained from this garden were included in this study.

3.3.2 On-farm monitoring and evaluation

The current study set out to evaluate on-farm, the suitability of the Drum and Drip micro-irrigation system to use for vegetable production in home gardens. Two aspects of the technology were monitored and assessed, namely the productivity brought about by the technology, and the adoption of the technology by participants.

Data collection in this study started in August 2000, and ended in September 2002. Data were collected in two phases. During the first phase, which lasted from August 2000 to September 2001, the researcher resided in Sekuruwe, and visited all participants once a week. During the second phase of data collection, which lasted from October 2001 to
September 2002, the researcher only visited the participants once per production season. Table 3.3 presents the two phases of data collection and the six production seasons. Visits were in accordance with a timetable constructed in consultation with each participant to ensure that participants were present during visits, and that visits did not inconvenience them.

TABLE 3.3: Phases in data collection and vegetable production seasons

<table>
<thead>
<tr>
<th>Phase</th>
<th>Production season</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>August 2000 to January 2001</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>February 2001 to May 2001</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>June 2001 to September 2001</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>October 2001 to January 2002</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>February 2002 to May 2002</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>June 2002 to September 2002</td>
</tr>
</tbody>
</table>

The productivity of the irrigation system was monitored by means of records kept by participants. All participants were supplied with food scales with an accuracy of 20 g, to weigh produce whenever it was harvested. Diaries were used to enter yields and irrigation data. The participants were trained on how to use food scales and how to record irrigation information. In the two cases where the main participants were illiterate, other members of the households kept records. The data recorded by participants included fresh mass of harvested vegetables, harvesting dates, allocation of the produce to home consumption, donations and sale, time and amount of irrigation, and source of water used. The researcher also used the weekly visits to verify the records, and to copy the information that had been recorded. Leaving the responsibility of keeping records to the participants provided them with the freedom to harvest or irrigate their gardens whenever they wanted or were able to.
Adoption of the intervention was monitored by means of observations complemented by interviews. During each field visit the gardens were observed. The adoption scenario envisaged by NutriGro researchers and the designer of the Drum and Drip micro-irrigation system technology (Albertse, 2000 & Farming Systems Consulting Services, S.a.) was used as the basis for the comparison between the envisaged and the observed conduct. Special attention was paid to understanding the reasons behind divergences from the envisaged adoption scenario. Elements of the envisaged adoption scenario were:

(i) Use of the Drum and Drip micro-irrigation system for irrigation,
(ii) Use of grey water for irrigation,
(iii) Application of 3 x 200 l of water per week,
(iv) Daily harvest and consumption of vegetables, whenever available,
(v) Preservation or selling of surplus vegetables,
(vi) Growing of the vegetables recommended by the NutriGro research team; and
(vii) Growing of vegetables throughout the year.

Table 3.4 shows the vegetables recommended by the NutriGro research team for planting in the home gardens.
TABLE 3.4: Vegetables recommended by the NutriGro research team for planting in the irrigated home gardens, and their contents of selected nutrients

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Iron (mg/100g)</th>
<th>Vitamin A (µgRE/100g)</th>
<th>Vitamin C (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbages</td>
<td>0.7</td>
<td>64</td>
<td>39</td>
</tr>
<tr>
<td>Swiss chard</td>
<td>1.8</td>
<td>300</td>
<td>41</td>
</tr>
<tr>
<td>Onions</td>
<td>0.8</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Beetroot</td>
<td>-</td>
<td>Trace</td>
<td>6</td>
</tr>
<tr>
<td>Pumpkins</td>
<td>1.4</td>
<td>292</td>
<td>8</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>-</td>
<td>62</td>
<td>19</td>
</tr>
<tr>
<td>Carrots</td>
<td>0.7</td>
<td>1 088</td>
<td>8</td>
</tr>
<tr>
<td>Green peppers</td>
<td>2.6</td>
<td>290</td>
<td>140</td>
</tr>
</tbody>
</table>

Whenever a divergence from the envisaged adoption scenario was observed, the participants were asked why they had decided to do things differently. These sessions took the form of friendly conversations that were appreciative of the initiatives and opinions of participants, and during which the notion that gardeners should feel free to do things their way was re-enforced. Notes taken during the conversation were transcribed in full upon arrival in the room where the researcher was residing. These texts are presented in Appendix C.

An exit interview was conducted with each participant at the end of the data collection period. The objective of the exit interview was to obtain a synthesis of the views of each participant about the technological intervention. Exit interviews are a recommended practice in on-farm research (Norman et al., 1997:149).

The content of the texts was coded. Issues related to the technology intervention that emerged from the texts were selected as topics or codes (Poggenpoel, 1998). Codes are
tags or labels, which assign units of meaning to information compiled during the study. Codes are usually attached to parts of texts of varying size. They may be words, phrases, sentences or whole paragraphs, and may be connected or unconnected to a specific setting (Miles & Huberman, 1994:56). When coding, the texts were read and different segments of the texts were assigned to appropriate codes by highlighting them with a particular colour. The coded data were then read in order to identify themes and to categorize segments of texts with similar meanings. The codes, themes and categories emerging from the texts are presented in Appendix D.

3.4 SURVEY

In order to describe the context in which the introduction of the Drum and Drip micro-irrigation system occurred, the livelihoods of local households, and the role agriculture plays in these livelihoods, were investigated by means of a livelihoods survey.

3.4.1 Sampling

Prior to sampling, maps of both villages, drawn by Eskom, showing the residential sites, were obtained from the local electricity committees. There were 459 sites in Sekuruwe and 757 in Ga-Molekane. Most sites were residential, but some were allocated to buildings used for business or public community functions, and some were vacant. Vacant and non-residential sites were removed from the sampling frame. In Sekuruwe there were 28 sites that were vacant or non-residential, leaving a total of 431 occupied residential sites, which constituted the sampling frame (see Table 3.5). In Ga-Molekane 31 sites were vacant or
non-residential, leaving a total of 734 occupied residential sites, which was the sampling frame (see Table 3.5).

The sampling unit was an occupied residential site. The unit of analysis was a household. In selecting the sample, it was assumed that each residential site was occupied by a single household. Fieldwork showed this assumption to be true. A 10 % sample was selected in each village. Systematic sampling, a probability sampling method, was used to select 46 and 75 households in Sekuruwe and Ga-Molekane, respectively. Within limits, probability sampling allows for the generalisation from sample to population (Leedy & Omrod, 2001:211).

### TABLE 3.5: Categorisation of sites in the villages of Sekuruwe and Ga-Molekane (2001)

<table>
<thead>
<tr>
<th>Use</th>
<th>Sekuruwe</th>
<th>Ga-Molekane</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupied residential sites</td>
<td>431</td>
<td>734</td>
<td>1 165</td>
</tr>
<tr>
<td>Schools</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Churches</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Shops</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Vacant sites</td>
<td>10</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Abandoned</td>
<td>7</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total number of sites</strong></td>
<td><strong>459</strong></td>
<td><strong>767</strong></td>
<td><strong>1 226</strong></td>
</tr>
</tbody>
</table>

Systematic sampling was carried out in accordance to the procedures explained by Neuman (1997:211-212). Practically, the 431 occupied residential sites appearing on the map of Sekuruwe were numbered, from 1 to 431. The sampling interval was obtained by dividing the population size (N = 431) with the sample size (n = 46), yielding a sampling interval of 9.3, which was reduced to 9. A number between 1 and 9 was selected randomly to obtain the first sampling unit from the residential sites numbered 1 to 9. In the case of Sekuruwe
4 was selected. Subsequent units were obtained by adding the sampling interval of 9 to 4 (13, 22, 31, …) until 46 units were obtained. A similar procedure was followed to select the 75 residential sites out of 734 occupied residential sites in Ga-Molekane. In both villages, the twelve households that participated in the evaluation of the Drum and Drip micro-irrigation system were added to the sample, increasing the sample size from 121 to 133 households. During data capturing, two questionnaires were excluded from analysis because of the poor quality of the data. This resulted in a total sample of 131 households.

3.4.2 Survey instrument

A modification of the interview schedule developed by the Agricultural and Rural Development Research Institute at the University of Fort Hare for the collection of socio-economic information in rural areas of the Eastern Cape was used as the survey instrument (Van Averbeke et al., 1998). A copy of the interview schedule is presented in Appendix B. The interview schedule sought information on the demographic characteristics, land and agriculture, sources of income in cash and kind, and expenditure of the households in the sample. The survey involved face-to-face interviews. Closed and open-ended questions appearing in the interview schedule were read to the respondents in their mother tongue. The responses were recorded on the schedule. The researcher, who has a working knowledge of all three languages spoken by residents, conducted all the interviews. In addition, two enumerators trained by NutriGro assisted with the interviews. These enumerators were fluent in SePedi, the dominant language in the two settlements, and had a working knowledge of Tsonga and isiNdebele.
3.4.3 Fieldwork

The survey was carried out during the period January to August 2001. During this period, households contained in the sample were located, and interviews were conducted during the first visit. In cases where members of households in the sample were not present on three successive visits, the neighbour living on the right-hand side when facing the front door of the house was selected as a replacement. This was necessary in five cases in Sekuruwe and in fourteen cases in Ga-Molekane. The main reason for the absence of people from their homes was long-term migration to urban areas.

Only adult members of households (persons more than 15 years old) were considered for the interview. In cases where no person was available to provide confident responses to all questions, an appointment was made for the conduct of a second interview with an appropriate member of the household. In most cases female spouses of heads of households were interviewed. This was the case in 36 of the 46 interviews in Sekuruwe and 60 of the 75 interviews in Ga-Molekane. In all other cases, knowledgeable adult members of the households were the respondents.

Before commencing with the interview, respondents were informed about the purpose of the interview and their consent to participate was requested. In cases where a household refused to be interviewed, the neighbour living on the right-hand side was used as a replacement. In Sekuruwe two households refused to be interviewed. In Ga-Molekane there were no refusals.
When collecting data on income generated from agriculture, the containers used to report yields of produce were identified, in each household. Mostly, maize meal bags and buckets (20 l and 4 l) were used to report yields. The containers were filled with the particular produce and weighed. This enabled estimation of yields based on estimates of the number of containers respondents reported to have obtained. The monetary value of produce was obtained by multiplying the mass of produce by the average price that was being charged in the village per unit mass of the produce.

Table 3.6 shows a list of agricultural produce, the containers used to measure quantities of each produce, and the average price charged per unit mass at the time of the survey.

When collecting data on food purchases, respondents were asked to list the types and quantities of food they usually purchased on a monthly basis, and where these were purchased. The retailers where residents purchased their food were visited during the period of the survey, and prices were recorded to enable accurate estimates of food expenditure.
TABLE 3.6: Agricultural products, containers used for particular products and their mass contents, and prices of products in Sekuruwe and Ga-Molekane (2001, n = 131)

<table>
<thead>
<tr>
<th>Agricultural product</th>
<th>Containers or units used in</th>
<th>Mean mass of produce in containers</th>
<th>Price per unit</th>
<th>Price per kg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize (dry grain)</td>
<td>bag</td>
<td>80 kg</td>
<td>R80</td>
<td>R1.00</td>
</tr>
<tr>
<td></td>
<td>half a bag</td>
<td>40 kg</td>
<td>R40</td>
<td>R1.00</td>
</tr>
<tr>
<td></td>
<td>20 l / bucket</td>
<td>20 kg</td>
<td>R20</td>
<td>R1.00</td>
</tr>
<tr>
<td></td>
<td>half of a 20 l / bucket</td>
<td>10 kg</td>
<td>R10</td>
<td>R1.00</td>
</tr>
<tr>
<td>Maize (fresh cobs)</td>
<td>1 cob</td>
<td>0.5 kg</td>
<td>R0.50</td>
<td>R1.00</td>
</tr>
<tr>
<td>Bambara groundnuts</td>
<td>4 l / bucket</td>
<td>6 kg</td>
<td>R10.00</td>
<td>R1.70</td>
</tr>
<tr>
<td>Beans (grain)</td>
<td>4 l / bucket</td>
<td>6 kg</td>
<td>R13.00</td>
<td>R2.16</td>
</tr>
<tr>
<td>Beans (green)</td>
<td>4 l / bucket</td>
<td>2 kg</td>
<td>R3.00</td>
<td>R1.50</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>4 l / bucket</td>
<td>6 kg</td>
<td>R10.00</td>
<td>R1.70</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>bag</td>
<td>13.5 kg</td>
<td>R22.00</td>
<td>R1.62</td>
</tr>
<tr>
<td>Pumpkin green</td>
<td>1</td>
<td>0.3 kg</td>
<td>R0.40</td>
<td>R0.12</td>
</tr>
<tr>
<td>Watermelon</td>
<td>bag</td>
<td>21.2 kg</td>
<td>R21.00</td>
<td>R0.99</td>
</tr>
<tr>
<td>Sweet reeds</td>
<td>Bunches</td>
<td>-</td>
<td>R2.50</td>
<td>R0.25 each</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>4 l / bucket</td>
<td>8 kg</td>
<td>R7.00</td>
<td>R0.88</td>
</tr>
<tr>
<td>Stock melons</td>
<td>3 in a bag</td>
<td>22 kg</td>
<td>R6.00</td>
<td>R0.27</td>
</tr>
<tr>
<td>Gourds</td>
<td>1</td>
<td>0.7 kg</td>
<td>R0.80</td>
<td>R1.14</td>
</tr>
<tr>
<td><strong>Livestock</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>1</td>
<td>-</td>
<td>R15.00</td>
<td>-</td>
</tr>
<tr>
<td>Milk</td>
<td>2 l</td>
<td>-</td>
<td>R5.00</td>
<td>R2.50 per l</td>
</tr>
<tr>
<td>Goat</td>
<td>1</td>
<td>-</td>
<td>R165.00</td>
<td>-</td>
</tr>
<tr>
<td>Sheep</td>
<td>1</td>
<td>-</td>
<td>R360.00</td>
<td>-</td>
</tr>
<tr>
<td>Cattle</td>
<td>1</td>
<td>-</td>
<td>R2000.00</td>
<td>-</td>
</tr>
<tr>
<td>Duck</td>
<td>1</td>
<td>-</td>
<td>R20.00</td>
<td>-</td>
</tr>
<tr>
<td>Pig</td>
<td>1</td>
<td>-</td>
<td>R120.00</td>
<td>-</td>
</tr>
<tr>
<td>Pigeon</td>
<td>1</td>
<td>-</td>
<td>R6.00</td>
<td>-</td>
</tr>
<tr>
<td>Guinea fowl</td>
<td>1</td>
<td>-</td>
<td>R14.00</td>
<td>-</td>
</tr>
</tbody>
</table>
3.4.4 Data analysis

The process of data analysis started by coding the data, and was followed by their capture on a spreadsheet using Microsoft Excel (Neuman, 1997:295). After capturing, the data were subjected to analysis using descriptive statistical analysis or by means of graphs, tables and charts. The data were also analysed statistically using Statistical Analysis Software ® version 8.01, statistical package (SAS Institute Inc, 2000).

Income data were subjected to a poverty analysis, using the absolute poverty line method (Carter and May, 1999). The unit for analysing poverty was a household. In this study a household was defined as a unit of consumption, consisting of all the people who ate and slept under the same roof, sharing the same bundle of incomes to support their consumption (Monde et al., 2000). Household members who lived elsewhere but contributed to income, e.g. by remitting money, were excluded from the household when analysing poverty. These members were excluded because they did not utilize the income available to the rural household.

In order to draw a poverty line, the 1999 Household Subsistence Level of R1125.15 per month for a family of five consisting of two adults and three children in the Polokwane area was used (Potgieter, 1999). This amount (R1125.15) was converted to an adult equivalent value to remove the effects of household composition (size and age) (Carter and May, 1999). The following formula, presented by Carter and May (1999) was used to calculate the number of adult equivalents in a household:

\[ \text{Number of adult equivalents} = \frac{\text{Income}}{R1125.15} \]
ADEQ = \((A + \frac{1}{2}C)^{0.9}\), whereby,

- ADEQ = Number of adults equivalents in a household
- A = Number of adults in the household (people aged 15 years and older)
- C = Number of children in the household (people younger than 15 years old)
- 0.9 = A scaling factor which reflects that as household size increases less money per individual member is required to achieve a particular living standard.

The poverty line per adult equivalent was calculated by dividing the household subsistence level of R1125.15 by the number of adult equivalents for a household of five (two adults and three children), which formed the basis of the household subsistence level value. The poverty line that was obtained was R364.13 per adult equivalent per month. This was the minimum monthly income a single adult living in Polokwane needed to meet his or her basic needs in 1999. This amount was adjusted to the period during which the survey was conducted (January to August, 2001) using the Consumer Price Index supplied by Statistics South Africa (2001). The poverty line for that period was R413.11 per adult equivalent per month. Households with monthly adult equivalent incomes higher than R413.11 were considered not poor, and those with monthly adult equivalent income lower than R413.11 as poor. The category of the poor was subdivided further into poor and ultra-poor. Households with monthly adult equivalent incomes of R206.56 or more (half of the poverty line of R413.11) were classified as poor. Households earning less than R206.56 per month per adult equivalent were classified as ultra poor.

The endowment and entitlement approach by Sen (1991) was used to develop livelihood categories. Entitlements refer to legitimate effective command over bundles of resources that are instrumental for achieving well-being (Sen, 1981:1). According to Hebinck
(2000), entitlements arise from endowments. Endowments are assets that may be tangible, such as land and labour, or intangible such as welfare and social rights, or familial reciprocity. Endowments form the basis for gaining access to commodity bundles, such as food, services and facilities (Carter and May, 1999). The following entitlement-based categories developed by Sen (1981:7) were used to group the households:

(i) Trade-based (income obtained through commodity exchanges),
(ii) Production-based (income earned from agricultural production),
(iii) Own-labour-based (income earned by selling labour), and
(iv) Inheritance and transfer-based (income given by others, including the state).

This analysis enabled determination of the role production-based entitlements (agriculture) played in the livelihood strategies of households in the two settlements.

3.5 NUTRITION ANALYSIS

To link the study to the societal problem of chronic malnutrition, the contributions of purchased food, food produced by means of dryland agriculture, and food produced in the irrigated gardens to the nutritional requirements of households were estimated. Three nutrients were considered, namely, iron, vitamin A and vitamin C. Amissah (2000:206-210) reported that calcium, iron, vitamin A, and vitamin C were deficient in the diets of the children in the study area. In one of the two food conversion tables that were used the calcium contents of foods were not listed. As a result, the adequacy of calcium in the local diets was not analysed for.
The data on purchased food were collected as part of the household expenditure section of the survey. Food items, which households usually purchased on a monthly basis, were enumerated. This was done to determine how much they spent on food per month, and to find out which foods they bought. Data on food obtained by means of agriculture were also collected during the survey, as part of the section on income. The data on food produced in the irrigated gardens were obtained from the records kept by the participants.

The food composition tables by Burgess et al. (1998:202-205) and Wolmarans, Langenhoven and Faber (1992:43-121) were used to estimate the nutrient contents of the different foods. Except in the case of meat, the nutrient contents of raw foods were used.

To determine the nutrient requirements of households, the Recommended Dietary Allowances (RDA) table presented by Burgess et al. (1998:29) was used. This RDA table contains daily individual nutrient needs for different age and sex groups. The members of each household in the survey sample were grouped into the appropriate age and gender categories proposed by Burgess et al. (1998:29). The total household requirement of a particular nutrient was the sum of the nutrient requirements of each member. Nutrients contained in purchased food, food produced by means of dryland agriculture, and food produced in the irrigated gardens were compared with the nutrient requirements of the households. In this study an intake of 67% or more of the RDA of a nutrient was taken as a critical level. Below this critical level, clinical symptoms may start occurring (Food and Nutrition Board, 1989). When intake reaches or exceeds this level clinical deficiency symptoms are no longer expected.
In the first part of the nutritional analysis all the 131 households that were surveyed were considered. The contribution of purchased food and food produced by means of dryland farming and livestock production to the nutritional requirements of the 131 households were determined. In this analysis, households were divided into three poverty categories. The data for a particular poverty category were the mean of all households contained in that category. In the second part, only 12 households (ten original recipients of the Drum and Drip micro-irrigation system and two replacements) were considered. For these 12 households, the contributions of food to the households nutritional produced in the gardens irrigated by the Drum and Drip micro-irrigation system, food produced by means of dryland agriculture and livestock production, and purchased food were analysed.

3.6 ETHICS

In the conduct of the study, the HSRC code of ethics of research published in 1997 was applied (HSRC, 1997). During the study informed consent was sought from all respondents and participants. At the beginning of each interview the objectives of the study were explained. Respondents were informed that their participation was voluntarily, that their responses would remain confidential, and that they had the right to end their participation at any time without the need to provide a reason. Assigning fictitious names or numbers in the transcription of the interviews maintained anonymity of respondents and participants. The research proposal was approved by the Technikon Pretoria Ethics Committee at its meeting of Monday 11 February 2002, and was assigned the reference number 2002/02/003.
CHAPTER 4
PRESENTATION OF RESULTS AND DISCUSSION OF THE
SURVEY AND ON-FARM MONITORING OF THE DRUM & DRIP
MICRO-IRRIGATION SYSTEM

4.1 INTRODUCTION

In this chapter, the results of the study are presented and discussed. The first part reports the results obtained in the survey. In the second part, the results of the monitoring and evaluation of the Drum and Drip micro-irrigation system are presented and discussed.

4.2 SURVEY RESULTS

In this section socio-economic characteristics of households residing in Sekuruwe and Ga-Molekane are presented and discussed. These include the demographics and sources of income and expenditure of households, their livelihoods, and the agriculture they practice.

4.2.1 Demography

The 51 households in the Sekuruwe sample contained a total of 317 people, and the 80 households in the Ga-Molekane sample 525 people. Of the people in the Sekuruwe sample 156 (49 %) were males and 161 (51 %) females. In the Ga-Molekane sample there were 238 (45 %) males and 287 (55 %) females.

The distribution of household size in Sekuruwe and Ga-Molekane is shown in Figure 4.1. Household size in the two villages ranged between one and 14. The mean and median of household size was six, and the mode five.
FIGURE 4.1: Frequency distribution of household size in Sekuruwe and Ga-Molekane (2001; n = 131)

Age and gender distribution of the people contained in the combined sample of the population of Sekuruwe and Ga-Molekane is presented in Figure 4.2. The sample contained a large number of people aged between 10 and 19 years old, relative to the other age categories. The presence of relatively few middle-aged and old people is typical for a young population, which is characterised by a population pyramid with a broad base and a narrow top. However, in the case of Sekuruwe and Ga-Molekane, the population pyramid was not quite that of a typical young population. There was a distinct narrowing at the base of the pyramid, caused by the presence of relatively fewer people in the category 0-9 years old than in the other youth categories (10-19 years old). ARDRI (2002) and Andersson and Galt (1998) reported a similar phenomenon in the Mbashe Municipality and the Wild Coast Region of the Eastern Cape Province, respectively.
The age distribution of the people contained in the Sekuruwe and Ga-Molekane sample of households differed from that of the Limpopo Province presented by Langethelm, Martins, and De J Van Wyk (2000:18), and illustrated in Figure 4.3.
FIGURE 4.3: Age distribution of people in Sekuruwe and Ga-Molekane, and in Limpopo Province as a whole (after Langethelm et al., 2000)

In Sekuruwe and Ga-Molekane the groups aged 10 to 14 and 15 and 19 were the largest. In Limpopo Province the two youngest age groups (0-4 and 5-9) were the largest. The population pyramid of Limpopo Province did not have a narrowing base, as was the case for the population of Sekuruwe and Ga-Molekane. A number of factors may be responsible for the low number of people aged between 0 and 4 in Sekuruwe and Ga-Molekane and some other rural areas of South Africa. The first might be urban migration of young women, taking their young children with them to the areas of migration. The population pyramid of Sekuruwe and Ga-Molekane shows relatively few women aged between 20 and 39 (see Fig 4.2). According to Calitz (1991:12), in the past males who had reached working age tended to migrate to the economic core areas of South Africa. Women were often left behind in the rural areas to take care of the children and the aged.
Repealing of legislation that restricted the free movement of people towards the end of the 1980’s brought about new migration patterns. Young women and their babies also moved to the cities and this may explain the low numbers of children in the age group of 0 to 4 in several rural areas of South Africa. Other factors may be an increase in infant mortalities, or a decline in the birth rates as a result of increasing use of contraceptives (Andersson & Galt, 1998).

The combined population of Sekuruwe and Ga-Molekane was categorized into an economically active and an economically inactive group on the basis of age. Persons in the age group of 15 to 64 years old were categorized as economically active. Persons younger than 15 years old or older than 64 years old were classified as economically inactive (Tait et al., 1996:76). Table 4.1 shows the frequency distribution of the economically active and inactive population in Sekuruwe and Ga-Molekane.

**TABLE 4.1: Economic status based on age of the population of Sekuruwe and Ga-Molekane (n = 131)**

<table>
<thead>
<tr>
<th>Status</th>
<th>Age group</th>
<th>Male (No.)</th>
<th>Male (%)</th>
<th>Female (No.)</th>
<th>Female (%)</th>
<th>Total (No.)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economically inactive</td>
<td>&lt; 15</td>
<td>132</td>
<td>31</td>
<td>141</td>
<td>32</td>
<td>273</td>
<td>33</td>
</tr>
<tr>
<td>Economically inactive</td>
<td>&gt; 64</td>
<td>20</td>
<td>5</td>
<td>43</td>
<td>10</td>
<td>70</td>
<td>8</td>
</tr>
<tr>
<td>Economically active</td>
<td>15 – 64</td>
<td>272</td>
<td>64</td>
<td>257</td>
<td>58</td>
<td>499</td>
<td>59</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>424</td>
<td>100</td>
<td>441</td>
<td>100</td>
<td>842</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.1 shows that 59 % of the total population in Sekuruwe and Ga-Molekane was categorized as economically active. About three out four people who were economically inactive were younger than 15 years old, and one out of four older than 64 years.
The rate of unemployment among the economically active people was determined using the expanded definition of unemployment, which considers all people who form part of the active population who are unemployed, either by choice or by a lack of jobs, as unemployed (Statistics South Africa cited by Lehohla, 2002). Table 4.2 presents the employment status of the economically active group in Sekuruwe and Ga-Molekane.

TABLE 4.2: Employment status of the economically active population of Sekuruwe and Ga-Molekane (2001, n = 499)

<table>
<thead>
<tr>
<th>Employment status</th>
<th>Sekuruwe (No.)</th>
<th>Sekuruwe (%)</th>
<th>Ga-Molekane (No.)</th>
<th>Ga-Molekane (%)</th>
<th>All (No.)</th>
<th>All (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed</td>
<td>58</td>
<td>31</td>
<td>80</td>
<td>25</td>
<td>138</td>
<td>28</td>
</tr>
<tr>
<td>Unemployed</td>
<td>88</td>
<td>47</td>
<td>139</td>
<td>45</td>
<td>227</td>
<td>45</td>
</tr>
<tr>
<td>Scholars</td>
<td>34</td>
<td>18</td>
<td>86</td>
<td>28</td>
<td>120</td>
<td>24</td>
</tr>
<tr>
<td>Retired or Pensioner</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Medically unfit</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>188</td>
<td>100</td>
<td>311</td>
<td>100</td>
<td>499</td>
<td>100</td>
</tr>
</tbody>
</table>

Both villages were characterized by high unemployment rates. Nearly half (45 %) of the economically active people in the two villages was unemployed in 2001. Unemployment in the two villages was higher than for South Africa as a whole, where 41 % of the economically active population was unemployed in February 2002 (Lehohla, 2002).

Figure 4.4 shows the gender distribution of heads of households in Sekuruwe and Ga-Molekane.
In the two villages 75 (57\%) of the households in the sample were headed by males and 56 (43\%) by females. Of the 75 male heads of households, 29 (35\%) did not spend most of their time at their homes. They either returned home once a month or less frequently. As a result, their female spouses were *de facto* heads, and had to take responsibility of most routine decisions. Woolard and Leibbrandt (2001) reported a similar situation in rural South Africa as a whole.

In South Africa, gender of the head of household has been related to the degree of poverty of the household. Budlender (1997) reported that female-headed households were generally poorer than male-headed households. Using the 1995 October Income Survey, Budlender (1997) found that female-headed households in South Africa had a mean monthly income of R1178 while male-headed households a mean of R3767 per month. The phenomenon that female-headed households are likely to be poor does not mean that
the children in these households are more likely to be affected by malnutrition. Studies in Ghana and Kenya have shown that malnutrition among preschool children was more severe in male-headed households than in female-headed households (Kennedy & Haddad, cited by Budlender, 1997). This apparent contradiction results from the roles that women play in households. According to Moser cited by Sadie and Loots (1998), women in Africa, including South Africa, have triple roles, namely reproductive, productive and community management. The reproductive role includes bearing and caring for children, preparing food, supplying water, collecting fuel, shopping, housekeeping, and family health care. The productive role involves the production of goods and services for consumption and trade, such as farming, employment, and self-employment in the informal sector. The community management role involves the collective organization of social events and services, including local political activities. When women are responsible for making the decisions on the allocation of household resources, they ensure that there is food for the whole family (Moser cited by Sadie & Loots, 1998). According to Lele et al. cited by Nqgaleni and Makhura (1996), women, when made responsible for making decisions on the use of income, tend to make sure that income contributes primarily to the family’s basic needs, such as food, clothing, education and other consumption. As a result, there is a high correlation between improvement in women’s economic status and family nutrition (Lele et al. cited by Nqgaleni & Makhura, 1996).

4.2.2 Sources of income

Households in Sekuruwe and Ga-Molekane earn their incomes from a range of sources. Table 4.3 shows the mean monthly contributions of various sources to the income of households in the two villages.
Incomes of households in Sekuruwe and Ga-Molekane depended mainly on their participation in the larger economy of South Africa (Table 4.3). Overall, this contributed 83% of total household income in cash and kind. State transfers in the form of old-age pensions and remittances were the two main sources of income. They each contributed 31% to total household income. Salaries and wages also made an important contribution of 19%, which was higher in Ga-Molekane (25%) than in Sekuruwe (6%). The contribution of the local economy to the mean monthly household income in the two villages was low, amounting to a mean of 17%. Agriculture and trade were the most important among the local sources of income. Agriculture contributed 7% to mean household income and trade 6%. Heavy reliance on old-age pension, remittances and salaries and wages appears to characterize many rural settlements in contemporary South Africa, because similar results were reported by Baber (1996) in Limpopo Province, May (1996) in KwaZulu Natal, and Monde-Gweleta et al. (1997) and Van Averbeke et al. (1998), ARDRI (2002), and Monde (2003) in the Eastern Cape.
## TABLE 4.3: Mean monthly income generated from various sources by households in Sekuruwe and Ga-Molekane

<table>
<thead>
<tr>
<th>Source of income</th>
<th>Sekuruwe (n = 51)</th>
<th>Ga-Molekane (n = 80)</th>
<th>All (n = 131)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monetary value</td>
<td>Proportion of total</td>
<td>Monetary value</td>
</tr>
<tr>
<td></td>
<td>(R)</td>
<td>(%)</td>
<td>(R)</td>
</tr>
<tr>
<td><strong>LARGER ECONOMY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old-age pensions</td>
<td>301.76</td>
<td>37.65</td>
<td>289.41</td>
</tr>
<tr>
<td>Disability grants</td>
<td>0.00</td>
<td>0.00</td>
<td>12.38</td>
</tr>
<tr>
<td>Child support grants</td>
<td>17.65</td>
<td>2.20</td>
<td>16.50</td>
</tr>
<tr>
<td>Remittances</td>
<td>289.78</td>
<td>36.16</td>
<td>290.59</td>
</tr>
<tr>
<td>Child maintenance</td>
<td>6.86</td>
<td>0.86</td>
<td>1.25</td>
</tr>
<tr>
<td>Salaries and wages</td>
<td>44.12</td>
<td>5.50</td>
<td>265.00</td>
</tr>
<tr>
<td><strong>Sub-total of larger economy</strong></td>
<td><strong>660.17</strong></td>
<td><strong>82.37</strong></td>
<td><strong>875.13</strong></td>
</tr>
<tr>
<td><strong>LOCAL ECONOMY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>51.59</td>
<td>6.44</td>
<td>78.27</td>
</tr>
<tr>
<td>Trade (buy &amp; sell)</td>
<td>32.50</td>
<td>4.05</td>
<td>68.66</td>
</tr>
<tr>
<td>Trade (make &amp; sell)</td>
<td>9.61</td>
<td>1.20</td>
<td>8.88</td>
</tr>
<tr>
<td>Housing</td>
<td>20.10</td>
<td>2.51</td>
<td>5.13</td>
</tr>
<tr>
<td>Services</td>
<td>0.00</td>
<td>0.00</td>
<td>1.67</td>
</tr>
<tr>
<td>Casual labour</td>
<td>6.86</td>
<td>0.86</td>
<td>6.63</td>
</tr>
<tr>
<td>Transport</td>
<td>18.82</td>
<td>2.35</td>
<td>1.50</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1.80</td>
<td>0.22</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Sub-total of local economy</strong></td>
<td><strong>141.27</strong></td>
<td><strong>17.63</strong></td>
<td><strong>170.72</strong></td>
</tr>
<tr>
<td><strong>Grant total</strong></td>
<td><strong>801.44</strong></td>
<td><strong>100.00</strong></td>
<td><strong>1045.85</strong></td>
</tr>
</tbody>
</table>
4.2.3 Food security

Incomes were assigned to the four food security entitlement categories proposed by Sen (1981) to identify on which entitlements household food security in the two villages depended most (see also section 3.4.4:57). The results are presented in Table 4.4.

TABLE 4.4: Categorisation of households in Sekuruwe and Ga-Molekane in accordance with the four food security entitlements identified by Sen (1981)

<table>
<thead>
<tr>
<th>Entitlement</th>
<th>Sekuruwe (n = 51)</th>
<th>Ga-Molekane (n = 80)</th>
<th>All (n = 131)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monetary value (R)</td>
<td>Proportion of total (%)</td>
<td>Monetary value (R)</td>
</tr>
<tr>
<td>Inheritances and transfers</td>
<td>616.05</td>
<td>76.87</td>
<td>610.13</td>
</tr>
<tr>
<td>Own labour</td>
<td>91.70</td>
<td>11.44</td>
<td>279.92</td>
</tr>
<tr>
<td>Trade</td>
<td>42.10</td>
<td>5.25</td>
<td>77.53</td>
</tr>
<tr>
<td>Own production</td>
<td>51.59</td>
<td>6.44</td>
<td>78.27</td>
</tr>
<tr>
<td>Total</td>
<td>801.44</td>
<td>100.00</td>
<td>1045.85</td>
</tr>
</tbody>
</table>

Two-thirds (64 %) of the mean income of households in Sekuruwe and Ga-Molekane was based on inheritance and transfer entitlements. Own labour entitlements were the second most important, with one-fifth (22 %) of income based on them. The trade-based and own production entitlements were relatively unimportant. About 7 % of income was based on trade, and 7 % on agriculture.

Households were grouped into food security mapping categories based on the entitlements on which their food security was based. Six categories were identified:
(i) *Welfare households* who derived at least 50% of their monthly income from claims against the State.

(ii) *Migrant households* who derived at least 50% of their monthly income from claims against kin.

(iii) *Wage-earning households* who derived at least 50% of their monthly income from selling their labour.

(iv) *Trader households* who earned at least 50% of their monthly income from exchange of commodities.

(v) *Farming households* who derived at least 50% of their monthly income from agriculture.

(vi) *Multiple-income households* who did not have a dominant source that contributed at least 50% to their total monthly income.

In Table 4.5 the results of this categorization of households in Sekuruwe and Ga-Molekane are presented.

**TABLE 4.5: Frequency distribution of households in the six food security mapping categories in Sekuruwe and Ga-Molekane (n = 131)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Sekuruwe (No.)</th>
<th>Sekuruwe (%)</th>
<th>Ga-Molekane (No.)</th>
<th>Ga-Molekane (%)</th>
<th>All (No.)</th>
<th>All (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare households</td>
<td>21</td>
<td>41</td>
<td>27</td>
<td>34</td>
<td>48</td>
<td>37</td>
</tr>
<tr>
<td>Migrant households</td>
<td>20</td>
<td>39</td>
<td>26</td>
<td>32</td>
<td>46</td>
<td>35</td>
</tr>
<tr>
<td>Wage-earning households</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>15</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Trader households</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Farming households</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Multiple-income households</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>100</strong></td>
<td><strong>80</strong></td>
<td><strong>100</strong></td>
<td><strong>131</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
As evident from Table 4.5, the majority (94 of 131) of the households in Sekuruwe and Ga-Molekane consisted of welfare and migrant households. About half (48 of 94) were welfare households, who relied mainly on claims against the State for their food security. The others (46 of 94) were migrant households who depended on claims against kin (remittances). Only three out of 131 households depended mostly mainly on own production entitlements (agriculture) for their food security. About 12 % of households relied primarily on own labour entitlements, and nearly 7 % on trade-based entitlements.

Table 4.6 presents the mean monthly incomes generated from various sources in the six categories of households in Sekuruwe and Ga-Molekane.

Table 4.6 shows that the households in the wage-earning category generated higher incomes than any other type of household. The mean income of the wage-earning category of households differed in a statistically significant way from the means of all other five categories of households. In terms of mean monthly income the wage-earning category of households was followed by the multiple income, farming, and welfare categories, respectively. Households in the migrant and trader categories tended to have the lowest income. Low incomes among households in the migrant category may be the result of migrant members only remitting part of their income, as they have to use part of their earnings to support their own living in the area to which they migrated. Low incomes among households in the trader category may be the result of the weak local economy within the two villages, limiting the income derived from (petty) trade (see also section, 4.3.2:69).
TABLE 4.6: Mean monthly household income generated from five principal sources of income by six food security mapping categories of households in Sekuruwe and Ga-Molekane (2000; n = 131)

<table>
<thead>
<tr>
<th>Household category</th>
<th>No. of households</th>
<th>Sources of income (in cash and kind)</th>
<th>Claims against the State</th>
<th>Claims against next of kin</th>
<th>Wages and salaries</th>
<th>Trade</th>
<th>Agriculture</th>
<th>All*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R</td>
<td>%</td>
<td>R</td>
<td>%</td>
<td>R</td>
<td>%</td>
<td>R</td>
</tr>
<tr>
<td>Welfare</td>
<td>48</td>
<td>632.67</td>
<td>75.67</td>
<td>114.06</td>
<td>13.64</td>
<td>16.35</td>
<td>1.96</td>
<td>15.21</td>
</tr>
<tr>
<td>Migrant</td>
<td>46</td>
<td>72.83</td>
<td>9.64</td>
<td>609.10</td>
<td>80.59</td>
<td>5.43</td>
<td>0.72</td>
<td>32.46</td>
</tr>
<tr>
<td>Wage-earning</td>
<td>17</td>
<td>235.63</td>
<td>12.29</td>
<td>86.40</td>
<td>4.51</td>
<td>1490.52</td>
<td>77.72</td>
<td>32.69</td>
</tr>
<tr>
<td>Trader</td>
<td>9</td>
<td>74.44</td>
<td>10.20</td>
<td>11.11</td>
<td>1.52</td>
<td>12.96</td>
<td>1.78</td>
<td>571.11</td>
</tr>
<tr>
<td>Farming</td>
<td>3</td>
<td>75.00</td>
<td>7.99</td>
<td>0.00</td>
<td>0.00</td>
<td>350.00</td>
<td>37.28</td>
<td>0.00</td>
</tr>
<tr>
<td>Multiple-income</td>
<td>8</td>
<td>374.44</td>
<td>35.21</td>
<td>388.89</td>
<td>36.57</td>
<td>113.33</td>
<td>10.66</td>
<td>51.56</td>
</tr>
<tr>
<td>All households</td>
<td>131</td>
<td>318.73</td>
<td>33.53</td>
<td>293.71</td>
<td>30.89</td>
<td>206.64</td>
<td>21.74</td>
<td>63.74</td>
</tr>
</tbody>
</table>

*Mean values that differ significantly from each other are distinguished by a different letter of the alphabet (Tukey’s LSD test at 5 % level of significance, p = <0.0001)
Table 4.6 shows that farming households were not entirely dependent on agriculture to generate their incomes. Instead, on average 45% of their income was earned from claims against the State such as old-age pensions, child support grants and disability grants, and from salaries and wages. The results show that to escape poverty, rural households in the study area opted for one of two livelihoods strategy options among the four identified by Swift and Hamilton (2001). These were to shift from reliance on agriculture to a wider range of economic activities, or to migrate partially or wholly to urban areas. The results also showed that the reliance of households in the study area on agriculture was very low. The seeking of higher output from agriculture as a livelihood strategy was rare. Shifting to a wider range of economic activities consisted mainly of claiming against the State, or finding work outside agriculture. May (1996), Baber (1996), Van Averbeke, et al. (1998) ARDRI (2002) and Monde (2003) also reported that having one or more members in wage-earning employment and making use of the social grants system operating in South Africa enabled many households to remain in the rural areas without engaging in any substantial agricultural activity or other local economic activity.

4.2.4 Poverty

The income data were subjected to a poverty analysis using an absolute poverty line (see section 3.4.4:54-57). Households were assigned to three poverty classes, namely non-poor, poor and ultra poor. The poverty line at the time of the survey was R413.11. Households generating a monthly income of R413.11 per adult equivalent or more were categorized as non-poor. Households with an income less than R413.11 were classified as poor. Ultra poor households were poor households with monthly incomes less than half of the poverty
line (less than R206.56). Table 4.7 shows the distribution of households in the three poverty classes.

**TABLE 4.7: Distribution of poverty in Sekuruwe and Ga-Molekane (2001, n = 131)**

<table>
<thead>
<tr>
<th>Poverty class</th>
<th>Sekuruwe</th>
<th>Ga-Molekane</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No of households (%)</td>
<td>No of households (%)</td>
<td>No of households (%)</td>
</tr>
<tr>
<td>Non-poor</td>
<td>14 27.45</td>
<td>16 20.00</td>
<td>30 22.90</td>
</tr>
<tr>
<td>Poor</td>
<td>15 29.41</td>
<td>33 41.25</td>
<td>48 36.64</td>
</tr>
<tr>
<td>Ultra poor</td>
<td>22 43.14</td>
<td>31 38.75</td>
<td>53 40.46</td>
</tr>
<tr>
<td>Total</td>
<td>51 100.00</td>
<td>80 100.00</td>
<td>131 100.00</td>
</tr>
</tbody>
</table>

Of all the households in the Sekuruwe and Ga-Molekane sample, only about one out of four (23%) was not poor. Three-quarters of the households had incomes below the poverty line, with 37% categorized as poor and 40% as ultra poor. Using the 1993 data of national living standards, Carter and May (1999) found that 52.1% of rural households were poor. This indicates that poverty was particularly widespread in the two villages of Sekuruwe and Ga-Molekane.

Reportedly, certain demographic characteristics are related to the poverty status of households. According to ARDRI (2002) large household size, and high dependency ratios are associated with poverty among households in the Mbashe Municipality. Table 4.8 presents a selection of demographic characteristics of households that have been related to poverty.
TABLE 4.8:  Relationships between the means of selected demographic variables and poverty among households in Sekuruwe and Ga-Molekane (2001, n = 131)

<table>
<thead>
<tr>
<th>Household demographics</th>
<th>Non-poor (n = 30)</th>
<th>Poor (n = 48)</th>
<th>Ultra poor (n = 53)</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household size</td>
<td>5.43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>No. of members in the economically active age group (&gt;15 and &lt; 65)</td>
<td>3.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.47&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>No. of children (&lt;15)</td>
<td>1.57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.72&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>No. of aged people (65+)</td>
<td>0.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.09</td>
</tr>
<tr>
<td>Dependency ratio</td>
<td>0.92&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.81&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Means values that differ significantly from each other are distinguished by a different letter of the alphabet (Tukey’s LSD test at 5% level of significance, p = <0.0001)

Table 4.8 shows that degree of poverty increased with household size, number of members in the economically active age group and number of children. The difference between the means of these three variables for the non-poor and the poor categories was not statistically significant, but the means for the ultra poor category were significantly different from those of the other two poverty categories, and statistically the differences were highly significant. The observed negative relationship between adult equivalent income of a household and the number of members it had in the economically active age group can be ascribed to the high level of unemployment, and the relative high number of scholars contained in this age category. As a result, containing a large number of economically active members did not imply that a household was generating a large income. In fact, when these economically active members were all unemployed, that household was likely
to be categorized as ultra poor. These factors also explain the absence of a relationship between degree of poverty and dependency ratio. Overall, household size was a good indicator of degree of poverty, but increasing household size was not associated with an increasing dependency ratio, as could be expected. Instead, the dependency ratio tended to be higher among smaller families where most of the non-poor were found. Non-poor households tended to have more aged members (older than 65 + years) than the other household categories. Old people contributed to household income by way of pensions. This confirmed and underlined the important role of old-age pensions in the livelihoods of rural households in contemporary South Africa, as pointed out by Monde-Gweleta et al. (1997), Van Averbeke et al. (1998), and Monde (2003).

According to Sen (1981:4), entitlements determine the ability of households to avoid poverty. The contribution made by the four entitlement categories to the monthly adult equivalent income of households grouped according to the three poverty classes was analyzed. Table 4.9 shows the contribution of the four entitlements to the incomes of the non-poor, poor and ultra poor households.

TABLE 4.9: Contribution of the four entitlements identified by Sen (1981) to the monthly incomes of the three poverty categories of households in Sekuruwe and Ga-Molekane (n = 131)

<table>
<thead>
<tr>
<th>Poverty class</th>
<th>Inheritances &amp; transfers (R)</th>
<th>Inheritances &amp; transfers (%)</th>
<th>Own labour (R)</th>
<th>Own labour (%)</th>
<th>Trade (R)</th>
<th>Trade (%)</th>
<th>Own production (R)</th>
<th>Own production (%)</th>
<th>Total (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Poor</td>
<td>751.58</td>
<td>73.53</td>
<td>137.33</td>
<td>13.44</td>
<td>63.33</td>
<td>6.20</td>
<td>69.92</td>
<td>6.84</td>
<td>1022.16</td>
</tr>
<tr>
<td>Poor</td>
<td>633.10</td>
<td>60.40</td>
<td>244.76</td>
<td>23.35</td>
<td>79.43</td>
<td>7.58</td>
<td>90.95</td>
<td>8.68</td>
<td>1048.24</td>
</tr>
<tr>
<td>Ultra poor</td>
<td>514.95</td>
<td>62.65</td>
<td>211.35</td>
<td>25.71</td>
<td>49.76</td>
<td>6.05</td>
<td>45.84</td>
<td>5.58</td>
<td>821.91</td>
</tr>
<tr>
<td>All</td>
<td>612.43</td>
<td>64.42</td>
<td>206.64</td>
<td>21.74</td>
<td>63.74</td>
<td>6.70</td>
<td>67.88</td>
<td>7.14</td>
<td>950.70</td>
</tr>
</tbody>
</table>
Overall, all three types of households relied for more than two-thirds of their monthly income on inheritance and transfer entitlements (Table 4.9). The poor and ultra poor households tended to rely more on own labour than the non-poor. All three types of households based similar proportions of their monthly incomes on trade and own production entitlements.

4.2.5 Expenditure patterns

The study also investigated how households spent their incomes. Table 4.10 presents the expenditure patterns of households categorized in the three poverty classes.
### TABLE 4.10: Expenditure patterns of households in Sekuruwe and Ga-Molekane according to poverty status (n = 131)

<table>
<thead>
<tr>
<th>Class</th>
<th>Non-poor (30)</th>
<th>Poor (48)</th>
<th>Ultra poor (53)</th>
<th>All (131)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monetary value</td>
<td>Proportion of total</td>
<td>Monetary value</td>
<td>Proportion of total</td>
</tr>
<tr>
<td>Food</td>
<td>373.67</td>
<td>40.21</td>
<td>391.40</td>
<td>40.67</td>
</tr>
<tr>
<td>Durables</td>
<td>119.10</td>
<td>12.82</td>
<td>150.35</td>
<td>15.62</td>
</tr>
<tr>
<td>Savings</td>
<td>126.17</td>
<td>13.58</td>
<td>121.40</td>
<td>12.62</td>
</tr>
<tr>
<td>Cleaning</td>
<td>70.13</td>
<td>7.55</td>
<td>71.85</td>
<td>7.47</td>
</tr>
<tr>
<td>Energy</td>
<td>64.87</td>
<td>6.98</td>
<td>58.65</td>
<td>6.09</td>
</tr>
<tr>
<td>Housing</td>
<td>18.37</td>
<td>1.98</td>
<td>49.44</td>
<td>5.14</td>
</tr>
<tr>
<td>Education</td>
<td>30.04</td>
<td>3.23</td>
<td>22.12</td>
<td>2.30</td>
</tr>
<tr>
<td>Transport</td>
<td>31.35</td>
<td>3.37</td>
<td>20.10</td>
<td>2.09</td>
</tr>
<tr>
<td>Medical</td>
<td>17.59</td>
<td>1.89</td>
<td>9.79</td>
<td>1.02</td>
</tr>
<tr>
<td>Maintaining goods</td>
<td>5.80</td>
<td>0.62</td>
<td>2.11</td>
<td>0.22</td>
</tr>
<tr>
<td>Agriculture</td>
<td>15.73</td>
<td>1.69</td>
<td>18.69</td>
<td>1.94</td>
</tr>
<tr>
<td>Church/M</td>
<td>12.31</td>
<td>1.32</td>
<td>8.34</td>
<td>0.87</td>
</tr>
<tr>
<td>Credit</td>
<td>0.00</td>
<td>0.00</td>
<td>2.60</td>
<td>0.27</td>
</tr>
<tr>
<td>Entertainment</td>
<td>24.95</td>
<td>2.69</td>
<td>12.44</td>
<td>1.29</td>
</tr>
<tr>
<td>Labour</td>
<td>7.69</td>
<td>0.83</td>
<td>12.20</td>
<td>1.27</td>
</tr>
<tr>
<td>Communication</td>
<td>11.40</td>
<td>1.23</td>
<td>10.94</td>
<td>1.14</td>
</tr>
</tbody>
</table>

**Total**

929.16          | 100.00        | 962.43      | 100.00          | 760.66      | 100.00          | 884.08          | 100.00          |
Among the expenditure categories in Table 4.10, food was found to be the most important. On average, households in Sekuruwe and Ga-Molekane spent 45% of their monthly income on food. Other important categories included durables, savings, cleaning materials, and energy. A notable difference in expenditure among the three groups of households was in terms of food. On average, ultra poor households spent 57% of their monthly income on food, whereas the poor and non-poor only spent about 40%. Other important differences in expenditure occurred in durables, savings, and transport. Ultra poor households spent relatively less on these expenditure categories than the non-poor and poor households. Monde et al. (2000), ARDRI (2002) and Monde (2003) reported similar expenditure patterns in the rural areas of Eastern Cape.

In Figure 4.5 the relationship between household income and relative expenditure on food is presented.

FIGURE 4.5: Relationship between household income (expressed in Rand per adult equivalent per month) and the proportion of total expenditure spent on food at Sekuruwe and Ga-Molekane in 2001 (n = 131)
Figure 4.5 shows that relative expenditure on food by rural households increased rapidly once their income fell below the poverty line of R413.11. A similar relationship was described by ARDRI (2002) and Monde (2003) for rural communities in the Eastern Cape, and respectively by Maswikaneng (2003) for a poor urban community near Pretoria.

4.2.6 Agriculture

In the two villages agriculture was practiced on three types of land, namely, residential, arable and rangeland. The residential sites in Sekuruwe and Ga-Molekane contained buildings, enclosures for livestock, and home gardens. In the ensuing discussion on the residential sites the space occupied by buildings is referred to as the built-up area, and the space used for other purposes as the yard. Figure 4.6 depicts a typical residential site in Sekuruwe and Ga-Molekane.

![Diagram of a typical residential site in Sekuruwe and Ga-Molekane](image)

FIGURE 4.6: A diagram of a typical residential site in Sekuruwe and Ga-Molekane
The size of residential sites in Sekuruwe and Ga-Molekane ranged between 1135 m$^2$ and 2600 m$^2$ and the mean was 2020 m$^2$. The size of the yard ranged from 616 m$^2$ to 2135 m$^2$ and the mean was 1448 m$^2$. In most cases part of the yard was used as a home garden for dryland cropping. The ten Drum & Drip micro-irrigation systems were set up in these home gardens.

Crop production in Sekuruwe and Ga-Molekane involved the cultivation of summer crops under rainfed conditions in the residential gardens and arable fields. The first spring rain occurring in October usually marked the start of the cropping season (selemo). During this time, some of the farmers incorporated crop residues and kraal manure into the soil. Planting started immediately after the first rains and all planting was completed by the end of December or early January. Towards the end of October people started collecting edible weeds (morogo) in their yards and fields. Part of the harvest of these weeds and the leaves of pumpkin and runner beans were preserved for use out of season. To make these preserves, the leaves were boiled and then dried in the sun. Figure 4.7 shows the duration of the cropping season and the time during which fresh edible weeds were available. The crop production period ended late April or early May, when the dry maize grain, and the pumpkin and melon fruits were harvested from the arable land and transported to the homesteads. At that time, some farmers selected seeds for the following cropping season. Dry maize was not stored. Instead it was exchanged for processed maize meal at local shops. In 2001, farmers obtained an 80 kg bag of maize meal when they handed in an 80 kg bag of maize grain and paid an additional R80.00. During that period the regular price of an 80 kg bag of maize meal was R160.00.
During the 2000/2001 growing season 126 (96 %) of the 131 households in the sample cultivated their home gardens. Crops grown included maize, groundnuts, runner beans, bambara groundnuts (*Vigna subterranean*), watermelons, sweet reeds, sweetpotatoes, pumpkins and gourds (*Lagenaria vulgaris*). Figure 4.8 shows the frequency distribution of households growing particular crops in their home gardens.
FIGURE 4.8: Relative frequency distribution of crops grown by households who cropped their residential gardens in Sekuruwe and Ga-Molekane (2000/2001, n = 126)

As evident from Fig 4.8, maize was the most important crop in Sekuruwe and Ga-Molekane. All households that cultivated their home gardens during the 2000/2001 growing season planted maize. Four out of five home gardeners grew runner beans and pumpkins, and three out of five groundnuts and sweet reeds. Other important crops were bambara groundnuts and sweet potatoes. Watermelons and gourds were grown by about one-third of the 126 gardeners. In Table 4.11 the quantities of different crops gardeners reportedly obtained during the 2000/01 cropping season are presented. The quantities of crops presented in Table 4.11 were estimated using the procedures described in section (3.4.3:53-55).
TABLE 4.11: Mean quantities of crops grown obtained in home gardens in Sekuruwe and Ga-Molekane during the 2000/2001 growing season (n = 126)

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. of households</th>
<th>Output (in kg)</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize (dry grain)</td>
<td>126</td>
<td>5 – 166</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Green maize (fresh mass of cobs)</td>
<td>126</td>
<td>9 – 110</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Beans (dry grain)</td>
<td>101</td>
<td>1 – 24</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Beans (fresh mass of green pods)</td>
<td>101</td>
<td>2 – 10</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Groundnuts</td>
<td>77</td>
<td>1 – 22</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Bambara groundnuts</td>
<td>56</td>
<td>2 – 36</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Pumpkins (ripe)</td>
<td>101</td>
<td>18 – 54</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Pumpkins (green)</td>
<td>101</td>
<td>1 – 5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Watermelon</td>
<td>41</td>
<td>10 – 65</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Sweet reeds</td>
<td>72</td>
<td>3 – 18</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Sweet potato</td>
<td>64</td>
<td>24 – 104</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Gourds</td>
<td>38</td>
<td>1 – 13</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Indigenous vegetables (green)</td>
<td>126</td>
<td>2 – 36</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Indigenous vegetables (dry)</td>
<td>126</td>
<td>2 – 14</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Households in the two villages commenced harvesting maize when it was still green, and continued to do so until the crop was mature. The same applied to beans and pumpkins. The respondents also harvested a range of indigenous leafy vegetables (*morogo*), such as *Cleome gynandra* (*lerotho*) and a range of species of *Amaranthus* (*thepe*). The leaves and flowers of pumpkin (*lephotsi*) and the leaves of runner beans (*dinawa*) also formed part of this category of vegetables. The quantities of leafy vegetables harvested and consumed fresh ranged from 2 to 40 kg per household with a mean of 4 kg. The mass of dried leafy vegetables harvested from the residential gardens ranged from 2 to 14 kg with a mean of 4 kg.
Of the 131 households in the sample, 106 (80 %) grew fruit trees in their yards. Types of fruit trees included citrus, peach, pomegranates (*Punica granatum*), mango, apricot, avocado, guava and apple. The number of fruit trees grown in the two villages ranged from one to 36 with a mean of six trees per yard. No data on quantities of fruit were collected.

Crops were also produced on the arable lands situated outside the residential area. Eighty-eight (67 %) of the households in the sample owned arable land. Seven of these held more than one field. The size of the land ranged between 0.4 ha and 3.6 ha, and the mean was 1.7 ha.

During the 2000/2001 growing season 73 % (64) of the households holding arable land cropped it. The 24 (27 %) households that did not cultivate their fields during the 2000/2001 growing season cited a lack of money to purchase production inputs and to hire a tractor for soil preparation as the main constraint. Other constraints included a lack of labour, fields that were too wet after rain, and fields that had dried out whilst waiting for tractors to prepare the soil. Some households had lost interest in crop production on a field scale because of poor yields in the past.

Field crops grown included maize, groundnuts, runner beans, bambara groundnuts, watermelons, sweet reeds (*Sorgum vulgare var. Saccharatus*), pumpkins, bitter watermelons (*Citrullus vulgaris*), and gourds. The only differences between home gardens and arable land in terms of crop selection was the absence of sweet potatoes from arable land, and the absence of stock melons from home gardens. Figure 4.9 presents the frequency distribution of crops grown by the 64 households that cultivated their fields during the 2000/2001 growing season.
FIGURE 4.9: Relative frequency distribution of crops grown by households that cropped their fields during 2000/01 in Sekuruwe and Ga-Molekane (n= 64)

As was the case in home gardens, all households that cultivated their fields grew maize. Runner beans and pumpkins were grown by more than 80% of the households, and about 75% grew gourds and watermelons. Groundnuts, bambara groundnuts and sweet reeds were also important crops, with more than 50% of the households growing them. Bitter watermelons were grown by 48%. Table 4.12 reports the quantities of crops grown in fields during the 2000/2001 growing season. The quantities reported in Table 4.12 are based on estimations (see section 3.4.3:53-55 for procedures).
### TABLE 4.12: Mean quantities of crops harvested on arable fields in Sekuruwe and Ga-Molekane during the 2000/2001 growing season (n = 64)

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. of households</th>
<th>Output (in kg)</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize (dry grain)</td>
<td>64</td>
<td>80 – 4320</td>
<td>520</td>
<td></td>
</tr>
<tr>
<td>Green maize (fresh mass of cobs)</td>
<td>47</td>
<td>7 – 94</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Beans (dry grain)</td>
<td>53</td>
<td>9 – 36</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Beans (fresh mass of green pods)</td>
<td>31</td>
<td>2 – 10</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Groundnuts</td>
<td>47</td>
<td>9 – 48</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Bambara groundnuts</td>
<td>33</td>
<td>3 – 21</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Pumpkins (ripe)</td>
<td>57</td>
<td>18 – 54</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Pumpkins (green)</td>
<td>33</td>
<td>1 – 5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Watermelons</td>
<td>48</td>
<td>25 – 140</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Sweet reeds</td>
<td>35</td>
<td>6 – 24</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Bitter watermelon</td>
<td>31</td>
<td>28 – 140</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Gourds</td>
<td>49</td>
<td>4 – 21</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Indigenous vegetables (green)</td>
<td>57</td>
<td>2 – 40</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Indigenous vegetables (dry)</td>
<td>64</td>
<td>5 – 25</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Maize grown on the arable lands was intended mainly for grain, whereas maize in the home gardens was primarily intended for green maize. For this reason, green maize harvested from the fields was relatively less important (ranging from 7 to 94 kg) than that harvested from the home gardens (ranging from 9 to 110 kg). The quantities of dry grain of maize harvested from the fields was substantially higher (a mean of 520 kg) than that harvested from home gardens (a mean of 49 kg). The same applied to watermelons.

Agriculture in Sekuruwe and Ga-Molekane also involved livestock production, which consisted of the rearing of micro, small and large livestock. Livestock was kept for home consumption, sales, and for ploughing (donkeys). Only cattle, sheep, and goats were sold. Cattle were slaughtered on special occasions. The reported mean frequency of slaughtering cattle was once in four years. The other livestock were slaughtered more frequently than cattle. On average, selling of cattle occurred every three years. Selling
consisted nearly always of distress sales to meet an urgent financial need. Few households milked their cattle. Those who did, used the milk for home consumption and sales. Most of the households who did not milk their cattle cited poor grazing as the reason. Those who milked their cattle only did so during summer, when there was enough water and grass.

Several types of micro livestock were kept in the two villages, namely chickens, pigeons, pigs, ducks, and guinea fowls. Figure 4.10 presents the proportion of households that kept a particular type of micro livestock.

![Relative frequency distribution of households keeping particular micro-livestock in Sekuruwe and Ga-Molekane (2001, n = 131)](image)

FIGURE 4.10: Relative frequency distribution of households keeping particular micro-livestock in Sekuruwe and Ga-Molekane (2001, n = 131)

A limited number of households kept micro-livestock. Chickens were the only species of note, being kept by 44 (34 %) of the 131 households. Pigeons, ducks, guinea fowls and
pigs were kept by no more than three of the 131 households in the sample. Table 4.13 shows the numbers of micro livestock kept by households.


<table>
<thead>
<tr>
<th>Micro livestock</th>
<th>No of keepers</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickens</td>
<td>44</td>
<td>1 – 45</td>
<td>11</td>
</tr>
<tr>
<td>Pigeons</td>
<td>3</td>
<td>10 – 20</td>
<td>15</td>
</tr>
<tr>
<td>Ducks</td>
<td>3</td>
<td>1 – 6</td>
<td>4</td>
</tr>
<tr>
<td>Pigs</td>
<td>2</td>
<td>1 – 2</td>
<td>2</td>
</tr>
<tr>
<td>Guinea fowls</td>
<td>1</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Irrespective of the species of micro livestock, the numbers kept by households in Sekuruwe and Ga-Molekane were small, suggesting that in most if not all cases the animals were kept for own use only.

Small and large livestock kept at the two villages included cattle, goats, sheep, and donkeys. Figure 4.11 shows the proportion of households that kept small and large stock in the two villages.
Figure 4.11 shows that few households kept small or large stock in the two villages. Seventeen (13%) of the 131 sampled households kept cattle, 15 (11%) kept goats, 2 kept sheep, and 2 kept donkeys. Table 4.14 shows the size of the individual livestock herds in Sekuruwe and Ga-Molekane.

<table>
<thead>
<tr>
<th>Micro livestock</th>
<th>No. of households</th>
<th>Herd size</th>
<th>Range</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>17</td>
<td>3 - 17</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td>15</td>
<td>1 – 21</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>2</td>
<td>20 – 25</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Donkeys</td>
<td>2</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>
The use of rangeland by local people was also investigated. According to Cousins (1999), Scogings et al. (1999) and Shackleton et al. (2001), rangeland contributes substantially to the food and economic security of rural households in South Africa. People in communal areas extract many resources from the rangeland including wood, thatch, clay, sand, and medicinal plants. Table 4.15 shows how households used rangeland in Sekuruwe and Ga-Molekane.

TABLE 4.15: Use of rangeland in Sekuruwe and Ga-Molekane (2001, n = 131)

<table>
<thead>
<tr>
<th>Utilization of rangeland</th>
<th>No. of households</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect firewood</td>
<td>108</td>
<td>82</td>
</tr>
<tr>
<td>Collect dry dung for cooking</td>
<td>48</td>
<td>37</td>
</tr>
<tr>
<td>Collect wild fruit</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>Grazing of livestock</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>Collect wood for kraals or other enclosures</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Collect grass for thatching</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Collect plants for medicinal purposes</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Collect wood for fencing</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Collect wood for building</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 4.15 shows that most of the households (82%) in Sekuruwe and Ga-Molekane used rangeland to collect firewood. The two villages are electrified, but many people still use firewood and dry dung for cooking, to minimize expenditure on paraffin or electricity. Other important uses of rangeland included the collection of wild fruit and the grazing of livestock. The most commonly collected wild fruit was marula, which was used to make an alcoholic beverage for home consumption and sale. About one out of ten households collected wood from the rangeland to make kraals or other enclosures, and about the same number used the rangeland to collect grass for thatching and medicinal plants.
Overall, the results indicated that agriculture practiced in Sekuruwe and Ga-Molekane did not differ much from the farming occurring in other rural areas of South Africa (Baber, 1996, Shackleton et al., 2001 and ARDRI, 2002). The utilisation of rangeland in the study area was similar to that in other parts (Shackleton et al., 2001), and so was the practice of mixed farming involving the production of crops in home gardens and arable fields, and the rearing of micro, small and large livestock. Food produced from agriculture was mainly used for home consumption, and small and occasionally large stock were sold or slaughtered. Crop production in Sekuruwe and Ga-Molekane involved the cultivation of summer crops under rainfed conditions. Important crops included maize, runner beans, groundnuts and pumpkins. According to Albertse (2000), households in the study area do not grow vegetables because of lack of water. In other areas where water is more abundant the growing of vegetables such as cabbages, Swiss chard, tomatoes, pumpkins, beetroot, onions, potatoes, and butternuts is quite common (Monde, 2000). The rate of cropping of arable land was higher in Sekuruwe and Ga-Molekane than in many other areas of South Africa. In the two villages combined, 73 % of households that held arable land cropped it during the 2000/2001 cropping season. Considering the dry conditions, this is surprisingly high when compared with the 47 % reported by Baber (1996) for Rantlekane and Mamone in Limpopo Province in 1993 and 1995, the 12 % reported by Mbuti (2000) in Koloni and Guquka (Eastern Cape Province) in 1997, and the 32 % reported by ARDRI (2002) in the Mbashe Local Municipality (Eastern Cape Province) in 1996.

Although the types of livestock kept in Sekuruwe and Ga-Molekane did not differ from those kept in other rural areas of South Africa, the proportions of households owning a particular type were less. The mean size of individual cattle herds in Sekuruwe and Ga-Molekane, which was eight animals, was near the lower limit of the mean herd size range
reported by Schwalbach et al. (2001) for South African smallholders in general, which was 7 to 29 animals.

4.3 ON-FARM MONITORING OF THE DRUM & DRIP MICRO-IRRIGATION SYSTEM

In this section, the results of monitoring the Drum and Drip micro-irrigation system are presented and discussed. Technical aspects, which were monitored during the first three production seasons are dealt with first. These included water use and crop yields. Issues of technology adoption conclude the section. Table 4.16 presents a summary of the cropping seasons in the 10 gardens.

TABLE 4.16: Cropping of gardens equipped with the Drum and Drip micro-irrigation systems during the period August 2000 to September 2002

<table>
<thead>
<tr>
<th>Production season</th>
<th>Period</th>
<th>Number of gardens cropped</th>
<th>Type of plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>August 2000 to January 2001</td>
<td>10</td>
<td>Vegetables</td>
</tr>
<tr>
<td>2</td>
<td>February 2001 to May 2001</td>
<td>9</td>
<td>Field crops</td>
</tr>
<tr>
<td>3</td>
<td>June 2001 to September 2001</td>
<td>10</td>
<td>Vegetables</td>
</tr>
<tr>
<td>4</td>
<td>October 2001 to January 2002</td>
<td>9</td>
<td>Vegetables</td>
</tr>
<tr>
<td>5</td>
<td>February 2002 to May 2002</td>
<td>1</td>
<td>Field crops</td>
</tr>
<tr>
<td>6</td>
<td>June 2002 to September 2002</td>
<td>7</td>
<td>Vegetables</td>
</tr>
</tbody>
</table>
4.3.1 Water use

The results on water use focus mainly on the sources of water that were used to irrigate the gardens. Of special interest was the use of grey water, because its use was expected to safeguard users against an increase in their normal water requirements.

The total quantities of water that were collected from the different sources and that were applied to the gardens are presented in Tables 4.17, 4.18 and 4.19 for the first, second and third production seasons, respectively.

TABLE 4.17: Total quantities of water collected from different sources and applied to the irrigated gardens in Sekuruwe and Ga-Molekane during the first production period, which lasted from August 2000 to January 2001 (n = 10)

<table>
<thead>
<tr>
<th>Garden</th>
<th>Source of water</th>
<th>Grey (l)</th>
<th>Grey (%)</th>
<th>Borehole (l)</th>
<th>Borehole (%)</th>
<th>Other (l)</th>
<th>Other (%)</th>
<th>Total (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>3600</td>
<td>52</td>
<td>-</td>
<td>-</td>
<td>3300</td>
<td>48</td>
<td>6900</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>4050</td>
<td>56</td>
<td>-</td>
<td>-</td>
<td>3150</td>
<td>44</td>
<td>7200</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>4300</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4300</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>-</td>
<td>-</td>
<td>7400</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>7400</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>-</td>
<td>-</td>
<td>6800</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>6800</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>3550</td>
<td>52</td>
<td>-</td>
<td>-</td>
<td>3250</td>
<td>48</td>
<td>6800</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>3700</td>
<td>51</td>
<td>-</td>
<td>-</td>
<td>3600</td>
<td>49</td>
<td>7300</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>-</td>
<td>-</td>
<td>6800</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>6800</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>5700</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5700</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>3200</td>
<td>47</td>
<td>-</td>
<td>-</td>
<td>3600</td>
<td>53</td>
<td>6800</td>
</tr>
</tbody>
</table>
Three of the ten households that were supplied with the drum and drip micro-irrigation systems had boreholes on their residential sites. These were gardens 4, 5 and 8. During the first production period, the ten gardeners attempted to follow as closely as possible the instructions they had received during training in the use of the system. Eight gardeners applied 600 l of water per week to their crops, and two (gardens 3 and 9) applied between 300 and 400 l per week. These two gardeners only used grey water for irrigation, and irrigated less than the recommended amount. Gardeners with access to borehole water (garden 4, 5 and 8) only used borehole water to irrigate. The others combined grey water with water from other sources in order to apply the recommended amount of 600 l of water per week. Other sources of water used included spring, river (only at Ga-Molekane), rain, and tap water when available.

TABLE 4.18: Total quantities of water collected from different sources and applied to the irrigated gardens in Sekuruwe and Ga-Molekane during the second production period, which lasted from February to May 2001 (n = 9)

<table>
<thead>
<tr>
<th>Garden</th>
<th>Source of water</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(l)</td>
<td>(%)</td>
<td>(l)</td>
<td>(%)</td>
<td>(l)</td>
</tr>
<tr>
<td>1</td>
<td>Not planted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 400</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>1 400</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>2 600</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
<td>2 000</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>2 500</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>2 000</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>-</td>
<td>5 000</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>1 400</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>2 200</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
During the second production period, which lasted from February to May 2001, nine gardeners used their irrigated gardens. Garden 1 was not planted during this production period. Instead of growing vegetables, all remaining nine gardeners planted maize, dry beans, and groundnuts, in their gardens. These are dryland crops that are commonly grown during the summer season (see section 4.2.6:84). Irrigation was reduced from 600 l per week to between 200 l and 400 l per week in all nine planted gardens. The six gardeners without boreholes only used grey water to irrigate their crops. The three gardeners with boreholes (gardens 4, 5 and 8) continued irrigating with borehole water only.

In the third production period, which lasted from May to October 2001, the participants again planted vegetables. Two of the original recipients of the technology (garden 1 and 3) gave up, and handed over their irrigation systems to new participants, both of whom owned a borehole. This increased the number of participants with boreholes from three to five. Goats destroyed garden 2 and for this reason it was excluded from the analysis.
TABLE 4.19: Total quantities of water collected from different sources and applied to the irrigated gardens in Sekuruwe and Ga-Molekane during the third production period, which lasted from June to October 2001 (n = 9)

<table>
<thead>
<tr>
<th>Garden</th>
<th>Grey</th>
<th>Source of water</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(l)</td>
<td>Borehole (l)</td>
<td>(%)</td>
<td>Other (l)</td>
<td>(%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>16 000</td>
<td>68</td>
<td>7 600</td>
<td>32</td>
<td>23 600</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>Destroyed by goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>6 100</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>6 100</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>11 300</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>11 300</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>12 100</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>12 100</td>
</tr>
<tr>
<td>6</td>
<td>1 850</td>
<td>50</td>
<td>1</td>
<td>6 300</td>
<td>76</td>
<td>8 200</td>
</tr>
<tr>
<td>7</td>
<td>3 000</td>
<td>600</td>
<td>8</td>
<td>3 800</td>
<td>51</td>
<td>7 400</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>10 100</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>10 100</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>3 700</td>
<td>79</td>
<td>1 000</td>
<td>21</td>
<td>4 700</td>
</tr>
<tr>
<td>10</td>
<td>3 100</td>
<td>-</td>
<td>-</td>
<td>5 700</td>
<td>65</td>
<td>8 800</td>
</tr>
</tbody>
</table>

Four of the five gardeners with boreholes in their yards only used borehole water to irrigate their garden. Three of the four (garden 4, 5, and 8) applied about 600 l of water per week, and one (garden 3) about 300 l. The fifth gardener with a borehole (garden 1) combined borehole and river water, irrigating 200 l per day, six days per week, thus doubling up on the recommended amount. Table 4.19 shows that one of the four gardeners without access to a borehole (garden 9) stopped using grey water, and relied entirely on other water, including borehole, spring and tap water for irrigation. This gardener had obtained access to borehole water from his neighbour, who was his relative. The remaining three gardeners (gardens 6, 7 and 19) combined grey water with water from other sources.
Use of grey water by gardeners without a borehole during the three production periods was compared. Figure 4.12 shows the proportions of grey and water from other sources used for irrigation by gardeners without boreholes.

![Graph showing water usage ratios](image)

**FIGURE 4.12**: Sources of water used by households without boreholes to irrigate the gardens during the first three production periods (n = 7)

Figure 4.12 shows that during the first production period 65% of the water applied by gardeners without boreholes consisted of grey water, and 35% was collected from other sources. During the second production period only grey water was used. The contribution of grey water dropped to 25% during the third production period. The reasons for the decline in the use of grey water during the third production period are discussed in section 4.3.3.

Irrigation scheduling recommended by Farming Systems Consulting Services (S.a.) for use in the Drum and Drip micro-irrigation system is very basic. It results in the supply of 86 l
per\textsuperscript{-1} day to an area of 36 m\textsuperscript{2}, which is equivalent to 2.38 mm per day\textsuperscript{-1}. This recommendation does not consider possible differences in crop evapotranspiration demand due to season. Figure 4.13 and 4.14 compare estimates of crop evapotranspiration of selected vegetables that were recommended for planting in the irrigated gardens with the water supply in accordance with the 600 l per week recommendation for use in the Drum and Drip micro-irrigation system (Farming Systems Consulting Services, S.a.). Crop evapotranspiration for the different vegetables were obtained by multiplying reference evapotranspiration for the Potgietersrus area as estimated by De Mey (2002:102) with the relevant crop factors supplied by Green (1985:26).

FIGURE 4.13: Comparison of crop evapotranspiration of selected vegetables during the summer season in the Potgietersrus area with the supply of water (Farming Systems Consulting Services, S.a.) for use in the Drum and Drip micro-irrigation system
During the summer season (Figure 4.13), the recommended supply of water of 600 l per week or 2.38 mm per day exceeded the irrigation requirements of the four vegetables during the first 40% of the growing period. Thereafter, the recommended supply failed to replace the water lost by crop evapotranspiration for all four vegetables. A similar analysis for the winter season (Figure 4.14) showed that the recommended supply of water was slightly higher than crop evapotranspiration during the first 20% of the growing period, more or less adequate during the 20 – 40% of the growing period, and less than required thereafter. In Table 4.20, improved irrigation scheduling recommendations for use in vegetable production in the Potgietersrus area are presented for both the winter and summer seasons.
During the on-farm research, differences in water supply among the ten gardens appeared not to have an effect on production. Yields obtained by participants who irrigated the recommended 600 l per week were similar to those obtained by gardeners who applied less or more water than recommended.

**TABLE 4.20:** Proposed irrigation scheduling for vegetable production during summer and winter in the Potgietersrus area

<table>
<thead>
<tr>
<th>Proportion of growing season</th>
<th>Supply of water*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
</tr>
<tr>
<td></td>
<td>mm/day</td>
</tr>
<tr>
<td>0 – 20</td>
<td>1.5</td>
</tr>
<tr>
<td>20 – 40</td>
<td>2.5</td>
</tr>
<tr>
<td>40 – 60</td>
<td>3.0</td>
</tr>
<tr>
<td>60 – 80</td>
<td>3.5</td>
</tr>
<tr>
<td>80 – 100</td>
<td>3.7</td>
</tr>
</tbody>
</table>

*For use in the Drum and Drip micro-irrigation system covering an area of 36 m²

4.3.2 Crop yields

This section reports on the yields obtained in the irrigated gardens during the first three production periods. The yields obtained in each of the ten gardens during the three production periods are presented in Table 4.21. In analysing the productivity of the irrigated gardens only the production periods in which vegetables were grown were considered. The second production period was excluded from the analysis because field crops were grown. When compared with the recommended range of vegetables the field crops that were planted were poor suppliers of micronutrients, such as vitamin A and vitamin C. Since the main objective of the intervention was to address inadequate intake of selected micronutrients, the use of the irrigated gardens for production of field crops was considered inappropriate.
TABLE 4.21: Yields of vegetables (and grains and pulses) obtained from ten gardens equipped with the Drum and Drip micro-irrigation system in Sekuruwe and Ga-Molekane during the three production periods

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>GARDEN</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
<th>G7</th>
<th>G8</th>
<th>G9</th>
<th>G10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fresh mass (in kg) of vegetables produced in each garden during production period 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beetroot</td>
<td>0.00</td>
<td>26.00</td>
<td>11.90</td>
<td>11.40</td>
<td>12.90</td>
<td>7.50</td>
<td>12.20</td>
<td>3.20</td>
<td>11.10</td>
<td>27.30</td>
<td>12.35</td>
<td></td>
</tr>
<tr>
<td>Beetroot leaves</td>
<td>0.00</td>
<td>5.00</td>
<td>8.00</td>
<td>5.80</td>
<td>5.80</td>
<td>4.60</td>
<td>6.30</td>
<td>7.40</td>
<td>6.40</td>
<td>3.40</td>
<td>5.27</td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td>0.00</td>
<td>13.50</td>
<td>0.00</td>
<td>23.30</td>
<td>18.00</td>
<td>27.00</td>
<td>15.00</td>
<td>12.00</td>
<td>0.00</td>
<td>9.60</td>
<td>11.84</td>
<td></td>
</tr>
<tr>
<td>Onion</td>
<td>15.20</td>
<td>12.50</td>
<td>10.50</td>
<td>11.50</td>
<td>11.40</td>
<td>11.30</td>
<td>8.50</td>
<td>11.00</td>
<td>9.80</td>
<td>-</td>
<td>10.17</td>
<td></td>
</tr>
<tr>
<td>Pumpkins</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>27.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>Pumpkin leaves</td>
<td>6.80</td>
<td>5.60</td>
<td>7.60</td>
<td>2.60</td>
<td>6.10</td>
<td>7.50</td>
<td>7.20</td>
<td>5.90</td>
<td>6.70</td>
<td>6.90</td>
<td>6.29</td>
<td></td>
</tr>
<tr>
<td>Swiss chard</td>
<td>32.72</td>
<td>33.56</td>
<td>28.50</td>
<td>21.70</td>
<td>0.00</td>
<td>13.20</td>
<td>21.80</td>
<td>25.60</td>
<td>22.00</td>
<td>22.40</td>
<td>22.15</td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td>10.76</td>
<td>7.30</td>
<td>6.60</td>
<td>0.00</td>
<td>15.99</td>
<td>6.00</td>
<td>3.40</td>
<td>7.00</td>
<td>3.50</td>
<td>3.20</td>
<td>6.38</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>65.48</td>
<td>103.46</td>
<td>73.10</td>
<td>103.30</td>
<td>70.19</td>
<td>77.40</td>
<td>72.10</td>
<td>59.50</td>
<td>72.80</td>
<td>77.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fresh mass of green maize and dry mass of pulses (in kg) produced in each garden during production period 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>-</td>
<td>12.50</td>
<td>10.20</td>
<td>19.00</td>
<td>16.20</td>
<td>22.40</td>
<td>-</td>
<td>16.20</td>
<td>5.40</td>
<td>13.60</td>
<td>12.83</td>
<td></td>
</tr>
<tr>
<td>Beans</td>
<td>-</td>
<td>5.80</td>
<td>-</td>
<td>9.30</td>
<td>5.70</td>
<td>-</td>
<td>9.90</td>
<td>7.00</td>
<td>-</td>
<td>12.20</td>
<td>5.54</td>
<td></td>
</tr>
<tr>
<td>Groundnuts</td>
<td>-</td>
<td>7.50</td>
<td>8.00</td>
<td>-</td>
<td>6.80</td>
<td>-</td>
<td>11.00</td>
<td>5.40</td>
<td>10.60</td>
<td>-</td>
<td>5.48</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-</td>
<td>25.80</td>
<td>18.20</td>
<td>28.30</td>
<td>28.70</td>
<td>22.40</td>
<td>20.90</td>
<td>28.60</td>
<td>16.00</td>
<td>25.80</td>
<td>23.86</td>
<td></td>
</tr>
<tr>
<td><strong>Fresh mass (in kg) of vegetables produced in each garden during production period 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beetroot</td>
<td>12.40</td>
<td>-</td>
<td>8.40</td>
<td>11.20</td>
<td>9.20</td>
<td>5.10</td>
<td>8.50</td>
<td>11.80</td>
<td>10.80</td>
<td>7.40</td>
<td>9.42</td>
<td></td>
</tr>
<tr>
<td>Beetroot leaves</td>
<td>6.50</td>
<td>-</td>
<td>7.20</td>
<td>8.30</td>
<td>3.70</td>
<td>1.50</td>
<td>9.30</td>
<td>4.80</td>
<td>4.40</td>
<td>0.00</td>
<td>5.08</td>
<td></td>
</tr>
<tr>
<td>Cabbage</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.90</td>
<td>31.70</td>
<td>11.00</td>
<td>7.70</td>
<td>0.00</td>
<td>6.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrots</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.90</td>
<td>3.50</td>
<td>-</td>
<td>-</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green pepper</td>
<td>0.20</td>
<td>-</td>
<td>0.00</td>
<td>1.00</td>
<td>1.80</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Onion</td>
<td>9.00</td>
<td>-</td>
<td>-</td>
<td>5.30</td>
<td>9.50</td>
<td>-</td>
<td>4.60</td>
<td>4.40</td>
<td>5.30</td>
<td>-</td>
<td>4.23</td>
<td></td>
</tr>
<tr>
<td>Swiss chard</td>
<td>38.20</td>
<td>-</td>
<td>13.50</td>
<td>21.30</td>
<td>9.30</td>
<td>7.00</td>
<td>33.50</td>
<td>17.20</td>
<td>18.20</td>
<td>16.90</td>
<td>19.46</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>66.30</td>
<td>-</td>
<td>29.10</td>
<td>47.10</td>
<td>33.50</td>
<td>17.50</td>
<td>89.50</td>
<td>52.70</td>
<td>46.40</td>
<td>24.30</td>
<td>45.16</td>
<td></td>
</tr>
</tbody>
</table>
In Table 4.22, the mean yields of vegetables per square metre obtained from the irrigated gardens were compared with the optimum yields that can be obtained under South African conditions according to Brutsch (1994) and Allemann and Young (1998).

### TABLE 4.22: Yields of vegetables harvested during the first production period in the gardens equipped with the Drum and Drip micro-irrigation system in Sekuruwe and Ga-Molekane and optimum yields that can be obtained under South African conditions

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Mean yield (kg m(^{-2}))</th>
<th>Optimum yield (kg m(^{-2}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beetroot</td>
<td>2.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Beetroot leaves</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td>Cabbage</td>
<td>1.6</td>
<td>10.0</td>
</tr>
<tr>
<td>Onion</td>
<td>2.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Pumpkins</td>
<td>1.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Pumpkin leaves</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Swiss chard</td>
<td>4.1</td>
<td>6.0</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>0.8</td>
<td>7.5</td>
</tr>
</tbody>
</table>

During the first production period the gardens were planted to beetroot, cabbages, onions, pumpkins, Swiss chard and tomatoes. Table 4.22 shows that yields of Swiss chard, beetroot and onions obtained in the gardens were fairly high. For all three of these vegetables the mean yield obtained in the gardens was at least 50 % of the optimum. The yields of the other vegetables, namely cabbages, tomatoes and pumpkins, were low. Low yields of tomatoes were ascribed to the hail that occurred. Hailstorms occurred in both villages. They severely damaged the tomato crop, causing fruit drop, physical damage to the fruit (cracked fruits), and defoliation of the plant, exposing fruits to direct sunlight and causing sunburn. The foliage of the other crops was also damaged by the hailstorm, but it recovered quickly. Figures 4.15 and 4.16 show tomatoes before and after the hailstorm.
FIGURE 4.15: Tomatoes growing in one of the gardens during the first production period, before a hailstorm damaged the crop

FIGURE 4.16: Tomatoes in one of the gardens during the first production period, after being damaged by a hailstorm
Pumpkin flies (*Didacus cilliatus*) attacked the pumpkins, and aphids (*Aphididae spp.*) and diamond-back moth (*Pultella xylostella*) the cabbages. Gardeners did not execute measures to control these pests. Training in crop protection using home-made crop protectants was only offered during the third production period. The lack of effective crop protection by gardeners had a negative effect on yields. There was no harvest of pumpkin fruits in the majority of the gardens, because flies infected the fruits whilst they were still young. The cabbages harvested from the gardens were small, weighing about 2 kg, whereas certain cultivars of cabbage could weigh up to 4 kg, under irrigation (Böhringer, 1999).

In some of the gardens, chickens damaged the growing crops. However, damage was minimised as most gardeners with chickens fenced off their gardens as shown in Figure 4.17.

![Figure 4.17: During the first production period garden 2 was fenced off using empty maize bags to prevent chickens from damaging the crop](image)
During the third production period the gardens were again planted to the recommended vegetables, which included beetroot, cabbages, carrots, onions, and Swiss chard. Table 4.23 presents the mean yields obtained per square metre and the optimum yield that can be obtained under South African conditions (Brutsch, 1994 & Allemann and Young, 1998).

TABLE 4.23: Yields of vegetables harvested in gardens equipped with the Drum and Drip micro irrigation systems in Sekuruwe and Ga-Molekane and optimum yields under South African conditions, (third production period, n = 10)

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Mean yield (kg m(^{-2}))</th>
<th>Optimum yield (kg m(^{-2}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beetroot</td>
<td>1.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Beetroot leaves</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td>Cabbages</td>
<td>1.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Carrots</td>
<td>0.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Onions</td>
<td>0.9</td>
<td>5.0</td>
</tr>
<tr>
<td>Swiss chard</td>
<td>1.8</td>
<td>6.0</td>
</tr>
</tbody>
</table>

As is evident from Table 4.23, yields of all vegetables harvested during the third production period were low. During this production period, factors that may have contributed to the low yields included damage by livestock, inadequate pest control and inadequate nutrient supply.

During the first production period, the gardens were fertilized at planting with a chemical fertilizer mixture supplied by the NutriGro research team. During the second production period no fertilizers were supplied and no nutrients were added to the soil by any of the 10 participants. In the third production period, only four gardeners (gardens 3, 7, 9 and 10) applied poultry or cattle manure before planting. The rest did not apply any nutrients to their soils. This most likely contributed to poor yields in the gardens that were not
fertilized. Table 4.24 compares the yields per square metre of vegetables obtained in garden 6 (not fertilized) and 9 (applied kraal manure).

### TABLE 4.24: Yields per square meter obtained from garden 6 and 9 during the third production period

<table>
<thead>
<tr>
<th>Crop</th>
<th>Garden 6 (no fertilizer added)</th>
<th>Garden 9 (kraal manure applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (kg m(^{-2}))</td>
<td>Yield (kg m(^{-2}))</td>
</tr>
<tr>
<td>Beetroot</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Beetroot leaves</td>
<td>0.27</td>
<td>0.37</td>
</tr>
<tr>
<td>Cabbage</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Onion</td>
<td>-</td>
<td>0.9</td>
</tr>
<tr>
<td>Swiss chard</td>
<td>0.6</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 4.24 shows that gardens 6 and 9 produced similar yields of beetroot and beetroot leaves. The yields of cabbage and Swiss chard were considerably higher in garden 9 than in garden 6. This suggests that lack of nutrients may have contributed to low yields in some gardens.

Chickens and goats caused severe damage to three gardens (gardens 2, 5 and 10), because the fences that were put up during the first production period were no longer effective, and gardeners failed to repair them in time. Goats destroyed all the crops in garden 2, resulting in the exclusion of this garden from the analysis, because no crops were harvested. Chickens caused damage to gardens 5 and 10. The extent of the damage to garden 10 caused the participant to stop irrigating her crops. The participant in garden 5 continued to irrigate her garden, and Swiss chard and beetroot recovered from the damage. Figure 4.18 shows the condition of the fence in garden 2 during the third production period, and Figure 4.19 shows damage to crops by chickens in garden 5 during that same production period.
FIGURE 4.18: Garden 2 was fenced with corrugated iron and thorn branches during the third production period, but goats managed to get to the crops.

FIGURE 4.19: Chickens removed nearly all the foliage of the vegetables in garden 10 during the third production period.
The yields obtained during the third production period in gardens 5 and 7 allowed for an assessment of the effect of the damage caused by chickens to the vegetable crops. Table 4.25 shows the yields obtained in gardens 5 and 7 during the third production period.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Garden 5 (damaged by chickens)</th>
<th>Garden 7 (not damaged)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (kg m$^{-2}$)</td>
<td></td>
</tr>
<tr>
<td>Beetroot</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Beetroot leaves</td>
<td>0.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Cabbage</td>
<td>0.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Onion</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Swiss chard</td>
<td>0.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Table 4.25 shows that the two gardens produced similar yields of beetroot and onions, which were the crops that were least damaged by the chickens. The chickens destroyed the cabbage crop in garden 5, and severely reduced the yield of Swiss chard.

The mean yield of fresh vegetables produced by the ten gardeners during the first production period (77 kg) was higher than the mean obtained during the third production period (45 kg). Various factors contributed to the low yield obtained during the third production period. These included damage of crops by livestock, poor nutrient supply, and lack of crop protection against pests and diseases. During the first production period there was no problem of damage of crops by livestock, because gardeners with livestock fenced off their gardens. There was also no lack of nutrients, because the gardens had been fertilised at planting. During the third production period the fences were no longer effective and in most of the gardens nutrients were not supplied. Generally, yields
obtained during both the first and third production periods were lower than the optimum yields obtainable under South African conditions as reported by Brutsch (1994) and Allemann and Young (1998). Several limiting factors were identified, among which the absence of crop protection and damage by hail were the most important. The recommended irrigation was found to be insufficient during the second half the growing period of the vegetables, but that did not seem to have an impact on yields. The results, therefore, suggest that with optimum management and the absence of damage by hail or livestock, the irrigated gardens have the potential to produce between 80 and 100 kg of fresh vegetables per production season of four months, or about 240 to 300 kg per year.

4.3.3 Technology adoption

This section reports on the way in which the ten volunteers adopted and modified the Drum and Drip micro-irrigation and irrigated vegetable production technologies. Central to the analysis was the utilization scenario envisaged by the designers of the intervention (see section 3.3.2:48). Using this scenario as a base, divergences were identified and explanations for these were sought from the participants. The presentation and discussion of results is arranged according to themes, which appear in bold at the start of each section. At the end, the main conclusions arising from this component of the study are presented under the heading ‘concluding thoughts’.

Statements from people that participated in the evaluation of the Drum and Drip micro-irrigation system were used to support the findings. At the end of each quote, a code appears. This code represents the number of the garden and the number of the transcribed interview from which the quote was extracted. For example, a code for garden eight,
Use of grey water

Grey water was envisaged to be the main if not the only source of irrigation water in the gardens (see section 3.3.2:48). The participants were informed that applying grey water by means of the Drum and Drip micro-irrigation system removed the health hazard associated with the use of such water. The explanation was that the system prevented contact between the water and the leafy parts of the plants. However, this failed to persuade the participants to use grey water ardently. All gardeners who had a borehole did not make use of grey water, relying on borehole water instead. The main reason for the reluctant use of grey water by gardeners was that they perceived it to be unhygienic. “I cannot use the water that has been used to wash dirty clothes or for bathing to irrigate the vegetables that I will eat (G8.1)”. Participants also seemed to be concerned about how the community at large would react to their use of grey water for the irrigation of vegetables. “What will people say when they see me irrigating with used water? (G5.1)”. There was also a fear that grey water would make the soil to smell badly. “This dirty water stinks where we discard it. Therefore, the water will also make the soil in my garden to stink (G4.1)”.

During the first production period five of the seven participants without a borehole combined grey water with water from other sources, including water from springs, river, and tap when available. This was done because the grey water that became available was insufficient to irrigate the recommended amount of 600 l per week. “Recycled water that
is produced in my house in two days fills the drum only half way. I have to go to the spring to fetch water to get the rest of the water to fill the drum (G6.1)”. During the second production period, these participants relied only on grey water to irrigate their gardens. This was possible because they reduced the amount of irrigation to about 300 l per week. The reason for irrigating less than recommended is discussed in the next section that deals with amount and frequency of irrigation. By reducing irrigation the production of grey water was enough to constitute the sole source. During the third production period, the remaining participants without boreholes stopped or reduced the use of grey water. They now also claimed that using grey water presented a health hazard. “This water presents no problem for crop growth, but I think we can get sick in the long run if we continue using it (G10.6)”. Another reason for reducing the use of grey water was that it had a negative effect on the soil, resulting in poor infiltration. “The soap content makes my soil to be dry and white. When I irrigate the water does not penetrate the soil (G7.6)”. 

FIGURE 4.20: Women collecting water from the river for irrigation in Ga-Molekane
**Amount and frequency of irrigation**

During the first production period, most participants followed instructions and applied 600 l of irrigation water per week to their crops. Two participants applied less than 600 l per week. They collected about 300 l grey water per week, but failed to collect water from other sources as was done by other gardeners without a borehole. “*I cannot go to the river to fetch water to fill up the drum because I am very busy. I look after my grandchild, and I also sell snacks at the school (G3.1)*”. During the second production period, all participants applied less than 600 l per week. On average they applied more or less half of the recommended amount of water. The participants planted their irrigated gardens to field crops such as maize, groundnuts and dry beans. They were of the opinion that these crops did not require as much as water as vegetables. “*These crops are not like the previous ones. Usually we don’t even irrigate them. This year it is very hot and the rain is not good, which is why I am giving these crops a little water (G6.4)*”.

During the third production period, only three gardeners (garden 4, 5 and 8) irrigated 600 l per week. The rest of the participants either applied less than recommended, or more, with one participant doubling irrigation. The gardener who doubled irrigation (garden 1) perceived that if the soil surface was allowed to dry up, crops would lack water and might die. By applying water daily with a full drum she was ensuring that the soil surface was always moist. “*These kinds of vegetables need a lot of water. When the soil surface dries the crops don’t have water, and they may die at any time (G1.5)*”. The yield obtained in that garden was comparable to other gardeners who either applied water as recommended or less than that (see Table 4.21). This indicated that increasing irrigation in excess of the recommended 600 l per week did not increase yields. In garden 3, 6, 7 and 9 irrigation was less than 600 l per week. The four participants gave different explanations for reducing
water application. Garden 3 was not entirely planted because of the damage that occurred to the seedlings when the garden was transferred to the new participant. “My garden is not entirely planted, so there is no need to irrigate with a full drum (G3.6)”. In garden 6, irrigation was reduced because the crops were stunted as a result of poor nutrient supply (section 4.3.2:106). This discouraged the participant to fetch water to irrigate. “My crops are not growing well. It is a waste of water to irrigate these crops with a full drum, because they are not growing as well as in gardens 7 and 8 (G6.7)”. In garden 7, a bucket was used to irrigate instead of the Drum and Drip irrigation system. This participant felt that irrigation using the Drum and Drip system needed more water than irrigation by means of a bucket. “Now I have stopped using the irrigation system because it was not irrigating evenly. Irrigating with a bucket is better. When I was using the drum I was forced to fill it up completely. Now, with a little water I can still manage to irrigate my entire garden (G7.8)”. The participant in garden 9 applied kraal manure, which he believed would improve the water holding capacity of his soil. For this reason he felt that an irrigation of 300 l per week was enough. “I am not irrigating as much as the other people, but my crops are growing. I have applied kraal manure so that the soil can hold water for a long time (G9.5)”.

During the first production period the gardens were irrigated three days per week as per instruction. During the second production period all gardeners reduced the frequency of irrigation from thrice to once or twice per week, applying more or less half of the recommended amount of water, for reasons explained earlier. During the third production period many gardeners irrigated daily during the first few weeks after transplanting. They perceived that seedlings needed water daily in order to stay alive and grow. “I water them daily because you see that they are still small. When they are big I will water them three
days per week. These crops need to be watered daily when they are small (G4.6)”. “My soil does not hold water. So if I miss out a day without irrigating, my crops may die (G8.6)”.

Performance of the Drum and Drip micro-irrigation system

The Drum and Drip micro-irrigation was selected because it allows for the use of grey water and also because micro-irrigation is efficient. The designer of the technology trained the recipients in the operation of the Drum and Drip micro-irrigation system. The introducers of the technology expected gardeners to continue using the irrigation system. This was not the case. After the first two production periods participants started to use other methods of irrigation, including buckets and furrows, instead of the Drum and Drip micro-irrigation system. During the third production period, gardener 3 did not use the irrigation system because her garden was not entirely planted. This was the result of damage to some of her seedlings before transplanting. “I can’t use the irrigation system because next to some of the openings (drippers) there are no plants. Therefore, it will be a waste of water to irrigate with the pipes (G3.6)”. In garden 7, the participant was not happy with the water distribution of the drippers (see Fig. 21 and 4.22). “I have stopped using the irrigation system because it was not irrigating evenly. The main problem with this system is that it blocks. As a result it does not irrigate all the plants (G7.8)”.

When the researcher visited the gardeners on 12 July 2002, six participants had abandoned the use of the irrigation system. Three of them had planted only a portion of their gardens, and were of the opinion that using the irrigation system would be a waste of water. “I have stopped using the pipes because I did not plant the entire garden. Using the system would a waste because I would be irrigating empty spaces (G6.10)”.

In the other three gardens,
use of the irrigation system was stopped because the drums were leaking (see Fig 4.21 and 4.22). “The drum is leaking. We do not know how to seal it. That is the reason why we removed the pipes (G1.10)”. Upon inspection it became evident that all three drums were leaking in the same place. Where the drum had been drilled to insert the outlet, the exposed metal had rusted, causing leaks (Fig 4.22). High salt content in the water was the most probable cause for the rusting of the drums. High salt content in the irrigation water also appeared to be the cause for the clogging of the drippers, because a build-up of salts around the emitters was noticeable about seven months after installation (see Fig 4.21 and 4.22).

FIGURE 4.21: A dripper during the first production period (August, 2000)
FIGURE 4.22: Salt accumulation around a dripper a year after installation (September, 2001)

FIGURE 4.23: A garden with the Drum and Drip micro-irrigation system removed (July 2002)
Fig. 4.24: After about two years of use, the drums started to leak because rust had destroyed the metal where the drum had been drilled to insert the outlet.

Table 4.26 shows the electrical conductivity of water collected from various sources in Sekuruwe and Ga-Molekane.

Table 4.26: Electrical conductivity of different irrigation waters used in the home gardens in Sekuruwe and Ga-Molekane

<table>
<thead>
<tr>
<th>Village</th>
<th>Water source</th>
<th>Electrical conductivity (mSm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sekuruwe</td>
<td>Borehole</td>
<td>129</td>
</tr>
<tr>
<td>Sekuruwe</td>
<td>Spring</td>
<td>180</td>
</tr>
<tr>
<td>Ga-Molekane</td>
<td>Borehole</td>
<td>367</td>
</tr>
<tr>
<td>Ga-Molekane</td>
<td>River</td>
<td>278</td>
</tr>
</tbody>
</table>

All four water samples are rated as high salinity-hazard waters (Rowell, 1988). The waters from Ga-Molekane were even rated as presenting a very high salinity-hazard. Apart from negatively affecting the functioning of the irrigation system, there are other hazards associated with the use of such water. According to Rowell (1988), the continuous use of
water rated as presenting a high salinity hazard is expected to have detrimental effects on soil quality and may even render the soil unproductive.

**Frequent harvesting of fresh vegetables for home consumption**

The irrigated vegetable gardens were introduced to increase intake of selected micronutrients, including calcium, iron, vitamin A and vitamin C. It was assumed that households would consume the vegetables they produced in their gardens, since vegetables were in short supply. It was also assumed that surplus vegetables would be preserved for out of season use, or be sold to generate income.

During the first and third production period, when the gardens were planted to vegetables, participants only harvested fresh produce once or twice per week. The main explanation given for not harvesting vegetables more often was that vegetables were less tasty than the foodstuffs they were used to. “*We cannot eat vegetables daily. At month end we buy meat, fish and other things to eat with pap. When we feel that we have had enough meat, we eat vegetables (G1.3)*”. Especially children disliked vegetables, and were provided with other foodstuffs, because they refused to eat the vegetables. “*I do not harvest the vegetables daily because I will end up eating them alone. My children don’t like vegetables. If I give them vegetables for two days in succession, the second day they refuse to eat. If they refuse to eat vegetables I am forced to take the meat that I sell and cook it for them (the participant buys meat in Potgietersrust and sells it in Sekuruwe village). I cannot leave them to sleep without eating when there is something I can provide them with (G8.2)*”. In some participating households, children were forced to consume the vegetables, because there were no alternatives that the mothers could provide. This was the case in garden 3 where vegetables were harvested most frequently. “*Here they don’t have a chance to refuse eating vegetables, because there is nothing that I can give them when they don’t*
want the vegetables. The vegetables are helping us a lot. There is no money to buy meat every day. Now I buy meat or other foodstuffs once or twice a week. The rest of the days we eat vegetables (G3.2)”.

In garden 10, the participant was keen to harvest frequently, but she had to wait for a long period before she could harvest enough to meet her household requirements, and also to share some with her neighbours. “I would like to harvest the vegetables more frequently than I am doing now, but the problem is that when I do so I don’t get enough for all of us. So it is better to wait for a few days so that when I harvest everyone gets some and I also have some left to give to my neighbours (G10.3)”.

In garden 7, the garden was not harvested frequently because of aesthetic reasons. When the vegetables were big and green the garden looked beautiful and community members praised the looks of her garden. “After I have harvested my garden it no longer looks good. When the vegetables are big my garden looks very beautiful. My neighbours and the people that pass by my house praise me for having such a beautiful green garden (G7.3)”.

**After household requirements are met surplus vegetables are preserved for later use or sold to generate income**

During the first production period, surplus resulting from infrequent harvesting was given away (see Fig. 4.25). Donating produce supported the social networks of participants. “The people to whom I give vegetables give me food when I don’t have. If they have a certain food that they know I don’t have, they give it to me without me having to ask for it (G5.3)”.

During the third production period, the owners of gardens 1, 7, 8 and 9 sold produce to local families who did not have vegetable gardens. In the case of gardens 1 and 8 produce was sold to generate money to purchase other food and non-food necessities. In
both cases the bulk of the produce was sold instead of being consumed at home. “The children don’t like vegetables, which is why I think that selling is better. We generate money to buy the types of food that we prefer, such as bread and meat or fish (G1.7)”. “I have given some of the money we earned by selling produce to Karabo (the participant’s daughter) so that she could pay her debts at the burial club (G1.7)”. “I use the money I generate from the garden to buy meat and things like cooking oil. When I earn a lot, I use some of it to buy cigarettes and liquor (G9.6)”. In garden 7 and 8 the produce was sold to people who came to ask for vegetables, but who did not form part of the social network of the gardeners. “It is just that some people whom we don’t share things with came to ask me for vegetables. I could not give them for free, because they will never give me anything back. I told them that if they need vegetables they should buy (G7.7)”.

FIGURE 4.25: Infrequent harvesting leads to a feast and famine situation
Irrigation enables year-round production of the recommended vegetables

It was expected that participants would grow the recommended vegetables throughout the year. During the first production period, the participants were supplied with seedlings of the recommended vegetables. The participants were advised to grow these vegetables throughout the year. However, gardeners were not trained in the propagation of vegetable seedlings. After the vegetables grown during the first production period were harvested, participants did not plant vegetables again. Instead, they grew field crops such as maize, groundnuts and beans. This was done because people in the two villages usually grow field crops during that time (summer). “I have decided to grow these crops because now is their time. During summer we grow these crops here in our village (G3.3)”. Participants were also afraid that the recommended vegetables crops would not grow well during summer, because of the harshness of the climate. “If I plant them (recommended vegetables) now they won’t grow well because it is very hot”. Some participants expected that they would be supplied with seedlings again, as was the case during the first production period. Seeing that they were not given seedlings, and they didn’t know how to grow their own, they decided to grow the crops that they knew well. “I cannot grow vegetables because I don’t know how to prepare their seedlings. I decided to grow these crops because I know how to grow them. I thought that you were going to supply us with seedlings as the white man did when we started our gardens (G6.3)”. Participants also planted their gardens to show their dedication and gratitude to the NutriGro research team that supplied them with the irrigation systems. “It is not right to leave this garden unplanted. What will the people who gave us the gardens say when they come to check? These gardens should always be planted, so that when they come, they can see that we are serious (G7.4).”
As lack of capacity to produce vegetables was one of the reasons that made the participants to grow field crops during the second production period. Participants were again supplied with vegetable seedlings during the third production period. During that period the gardeners were trained in the production of vegetable transplants to ensure that from the fourth production period onwards, they would be able to produce their own seedlings. During the training, the participants were also supplied with a list of crops that could be grown in summer. During the fourth production period, October 2001 to January 2002, the participants grew vegetables from their own seedlings. Only garden 2 was abandoned because of damage to the seedlings by rodents. “I have bought seeds so that my grandchild could grow seedlings. He tried to grow the seedlings and mice ate them (G2.9).” After harvesting the vegetables in January 2002, nine of the ten gardens were not used between February and May 2002 (see Figure 4.26). The main reason for not planting was that there were wild vegetables and crops available in yards and fields. “There is no need to plant now, because there are traditional vegetables during this time (G5.9).” Another explanation was that in summer vegetables need a lot of water because it is very hot. “I remember that he (technology designer) said that some of the vegetables will grow during this time, but the problem is that they need more water than in spring and winter (G7.9).” In garden 10, the participant grew groundnuts, maize and bambara groundnuts. The participant appeared to prefer summer crops to vegetables during summer. “I know that vegetables could do well, but now I want to grow field crops, as it is their time. This period is called selemo (time for summer crops) (G10.8).”
During the sixth production period, which started in June 2002, four gardeners planted their gardens completely. Three of these gardeners produced their own seedlings, and one purchased seedlings from a commercial nursery in Mokopane town. Three gardens were planted partly (some rows were not planted), and the remaining three gardens were not planted at all, because of problems with the production of seedlings. “We have contributed money in a group of four people. The group consisted of my neighbour (gardener 5), two other ladies and myself. We sent a certain man to buy us the seedlings in town. He bought us very few (G3.10).

In gardens 2 and 8 responsibility for the gardens was transferred to the children. In both cases this contributed to inappropriate production practices and ultimately led to the discontinuation of production. “I wanted to give up this garden, and hand it over to
someone else, but my grandchild said that I should not give it up because he could do all the work. At first he was serious, but these days he no longer is (G2.9)”. “I like working in the garden but my problem is lack of knowledge. When my mother comes home to visit us she no longer helps me. She is no longer interested in the garden, because she does not stay here any more (G8.9)”.  

The exit interviews conducted during the final visit to the study area confirmed that seedling production remained a problem, despite the training that had been provided. The interviews showed that participants preferred buying seedlings from nurseries. “If you can organize that the nursery supplies us with seedlings when it is time to grow, I would prefer to pay for the seedlings and for their transport than to grow them myself (G3.11)”.

The efficiency and durability of the Drum & Drip micro-irrigation system

Participants discontinued use of the Drum and Drip micro-irrigation system mainly because the drums started leaking, and because the drippers clogged. “The drum is leaking. We do not know how to seal it. That is the reason why we removed the pipes (G1.10)”. “This time I will not use the irrigation system, because it blocks (clogging) so often. I know how to unblock the drippers, but it is a boring task, because after unblocking them they soon block again (G10.10)”. “When the crops are big you often don’t discover when the drippers are blocked. That is the main problem with the pipes (G1.11)”. Several participants adopted the use of buckets for irrigation. “The pipes caused my crops to grow unevenly. Using a bucket is tiring work, but it produces better crops than when I use the pipes (G4.9)”. “Blocking is the main problem, which is why I have stopped using the
system. The irrigation system irrigates unevenly because it blocks continuously. Now that I use a bucket my crops grow well, because they get water equally (G7.10)”.

**Grey water will eliminate the problem of lack of irrigation water**

The exit interviews confirmed that participants were or had become reluctant to use grey water to irrigate vegetables. ‘I have told you in the beginning that this water is not good for our health. It can make us sick. I even find that the vegetables smell of soap after they have been cooked. We rather go to the river to collect irrigation water than to use dirty water (G1.11)”.” “If there is no water in the spring or at the tap, I would rather wait than using the soap water (G10.10).”

**The importance of irrigated vegetable gardening**

Despite rejecting or abandoning certain elements or components of the technology that was introduced, several participants seemed to have developed an appreciation for the benefits of irrigated vegetable production. “I have made a lot of money from selling vegetables. It also helped me to save money. I am supposed to buy these vegetables. Where would I get money to buy these vegetables because I am not working (G9.9)?” “It is difficult to grow irrigated vegetables but I cannot give up because the vegetables that I get are helping me a lot. I am not working, where I would get the money to buy these vegetables (G6.10).”
Concluding thoughts

The results obtained by monitoring the use of the Drum and Drip micro-irrigation system for vegetable production in home gardens, and the exit interviews, conducted two years after installation of the system, showed that some of the assumptions of the designer of the technology package (Farming Systems Consulting Services, S.a.), and the researchers of the NutriGro team (Albertse, 2000) were incorrect or only partly correct.

Participants basically rejected the use of grey water, because they perceived its use to be unhygienic and to have a negative effect on their soils.

In terms of amount and frequency of irrigation, adherence to the recommendations faltered as time went by. Eight participants adhered to the recommendation of 600 l water per week during the first production period, but only three during the third production period. Failure to collect enough recycled water during the first production period made three participants to apply less water than recommended. The change from planting vegetables to field crops resulted in reduced irrigation by all participants during the second production period. During the third production period, one participant irrigated more than recommended, because she wanted to ensure that her crops had water at all times. She was convinced that her soil did not hold water for long when it was hot. Some participants applied less water than recommended. After stopping or reducing the use of grey water it was difficult for participants to collect enough water from other sources to fill up their drums, during irrigation sessions. Some reduced irrigation because their gardens were planted partially. After discontinuing the use of the Drum and Drip micro-irrigation
system, some participants reported that the irrigation methods to which they had reverted enabled them to irrigate all the crops without filling up the drum.

Technically, participants experienced three problems with the operation of the Drum and Drip micro-irrigation system. First, when participants did not plant their entire garden to crops, they failed to disconnect the dripper lines that had no plants. As a result, they stopped using their irrigation systems because it was wasting water. Secondly, about seven months after installation, the drippers developed a problem of frequent clogging, which could not be addressed by pulling the strings. Participants also found it difficult to identify clogged drippers once the plants had developed a dense canopy. Thirdly, during the second year of use, the drums started leaking because the metal around the taps had rusted through. These three problems made participants to resort to other methods of irrigation. Severin (2000:44-47) also found the Drum and Drip micro-irrigation system to have a limited life span (see also section 2.25:33-34). He found that most of the Drum and Drip irrigation systems installed in the Western and Northern Cape Provinces during 1995 had been abandoned by 1999 because of malfunctioning, but he did not indicate which component of the system was least durable.

The main aim of the vegetable gardening intervention was to improve the nutrition of the children by means of frequent intake of fresh vegetables (Albertse, 2000). However, children and other members of participating households did not like to eat vegetables frequently, preferring other foodstuffs, such as meat, bread and fish instead.

The on-farm research revealed that the irrigated vegetable production technology as it was introduced to participants had general shortcomings, including technical, knowledge and
cultural. Some of these shortcomings could have been avoided by using a collaborative instead of a consultative on-farm research approach. This would have allowed participants to help design the technology. International experience shows that lack of farmers’ involvement in technology design results in products that are often irrelevant to farmers’ circumstances or needs, leading to poor adoption (Selener, 1997:173). In this study farmer involvement in the selection of vegetables to be grown in the irrigated gardens would have revealed their preference for harvesting traditional vegetables during summer. However, despite the shortcomings of the intervention, many participants appeared to have developed a lasting appreciation for the benefits of irrigated vegetable production. The exit interviews revealed that eight gardeners intended to continue planting and irrigating their gardens, even when that meant walking long distances in search of irrigation water, use buckets to apply water, and purchase their vegetable seedlings from commercial outlets.
CHAPTER 5

PRESENTATION OF RESULTS AND DISCUSSION

OF NUTRITION IN SEKURUWE AND GA-MOLEKANE

5.1 INTRODUCTION

This Chapter reports on nutrition in Sekuruwe and Ga-Molekane. In the first section, estimates of the contributions of purchased food and food produced by dryland agriculture (the production of field crops and livestock production) to the nutritional requirements of the surveyed 131 households are presented. The second section estimates the contributions of purchased food, food produced by dryland cropping and livestock production, and food produced in the irrigated gardens to the nutritional requirements of the 12 households (ten original households and two replacements) that participated in the evaluation of the Drum and Drip micro-irrigation system. As indicated in section 3.5:58 only three nutrients were considered, namely iron, vitamin A and vitamin C. In this study an intake of 67 % or more of the Recommended Dietary Allowances (RDA) of a nutrient was considered enough. According to the Food and Nutrition Board (1989), 67 % of the RDA represents a critical intake level. Below this level clinical deficiency symptoms may start occurring. When intake reaches or exceeds this level clinical deficiency symptoms are no longer expected.

5.2 NUTRIENT INTAKE IN THE 131 SURVEYED HOUSEHOLDS IN SEKURUWE AND GA-MOLEKANE

In this section, estimates of the contributions made by purchased food and food produced by means of agriculture to the nutritional requirements of the 131 surveyed households
surveyed are assessed. Food produced for home consumption and food that was purchased was taken as being available to the members of household concerned and it was also assumed that surveyed household consumed all of these foods. Households were divided into three poverty categories (see section 4.2.4:75-76) and the results for a particular poverty category was the mean of all households contained in that category.

In Figure 5.1 the amounts of the three selected nutrients contained in the food purchased by households in the three poverty categories are presented. The amounts are expressed as proportions of the RDA.

FIGURE 5.1: Nutrients contained in food purchased by households in Sekuruwe and Ga-Molekane expressed as proportions of their RDA (2001; n = 131)

On average, food purchased by non-poor and poor households contained enough vitamin C to satisfy their RDA, but insufficient iron and vitamin A. The food purchased by ultra poor households contained insufficient amounts of all three nutrients under consideration. Table 5.1 shows examples of the foods purchased by households in Sekuruwe and Ga-
Molekane. The foods have been grouped into the categories used by Wolmarans, et al. (1992:43-121) and Burgess et al. (1998:96)

Table 5.1 shows that among the foods purchased by surveyed households in Sekuruwe and Ga-Molekane there were foods that were good sources of iron, and of vitamins A and C. However, not all households purchased all the foods listed in Table 5.1 and when they did they often purchased small quantities only. In addition, foods such as vegetables and fruits were not always available, because households only purchased them when they went to town (Amisah, 2000:214), or when hawkers sold these foods at pension pay points. This explains the shortage of vitamin C among the ultra poor households and lack of vitamin A among all three types of households. Table 5.1 also shows that households purchased a limited range of leafy vegetables, which are known to be rich in vitamin A and vitamin C (Wolmarans et al., 1992:8-21 and Burgess et al. 1998:200). The presence of meat and legumes, which are rich in iron, suggests that households in the two villages purchased only modest quantities of these foods and not enough to meet their RDA.
TABLE 5.1: Examples of main food items purchased by households in Sekuruwe and Ga-Molekane

<table>
<thead>
<tr>
<th>Cereals and their products</th>
<th>Meat, fish and their Products</th>
<th>Legumes and their products</th>
<th>Vegetables and their products</th>
<th>Fruits and their products</th>
<th>Dairy products</th>
<th>Other Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize meal</td>
<td>Meat (white)</td>
<td>Dry bean</td>
<td>Cabbage</td>
<td>Pumpkin</td>
<td>Citrus</td>
<td>Milk (powder) Soup</td>
</tr>
<tr>
<td>Samp</td>
<td>Meat (red)</td>
<td>Beans (canned)</td>
<td>Swiss chard</td>
<td>Tomato</td>
<td>Apple</td>
<td>Fresh milk</td>
</tr>
<tr>
<td>Rice Flour</td>
<td>Head &amp; Feet (chicken)</td>
<td>Peanut butter</td>
<td>Onion</td>
<td>Mango</td>
<td>Banana</td>
<td>Sour milk</td>
</tr>
<tr>
<td>White bread</td>
<td>Fish (fresh)</td>
<td>Soya mince</td>
<td>Carrot</td>
<td>Beetroot</td>
<td></td>
<td>Cooking oil</td>
</tr>
<tr>
<td>Brown bread</td>
<td>Fish (canned)</td>
<td></td>
<td>Green beans</td>
<td>Butternut</td>
<td></td>
<td>Coffee</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sweet potatoes</td>
<td>Tomato</td>
<td></td>
<td>Tea</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Potatoes</td>
<td></td>
<td></td>
<td>Sugar</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Butternut</td>
<td></td>
<td></td>
<td>Margarine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tomato sauce</td>
<td></td>
<td></td>
<td>Jam</td>
</tr>
</tbody>
</table>

Leafy | Non-leafy

Margarine | Coffee

Tea | Sugar

Margarine | Jam
Figure 5.2 shows the amount of nutrients contained in the food obtained by means of
dryland cropping and livestock production. The amounts are again expressed as
proportions of RDA.

![Graph showing nutrient supply for different types of households]

**FIGURE 5.2**: Nutrients contained in food produced by households in Sekuruwe and Ga-
Molekane expressed as proportions of RDA (2001; n = 131)

Figure 5.2 shows that food produced by means of dryland cropping and livestock
production supplied households with modest amounts of iron, and substantial quantities of
vitamins A and C. Generally, crops are not rich sources of iron (Wolmarans, Langenhoven
& Faber, 1992:9-25 and Burgess et al., 1998:200). Inadequacy of iron may also be
ascribed to the very small amounts of meat and milk produced by local livestock. Table
5.2 shows the crops and livestock products produced by the households in Sekuruwe and
Ga-Molekane. When considering food obtained from agriculture only, all three nutrients
were inadequate in all three types of households. As with purchased food, the nutrients
supplied by crops and livestock products decreased as poverty increased. This indicated
that the poor and ultra poor households did not make up for their low purchasing power by producing more food.

TABLE 5.2: Crops and livestock products produced by households in Sekuruwe and Ga-Molekane

<table>
<thead>
<tr>
<th>Agricultural products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crops</strong></td>
</tr>
<tr>
<td>Maize (grain and cobs)</td>
</tr>
<tr>
<td>Bambara groundnuts</td>
</tr>
<tr>
<td>Beans (grain and green pods)</td>
</tr>
<tr>
<td>Groundnuts</td>
</tr>
<tr>
<td>Pumpkin (green and ripe)</td>
</tr>
<tr>
<td>Watermelons</td>
</tr>
<tr>
<td>Sweet reeds</td>
</tr>
<tr>
<td>Sweet potatoes</td>
</tr>
<tr>
<td>Bitter watermelons</td>
</tr>
<tr>
<td>Gourds</td>
</tr>
<tr>
<td>Traditional vegetables</td>
</tr>
</tbody>
</table>

In Figure 5.3 the nutrients contained in purchased food and in the food obtained by dryland cropping and rearing of livestock are combined. When the two sources of food (purchased and own production) were combined, the RDA of vitamin A and vitamin C of non-poor households were more than satisfied. Only iron remained deficient. The same applied to poor households, but the food from the two sources contained only 70 % of their RDA of vitamin A. In the case of ultra poor households, purchased food and food from own production combined supplied 75 % of their RDA of vitamin C. The amounts of iron (18 % of RDA) and vitamin A (33 % of RDA) contained in these foods were still seriously deficient.
The analysis of the 131 households showed that when they relied on purchased food only, vitamin C was adequate in non-poor and poor households, and iron and vitamin A were inadequate. Purchased food failed to supply sufficient amounts of all three nutrients to the ultra poor households. On average, adding food obtained from agriculture to purchased food eliminated the deficiencies of vitamin A among non-poor and poor households, and vitamin C deficiency among the ultra poor households. However, the combination of food obtained from agriculture and purchases failed to remove the inadequacy of iron among all types of households. The analysis indicated that the nutrients that were seriously deficient were iron (in all types of households) and vitamin A (in the ultra poor households).
5.3 NUTRIENT INTAKE BY THE 12 HOUSEHOLDS THAT PARTICIPATED IN EVALUATION OF THE DRUM AND DRIP MICRO-IRRIGATION SYSTEM

In this section, estimates of the contributions made by food produced in the gardens irrigated with the Drum and Drip micro-irrigation system, foods produced by means of dryland cropping and livestock production, and purchased food to the nutrient intake of the twelve households that participated in the evaluation of the Drum and Drip irrigation system are analysed. Again it was assumed that the households concerned consumed all the foods available. Table 5.3 presents selected characteristics of the 12 households, which may have an impact on their nutritional security.
TABLE 5.3: Socio-economic characteristics of the 12 households that participated in the evaluation of the Drum and drip micro-irrigation system

<table>
<thead>
<tr>
<th>Garden</th>
<th>Poverty status</th>
<th>Type of household</th>
<th>Size of household</th>
<th>Adult equivalent income per month (R)</th>
<th>Proportion of income spent on food (%)</th>
<th>Dryland cropping</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Non-poor</td>
<td>Wage-earning</td>
<td>4</td>
<td>868</td>
<td>45</td>
<td>Home garden only</td>
</tr>
<tr>
<td>1b</td>
<td>Ultra poor</td>
<td>Welfare</td>
<td>11</td>
<td>157</td>
<td>50</td>
<td>Home garden only</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
<td>Welfare</td>
<td>7</td>
<td>287</td>
<td>50</td>
<td>Home garden &amp; field</td>
</tr>
<tr>
<td>3a</td>
<td>Poor</td>
<td>Migrant</td>
<td>6</td>
<td>387</td>
<td>45</td>
<td>Home garden only</td>
</tr>
<tr>
<td>3b</td>
<td>Poor</td>
<td>Migrant</td>
<td>6</td>
<td>324</td>
<td>67</td>
<td>Home garden only</td>
</tr>
<tr>
<td>4</td>
<td>Non poor</td>
<td>Wage-earning</td>
<td>3</td>
<td>2 143</td>
<td>49</td>
<td>Home garden only</td>
</tr>
<tr>
<td>5</td>
<td>Non poor</td>
<td>Wage-earning</td>
<td>3</td>
<td>763</td>
<td>22</td>
<td>Home garden only</td>
</tr>
<tr>
<td>6</td>
<td>Poor</td>
<td>Welfare</td>
<td>7</td>
<td>215</td>
<td>56</td>
<td>Home garden only</td>
</tr>
<tr>
<td>7</td>
<td>Non poor</td>
<td>Welfare</td>
<td>5</td>
<td>417</td>
<td>44</td>
<td>Home garden &amp; field</td>
</tr>
<tr>
<td>8</td>
<td>Poor</td>
<td>Migrant</td>
<td>9</td>
<td>275</td>
<td>37</td>
<td>Home garden only</td>
</tr>
<tr>
<td>9</td>
<td>Poor</td>
<td>Trader</td>
<td>1</td>
<td>208</td>
<td>16</td>
<td>Home garden only</td>
</tr>
<tr>
<td>10</td>
<td>Ultra poor</td>
<td>Migrant</td>
<td>7</td>
<td>137</td>
<td>52</td>
<td>Home garden &amp; field</td>
</tr>
</tbody>
</table>
5.3.1 Contributions of food produced in the gardens irrigated by the Drum and Drip micro-irrigation system, food produced by means of dryland agriculture, and purchased food to the nutrient intake of the twelve households that participated in the evaluation of the Drum and Drip irrigation system

Purchased food

In Figure 5.4 the amounts of the three nutrients contained in the food purchased by the 12 households that participated in the evaluation of the Drum and Drip micro-irrigation system is presented. The amounts are expressed as proportions of the recommended daily allowances (RDA).

FIGURE 5.4: Nutrients contained in food purchased by the 12 households expressed as proportions of RDA
Purchased food supplied adequate vitamin C to seven of the twelve households. Purchased food supplied adequate levels of vitamin A to two households only. Iron was seriously deficient in all twelve cases. The inadequacy of vitamin A and iron indicated that food purchased by households was both not rich in vitamin A and iron, or if it was, the quantities that were purchased were too small to meet the RDA. Food purchased by the 12 households was similar to that shown in Table 5.1.

**Food produced by means of dryland cropping and livestock**

Figure 5.5 shows the amount of nutrients contained in food obtained by means of dryland cropping and livestock production in the households that participated in the evaluation of the Drum and Drip micro-irrigation system. The amounts are again expressed as proportions of RDA.

![Nutrient supply graph](image)

**FIGURE 5.5:** Nutrients contained in crop and livestock products produced by the 12 participating households expressed as a proportion of RDA (2001; n = 12)
Crop and livestock products obtained by the 12 households were similar to those reported in Table 5.2. Food produced by means of dryland agriculture supplied adequate vitamin A and vitamin C to one household only. Again the effect of household size was notable because the only household that produced an adequate amount of vitamin A and vitamin C consisted of a single person only. Food obtained by means of dryland cropping and livestock production failed to supply adequate iron to any of the 12 households. According to Wolmarans et al. (1992:9-25) and Burgess et al. (1998:200), crops and vegetables are not rich sources of iron. Livestock products were not enough to supply adequate quantities of iron to any of the 12 households.

**Food from in the gardens irrigated with the Drum and Drip micro-irrigation system**

The combined contribution to the nutrient intake of households by vegetables grown during production periods one and three, and crops grown during production period two in the gardens irrigated with the Drum and Drip micro-irrigation system, was estimated to assess the impact of irrigated vegetable gardening on the nutrient intake of the twelve households. Figure 5.6 shows the quantities of nutrients contained in the vegetables and crops harvested from the irrigated gardens expressed as proportions of the RDA of the 12 households.
In three of the 12 cases, crops and vegetables harvested from the gardens equipped with the Drum and Drip micro-irrigation system contained enough vitamin A to meet 67% of their RDA. In two of the 12 cases they contained enough vitamin C to meet 67% of their RDA. Two of the three of households whose gardens supplied enough vitamin A (G4 and G5) had families of three people, and in garden 9 there was only one person. This indicates that size of the gardens should be matched to household size if vegetable gardening is to ensure adequate intake of selected micro-nutrients. Iron contained in the vegetables and crops harvested from the irrigated gardens was not enough to meet the RDA of any of the households. As mentioned earlier crops and vegetables are not good sources of iron. A list of vegetables grown in production periods one and three, and crops grown in production period two appears in Table 5.4.
TABLE 5.4: Vegetables and crops grown in the gardens irrigated by the Drum and Drip micro-irrigation system

<table>
<thead>
<tr>
<th>Production period 1</th>
<th>Production period 2</th>
<th>Production period 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beetroot</td>
<td>Maize</td>
<td>Beetroot</td>
</tr>
<tr>
<td>Cabbages</td>
<td>Dry beans</td>
<td>Cabbages</td>
</tr>
<tr>
<td>Onions</td>
<td>Groundnuts</td>
<td>Onions</td>
</tr>
<tr>
<td>Pumpkins</td>
<td></td>
<td>Green peppers</td>
</tr>
<tr>
<td>Swiss chard</td>
<td></td>
<td>Swiss chard</td>
</tr>
<tr>
<td>Tomatoes</td>
<td></td>
<td>Carrots</td>
</tr>
</tbody>
</table>

5.3.2 Combined contribution of food produced in the gardens irrigated by the Drum and Drip micro-irrigation system, food produced by means of dryland agriculture, purchased food to the nutrient intake of the twelve households that participated in the evaluation of the Drum and Drip irrigation system

In Figure 5.7 the nutrients contained in the vegetables harvested from the gardens irrigated by the Drum and Drip micro-irrigation system were combined with the nutrients contained in purchased food, and in the food produced by means dryland agriculture.
FIGURE 5.7: Nutrients contained in food obtained from three sources, namely the gardens irrigated by the Drum and Drip micro-irrigation system, dryland agriculture, and purchases food expressed as proportions of the RDA of the 12 participating households.

When the produce from the irrigated gardens was combined with purchased food and food produced by means of dryland agriculture, the intake of vitamin A was considered adequate in ten households, and the intake of vitamin C in 11 households. Combined, the three sources supplied an adequate amount of iron to one household only.

Summarized, the findings of the analysis of nutrition among the 12 households showed irrigated vegetable gardening to have the potential to remove the deficiencies in vitamin A and vitamin C, but not to address the inadequacy of iron in the local diets. This implies
that nutritional interventions other than crop and vegetable production in an irrigated garden are needed to address the inadequacy of iron among local households.

5.4 Distribution of nutrient supply over the year

In the analysis presented in the two previous sections (5.2 and 5.3) nutrient supply was assumed to be spread evenly over the duration of the year. In reality, nutrients supplied by produce from the irrigated gardens and from dryland cropping and livestock production were only available during periods of harvest and subsequent storage. Nutrients supplied by purchased food, on the other hand, were expected to be high during the first days of the month and low towards month end, but this was not taken into account. In this section the availability of specific nutrients over time during the period August 2000 to September 2001 is assessed on a monthly basis. Table 5.5 shows the periods during which households consumed crops and vegetables from dryland farming and vegetable gardening.

TABLE 5.5: Periods during which households consumed vegetables and field crops

<table>
<thead>
<tr>
<th>Source of nutrients</th>
<th>Period of consumption</th>
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<tr>
<td>Dryland crop production</td>
<td>October 2000 to April 2001</td>
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<tr>
<td>Irrigated gardens</td>
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<tr>
<td>Production period 1</td>
<td>October 2000 to January 2001</td>
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<tr>
<td>Production period 2</td>
<td>May 2000</td>
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<tr>
<td>Production period 3</td>
<td>July to September 2001</td>
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</table>

Analysis of the nutrients contained in the food purchased by the twelve households showed that on average this source supplied 88 % of the RDA of vitamin C, 33 % of the RDA of vitamin A and 21 % of the RDA of iron.
Figure 5.8 shows the distribution over time of nutrients contained in food produced by dryland farming to the 12 households expressed as proportions of their RDA, for the period August 2000 to September 2001. Consumption of the food was assumed to be distributed evenly over the period October to April. This was a simplification of the reality. During October the consumption of field crops by local people tended to be modest. In most cases they occasionally harvested small quantities of wild vegetables, because the plants that were used for this purpose were still young. Consumption peaked during the period December to February, when wild vegetables were fully grown, and leaves of runner beans and pumpkins became available. Green maize and green beans were also ready to be harvested at that time. From March onwards consumption of food from dryland agriculture decreased again as field crops started to dry off, and wild vegetables turned to seed and died. However, the data that were collected did not allow for the accurate determination of the distribution of nutrient supply by dryland agriculture over time. This is why the nutrient supply by this source was distributed evenly over the period October to April.
FIGURE 5.8: The distribution over time of nutrients contained in food produced by means of dryland agriculture expressed as a proportion of the RDA of the 12 participating households.

Over a period of seven months (October 2000 to April 2001), the nutrients contained in food obtained from dryland cropping and livestock production supplied households with adequate quantities of vitamin A and vitamin C. However, it failed to supply adequate quantities of iron to meet the RDA of the 12 households. As indicated earlier, these crops are generally not a rich source of iron, and the quantities of livestock products produced by the 12 households were too small to supply iron in sufficient quantities.

Figure 5.9 shows the distribution over time of the supply of nutrients by vegetables and crops harvested from the gardens irrigated by the Drum and Drip micro-irrigation system to the 12 households during the period August 2000 to September 2001. Nutrient supply is expressed as proportions of RDA. In the construction of Figure 5.9 nutrients supplied by
the food produced in the irrigated gardens were spread evenly over the full periods of harvest. In reality the quantities of vegetables harvested from the gardens tended to be low at the start and again at the end of the harvesting period, and high during the middle.

FIGURE 5.9: The distribution over time of nutrients contained in vegetables and crops, harvested from the gardens irrigated by the Drum and Drip micro-irrigation system, over the period of one year, with nutrients expressed as a proportion of the RDA of the 12 participating households

Figure 5.9 shows that the production of vegetables and crops in the irrigated gardens supplied nutrients during three distinct periods, namely, October to December 2000, May 2001, and July to September 2001, when vegetables or crops were harvested. The supply of vegetables during these three production periods varied in terms of quantities and duration of nutrients supplied. From October to December 2000 nutrient supply was the highest of all three periods. On average, vegetables harvested from the irrigated gardens
contained enough vitamin A and vitamin C to satisfy the RDA of the 12 households during that period, but the supply of iron was still deficient. During May 2001, nutrients supplied by garden produce were spread equally over a period of 30 days. During that period the irrigated gardens were planted to maize, groundnuts and dry beans. Maize was harvested when still green on less than four occasions, over a period of two weeks. Groundnuts and beans were harvested on one occasion, and the grains were dried for later use. During that period nutrients contained in the garden produce were inadequate to meet the RDA of households. Figure 5.9 shows that vitamin A supply was at its lowest during that period, but iron peaked. This was the case because dry legume grains (dry beans and groundnuts) are not rich sources of vitamins A and C, but they do contain large quantities of iron when compared with vegetables (Wolmarans et al., 1992:9-25 and Burgess et al., 1998:200). During the period July to September 2001, when the irrigated gardens were again planted to vegetables, the supply of vitamin A and vitamin C was again high, and that of iron was low once more.

In Figure 5.10 the distribution over time of the combined amount of nutrients supplied by purchased food, food produced by means of dryland agriculture, and food produced in the irrigated gardens is presented.
FIGURE 5.10: The distribution over time of three nutrients supplied by purchased food, food produced by dryland cropping, and food harvested from the gardens irrigated by Drum and Drip micro-irrigation system to the 12 participating households over a period of one year, with nutrients expressed as proportions of their RDA.
Figure 5.10 shows that the supply of nutrients contained in the various foods consumed by
the 12 households was uneven, and corresponded to a feast and famine scenario.
Generally, nutrient supply was low during periods when households relied on purchased
food only. This occurred during the period August to September 2000, and again in June
2001. During such times the supply of vitamin A and iron was seriously deficient, but that
of vitamin C was adequate. When both vegetables harvested from the gardens irrigated by
the Drum and Drip micro-irrigation system, and vegetables and crops harvested from yards
and fields were added to purchased food, nutrient supply peaked. When the three sources
of foods were available simultaneously (October to December 2000), the RDA of vitamin
A and vitamin C were more than satisfied. Even the supply of iron peaked, reaching near-
adequacy levels. When households combined purchased food and food obtained from
dryland agriculture (January to April 2001), the supply of vitamin A and vitamin C
remained adequate, but iron was deficient. During May 2001, when households harvested
field crops from their irrigated gardens, nutrient supply differed only slightly from that
during August to September 2000 or June 2001, when only purchased food was available.
This indicated that planting irrigated gardens to field crops, such as maize, groundnuts and
dry beans, did little in terms addressing the supply of critical nutrients. When vegetables
from irrigated gardens were again planted to supplement purchased food (July to
September 2001), all nutrients except iron were adequate.

The results presented in Figure 5.10 demonstrate that agriculture in general, and irrigated
vegetable production in particular, plays an important role in the nutritional security of
contemporary households in the study area. When food obtained from dryland agriculture
or vegetables from the irrigated gardens were available for combination with purchased
food, vitamin A and iron deficiencies were removed. The results also showed that there
were periods when nutrient deficiencies were severe. These occurred in August to September 2000, and May to June 2001, when households mainly relied on purchased food. These are the periods during which irrigated vegetable gardening could play an important role in nutrient supply. Timing the harvest periods to coincide with periods when no food is obtainable from dryland agriculture is crucial. This means that irrigated gardening should be planned to supply vegetables during the period May to September. The results showed that the range of vegetables that were introduced for production in the irrigated gardens suited the purpose of addressing deficiencies in vitamin A and C. Their failure to remove the iron deficiency indicated that there is a need for an additional nutritional intervention to alleviate this shortage.
CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Chronic malnutrition among children in rural areas in general, and in the villages of Sekuruwe and Ga-Molekane in particular, was the development problem, which gave rise to this study. Central to this development problem were the lack of calcium, iron, vitamin A and vitamin C in the diets of the children. These nutrient deficiencies were identified by Amissah (2000:206-210), who linked them, especially the lack of vitamin A and vitamin C, to the general absence of vegetables and fruit in the diets of local people. The lack of irrigation water necessary to enable people to produce their own fruit and vegetables, and poverty, preventing people from buying these foods were the two reasons why fruit and vegetables were largely absent from the diets (Amissah, 2000:214-218). Home gardening using the Drum and Drip micro-irrigation system was selected as an intervention because of its potential of enabling households to produce their own vegetables (Albertse, 2000). The present study was initiated to evaluate the suitability of this intervention on-farm. The study also assessed the contribution of food produced in the vegetable gardens irrigated by the Drum and Drip micro-irrigation system to the nutrition of participating households. This contribution was compared with those from purchased food and food obtained by means of dryland cropping and livestock production. To describe the context in which this food security intervention occurred, the livelihoods and broad food security strategies of local people were investigated by means of a household survey.

The survey results showed that livelihoods in Sekuruwe and Ga-Molekane were based mainly on income generated outside the two settlements. Remittances from migrant members of households and claims against the State in the form of old-age pensions were
the two most important sources of income. For the majority of households (72 %) these two sources provided at least half of their household income. Combined, they contributed 61 % of total household income in the two villages. The flow of money into the villages from elsewhere enabled many households to remain resident in these rural settlements, without engaging in any substantial agricultural production or other local economic activity. However, remittances and old-age pensions failed to lift the incomes of most households above the poverty line. More than three-quarters (77 %) of the households had monthly incomes below the poverty line of R413.11 per month per adult equivalent. The high degree of poverty in the two villages was associated with high rates of unemployment (45 %) among the economically active population. These circumstances appeared suitable for the introduction of irrigated gardening, because it is a local economic activity expected to increase food security, generate household income, and reduce poverty.

The on-farm evaluation of the Drum and Drip micro-irrigation identified several constraints, which affected vegetable production. Water remained a key constraint. The amount of grey water produced by participating households was not enough to meet recommended irrigation requirements. Moreover, participants disliked the use of grey water for reasons of hygiene. As a result, irrigated vegetable gardening did increase the water requirements of participating households contrary to what had been expected when the intervention was selected. In the study area, waters from all available sources were rated as presenting a high salinity hazard. Continuous use of these waters for irrigation is expected to have detrimental effects on soil quality as a result of salinisation. Consequently, irrigated vegetable gardening in the study area is not likely to be sustainable, unless better quality water is made available. Generally, irrigation in the ten gardens did not meet the water requirements of the selected crops. However, apparent
inadequacies in the supply of water did not have a notable effect on the yields obtained. Improved recommendations for the supply of irrigation water to four important vegetables were formulated.

Other constraints that affected the productivity of the irrigated gardens in which the Drum and Drip systems were installed included inadequate crop protection, low nutrient supply, and a lack of knowledge and experience in the growing of transplants among participants. Short training sessions in the form of lectures or once-off demonstrations proved inadequate to address this knowledge gap. This indicated that a more comprehensive and intensive training package is needed for participating gardeners to achieve full competency in irrigated vegetable gardening.

Several technical weaknesses affected the suitability of the Drum and Drip micro-irrigation system. Rusting of the drum around the outlet caused the development of leaks within a period of two years. Frequent clogging of the drippers was problematic also. The study showed that some participants thought that the 36 m$^2$ gardens were too large. When they reduced the planted area they abandoned use of the system because they did not realize that it could be adapted to smaller surfaces by disconnecting unused dripper lines. This emphasised the importance of presenting users with a comprehensive training package.

The study showed that participants lacked interest in irrigated vegetable production during summer, when traditional vegetables were available all around. Fallowing of the gardens during summer reduced their productivity.
A factor that directly reduced the positive impact of the irrigated gardens on the problem of chronic malnutrition among children was the general reluctance or refusal by most children, and also by other members of participating households, to eat vegetables on a daily basis, during the harvesting periods. This indicated that increasing vegetable production does not necessarily lead to a concomitant increase in vegetable consumption.

The consultative on-farm research approach that was used to introduce the irrigated vegetable gardening intervention was not ideal. It did not allow the intended end-users to contribute to the design of the technology. In this case, the use of a collaborative on-farm research approach would have been more appropriate.

The results of a nutritional analysis of the food consumed by the 131 surveyed households in the two villages showed that when these households relied solely on purchased food, vitamin C was adequate among the non-poor and poor households, but iron and vitamin A were not. Purchased food failed to supply adequate levels of all three nutrients among the ultra poor households. Adding food obtained from dryland agriculture to purchased food eliminated the deficiencies in vitamin A among non-poor and poor households, and deficiencies in vitamin C among all households. Iron, however, remained deficient among all three types of households. This analysis indicated that iron (in all types of households) and vitamin A (in the ultra-poor households) were the nutrients most deficient in the diets of the local people.

The supply of nutrients by purchased food and food produced by means of dryland agriculture to the 12 households that participated in the evaluation of the Drum and Drip micro-irrigation system did not differ much from that of the 131 surveyed households. The
supply of vitamin C was adequate in the majority of households and vitamin A in few. Iron was seriously deficient in all 12 households. When the produce from the irrigated gardens was added to purchased food and food produced by means of dryland agriculture, the intakes of vitamin A and vitamin C were adequate in nearly all 12 households, but iron remained deficient. This indicated that irrigated vegetable gardening was a suitable intervention to address the shortages of vitamin A among households in the study area, but not to remove deficiencies in iron.

Although agriculture in general, and irrigated vegetable production in particular, were found to play an important role in supplementing the nutrients obtained from purchased food, the analysis of nutrient availability revealed that supply to households was unevenly distributed, with intermittent periods of plenty and periods of scarcity. Periods of low nutrient availability occurred when households relied on purchased food only. When households added food obtained either from dryland farming or irrigated vegetable gardening to the food that they purchased, their RDA of vitamin A and vitamin C were met. Iron remained deficient throughout the year.

The findings of the study yielded several recommendations. Perhaps the most important was that the problem of lack of water in the two villages needed to be addressed. Besides making life a lot easier, especially for women, improved access to water is likely to enable households to engage in local economic activities, such as irrigated vegetable production, which will assist to reduce poverty. One modest way of addressing the lack of water is harvesting rainwater. Rainwater could be used to dilute other local irrigation waters, which were found to be highly saline.
The analysis of selected nutrients in the diets of local households revealed that nutritional interventions other than irrigated vegetable gardening are needed to address the chronic shortage of iron. There is also a need to devise cropping calendars and systems that even out the supply of produce over the different seasons.

With reference to vegetable gardening by means of the Drum and Drip micro-irrigation technology it is recommended that:

(i) introduction of irrigated vegetable production in areas where this practice is new must include the provision of a comprehensive training package that covers vegetable production practices, the use of grey water for irrigation purposes, and the importance of vegetables in human nutrition, and

(ii) introduction of the Drum and Drip micro-irrigation system for use in home gardens must include materials to fence off the irrigated plots to protect the plants against livestock.

The study also revealed the need for additional research. Issues requiring further investigation include:

(i) finding ways of increasing the life span of the metal drums, especially in areas where saline water is used for irrigation;

(ii) solving the problem of clogging of drippers, especially when saline water is used;

(iii) investigating the suitability of furrow irrigation as an alternative to micro-irrigation by means of the Drum and Drip micro-irrigation system; and
(iv) identifying suitable nutrition interventions to increase the intake of iron by households in the study area, which would include interventions other than the production and consumption of vegetables.
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APPENDIX A: MATERIALS REQUIRED TO CONSTRUCT THE DRUM AND DRIP MICRO-IRRIGATION SYSTEM

Construction of the Drum and Drip micro-irrigation system:

Materials needed to construct the system

1. 210 l metal drum
2. 6 x 6 metre x 15mm polyethylene class 3 pipes
3. 5 x 15 mm nylon T-pieces
4. 2 x 15 mm 90° nylon bends
5. 1 x 100 mm x 15 mm nylon running nipple with back nuts
6. 1 x 15 mm ball valve
7. 5 x 1.0 polyethylene class 3 pipes
8. 1 x 15 mm nylon 90° male bend with thread
9. 1 roll x 1.5 mm woven nylon string

Construction of the system

1. Dripper lines - On the polyethylene pipes, already cut to 6 metre lengths
   Measure and make marks on the pipes, every 30 cm apart. Heat a 1.5 mm
diameter nail, in a fire a burn a hole on the marks, through the pipes. Use a
darning needle and thread the string through the hole made in pipes. Tie a knot
at each end of the string. This is the dripper.

2. Drum - A 210 l oil drum with the lid removed is used as container to store
   water. A 20 mm diameter hole is drilled into the side of the drum near the
   bottom of the drum. A 15 mm running nipple is the fitted through the hole and
   fixed to the drum with two back nuts. Apply silicon sealer to prevent leakage.

3. Tap - A 15 mm ball valve is now fitted into the running nipple. The 15 mm
   male nylon bend is now fitted to face downwards.
4. Pipelines - The 6 x 1 metre short pipelines are now connected to the system. Starting from the end, a 90° nylon bend is connected to a T-piece and a dripper line and again to a short piece onto the next T. Continue until the 90° bend is connected to the last dripper line. These pipes are now connected with short piece of 30 cm to the male nylon bend connected to the tap.
APPENDIX B: INTERVIEW SCHEDULE FOR SOCIO-ECONOMIC SURVEY

SEKURUWE AND MOLEKANE SURVEY (2000 – 2001)

TECHNIKON PRETORIA

<table>
<thead>
<tr>
<th>Interviewer’s name</th>
<th>1: ........................................</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2: ........................................</td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Village</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Questionnaire office number</td>
<td></td>
</tr>
</tbody>
</table>
A. DEMOGRAPHIC INFORMATION

A1. HOUSEHOLD CHARACTERISTICS

<table>
<thead>
<tr>
<th>Member of household</th>
<th>Relation to head of household</th>
<th>Age</th>
<th>Gender</th>
<th>Marital status</th>
<th>Highest educ. qual.</th>
<th>Employment status</th>
<th>Occupation</th>
<th>Field of employment</th>
<th>Time at home</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A1.3</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A1.4</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A1.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A1.7</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A1.8</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>A1.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. LAND, AGRICULTURE & RANGELAND

RESIDENTIAL SITE

B1 What is the size of the residential site?  
…………………………m x …………………m

B2 Do you have a garden on your residential site?  
(Yes = 1; No = 2)

B3 What is its size?  
…………………………m x …………………m

B4 Do you grow crops or vegetables in your garden?  
(Vegetables = 1; Crops = 2; Both = 3; Nothing = 4)

B5 How many fruit trees do you have in your residential site?
B6 Which of the following micro-livestock do you keep? Indicate numbers owned.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number (s) owned</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6. 1 Broilers</td>
<td></td>
</tr>
<tr>
<td>B6. 2 Layers</td>
<td></td>
</tr>
<tr>
<td>B6. 3 Dual purpose chickens</td>
<td></td>
</tr>
<tr>
<td>B6. 4 Pigeons</td>
<td></td>
</tr>
<tr>
<td>B6. 5 Geese</td>
<td></td>
</tr>
<tr>
<td>B6. 6 Ducks</td>
<td></td>
</tr>
<tr>
<td>B6. 7 Turkeys</td>
<td></td>
</tr>
<tr>
<td>B6. 8 Rabbits</td>
<td></td>
</tr>
<tr>
<td>B6. 9 Pigs</td>
<td></td>
</tr>
<tr>
<td>B6. 10 Dogs</td>
<td></td>
</tr>
<tr>
<td>B6. 11 Cats</td>
<td></td>
</tr>
<tr>
<td>B6. 12 Other (specify)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ARABLE LAND

B7 Do you have access to one or more arable fields? (Yes = 1; No = 2) [ ]

B8 If yes, how many fields do you have access to? (Indicate numbers) [ ]

B9 What is the size of each field?

<table>
<thead>
<tr>
<th>Field</th>
<th>Area (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B9. 1 Field 1</td>
<td></td>
</tr>
<tr>
<td>B9. 2 Field 2</td>
<td></td>
</tr>
<tr>
<td>B9. 3 Field 3</td>
<td></td>
</tr>
</tbody>
</table>

B10 Did you grow any crops on your arable land during any of the past seasons? (Yes = 1; No = 2) [ ]

B11 If now, state a reason for not growing?

........................................................................................................................................
........................................................................................................................................
RANGELAND

B12 Do you have access to rangeland?
(Yes = 1; No = 2)

B13 What does dour household use access to rangeland? (tick where applicable)

<table>
<thead>
<tr>
<th>Uses</th>
<th>Yes = 1</th>
<th>No = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>B13. 1 Grazing of animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 2 Collect fire wood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 3 Collect wood for building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 4 Collect wood for fencing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 5 Collect bush for kraals and other enclosures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 6 Collect grass for feeding animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 7 Collect plants for medicinal purposes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 8 Collect grass for thatching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 9 Collect dry dung for cooking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 10 Collect fruit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B13. 11 Other (specify)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B14 Which of the following livestock do you keep? Indicate number(s) owned.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number(s) owned</th>
</tr>
</thead>
<tbody>
<tr>
<td>B14. 1 Cattle</td>
<td></td>
</tr>
<tr>
<td>B14. 2 Sheep</td>
<td></td>
</tr>
<tr>
<td>B14. 3 Goats</td>
<td></td>
</tr>
<tr>
<td>B14. 4 Horses</td>
<td></td>
</tr>
<tr>
<td>B14. 5 Donkeys</td>
<td></td>
</tr>
<tr>
<td>B14. 6 Other (specify)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. INCOME

What are the sources of income available to your household? Indicate amounts received a month or a year.

C1 External sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Income per month</th>
<th>Income per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1. 1</td>
<td>Remittance (cash)</td>
<td></td>
</tr>
<tr>
<td>C1. 2</td>
<td>Remittance (kind)</td>
<td></td>
</tr>
<tr>
<td>C1. 3</td>
<td>Child support from parent outside household</td>
<td></td>
</tr>
<tr>
<td>C1. 4</td>
<td>Salaries &amp; wages</td>
<td></td>
</tr>
<tr>
<td>C1. 5</td>
<td>Overtime</td>
<td></td>
</tr>
<tr>
<td>C1. 6</td>
<td>Bonuses</td>
<td></td>
</tr>
<tr>
<td>C1. 7</td>
<td>Pensions</td>
<td></td>
</tr>
<tr>
<td>C1. 8</td>
<td>Disability grant</td>
<td></td>
</tr>
<tr>
<td>C1. 9</td>
<td>Child support grant</td>
<td></td>
</tr>
<tr>
<td>C1. 10</td>
<td>Other government grant</td>
<td></td>
</tr>
</tbody>
</table>

C2 Local sources: Trade

<table>
<thead>
<tr>
<th>Source</th>
<th>Income per month</th>
<th>Income per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2. 1</td>
<td>Hawking (Food)</td>
<td></td>
</tr>
<tr>
<td>C2. 2</td>
<td>Hawking (Kind)</td>
<td></td>
</tr>
<tr>
<td>C2. 3</td>
<td>Spaza shop</td>
<td></td>
</tr>
<tr>
<td>C2. 4</td>
<td>Shop</td>
<td></td>
</tr>
<tr>
<td>C2. 5</td>
<td>Selling liquor / shebeen</td>
<td></td>
</tr>
<tr>
<td>C2. 6</td>
<td>Lending money</td>
<td></td>
</tr>
<tr>
<td>C2. 7</td>
<td>Other trade (specify)</td>
<td></td>
</tr>
</tbody>
</table>

C3 Local sources: Agriculture

<table>
<thead>
<tr>
<th>Source</th>
<th>Income per month</th>
<th>Income per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3. 1</td>
<td>Agriculture (cash): crops</td>
<td></td>
</tr>
<tr>
<td>C3. 2</td>
<td>Agriculture (kind): crops</td>
<td></td>
</tr>
<tr>
<td>C3. 3</td>
<td>Agriculture (kind): animals</td>
<td></td>
</tr>
<tr>
<td>C3. 4</td>
<td>Agriculture (cash): animals</td>
<td></td>
</tr>
</tbody>
</table>
**C4 Local sources: Housing industry**

<table>
<thead>
<tr>
<th>Source</th>
<th>Income per month</th>
<th>Income per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4. 1</td>
<td>Building of houses and thatching</td>
<td></td>
</tr>
<tr>
<td>C4. 2</td>
<td>Carpentry</td>
<td></td>
</tr>
<tr>
<td>C4. 3</td>
<td>Electrical installations</td>
<td></td>
</tr>
<tr>
<td>C4. 4</td>
<td>Plumbing</td>
<td></td>
</tr>
<tr>
<td>C4. 5</td>
<td>Making toilets</td>
<td></td>
</tr>
<tr>
<td>C4. 6</td>
<td>Sewing and selling clothing</td>
<td></td>
</tr>
<tr>
<td>C4. 7</td>
<td>Brick making</td>
<td></td>
</tr>
<tr>
<td>C4. 8</td>
<td>Brooms, baskets and other</td>
<td></td>
</tr>
<tr>
<td>C4. 9</td>
<td>Making and selling foods and meals</td>
<td></td>
</tr>
<tr>
<td>C4. 10</td>
<td>Preparing and selling traditional medicines</td>
<td></td>
</tr>
<tr>
<td>C4. 11</td>
<td>Arts and crafts</td>
<td></td>
</tr>
<tr>
<td>C4. 12</td>
<td>Chopping and selling wood</td>
<td></td>
</tr>
</tbody>
</table>

**C5 Local sources: Transport**

<table>
<thead>
<tr>
<th>C5. 1</th>
<th>Transport of goods and people</th>
<th></th>
</tr>
</thead>
</table>

**C6 Local sources: Maintenance**

| C6. 1  | Repair (electric) |  |
| C6. 2  | Repair (mechanical) |  |
| C6. 3  | Repairs (other) |  |

**C7 Local sources: Services**

| C7. 1  | Land preparation for farmers |  |
| C7. 2  | Fencing and kraal making |  |
### C8 Local sources: Other

<table>
<thead>
<tr>
<th>C8. 1</th>
<th>Provide casual labour to other community members</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8.2</td>
<td>Other self-employed activities</td>
</tr>
<tr>
<td></td>
<td>.........................................................</td>
</tr>
<tr>
<td></td>
<td>.........................................................</td>
</tr>
</tbody>
</table>

### D. EXPENDITURE

D. 1 How much money does your household spend on the following items per month or per year?

<table>
<thead>
<tr>
<th>Item</th>
<th>Expenditure per month (R)</th>
<th>Expenditure per year (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1. 1 Food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 2 Cleaning materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 3 Cosmetics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 4 Fuel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 5 Clothing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 6 Furniture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 7 Medical expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 8 Educational expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 9 Transport (work)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 10 Transport (other)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 11 Housing rates and rentals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 12 Maintenance / building of residence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 13 Maintenance (other)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 14 Hiring of labour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 15 Telephone and postage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 16 Subscription and membership fees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 17 Church contributions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 18 Entertainments, tobacco and liquor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 19 Interest on loans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 20 Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 21 Agricultural inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. 22 Other (specify)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
D2 Do you save money in any of the following?

<table>
<thead>
<tr>
<th>Institution</th>
<th>Amount saved per month</th>
<th>Amount saved per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2.1 Formal institution (bank,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>building societies, trusts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2.2 Saving policy / insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2.3 Burial clubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2.4 Mgalelo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2.5 Other (specify)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 Do you have any credit outstanding?  
(Yes = 1; No = 2)  

D4 If yes, please provide the following information

<table>
<thead>
<tr>
<th>Institution</th>
<th>Amount of credit (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4.1</td>
<td></td>
</tr>
<tr>
<td>D4.2</td>
<td></td>
</tr>
<tr>
<td>D4.3</td>
<td></td>
</tr>
<tr>
<td>D4.4</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C: RECORDS OF SEMI-STRUCTURED INTERVIEWS

This part contains interviews with the participants. All the interviews have been assigned codes in order to distinguish them. The code represents the garden number and the number of an interview itself. For example, interview number one in garden 1 is represented by the code: G1.1.

GARDEN 1

Production period 1: August 2000 to February 2001

Observation:
When I visited the participant on the 25th of September she was filling up the drum with river water.

Interview: no. G1.1: 25 September 2000

Researcher (R): I can see that you are filling the drum with river. Why don’t you use the recycled water?

Participant (P): The used water that I collect from my house does not fill the drum. This is because water is very scarce around here. As a result, we use very little for bathing and washing. Even when I have washed clothes the water cannot fill up the drum. In two days, the water that I collect for irrigation fills the drum half way. The white man (Mr. Albertse, the designer of the Drum and Drip micro-irrigation system) told us that we must irrigate with a full drum three times per week. If I only use recycled water I won’t be able to fill up for three times a week. To make sure that I fill up the drum I have to go the river to fetch water to fill up the other half. If I don’t water my plants as we have been instructed, I am afraid that my crops will not grow well.

R: I think going to the river limit your time for other domestic jobs

P: I do not have many things to do because our family is small. In the morning, when my husband and child have left for work and school, I go to the river with a wheelbarrow that carries three 20 l containers at a time. I go to the river there twice. I normally finish fetching water by 10 pm, and then start doing other jobs.

R: Isn’t this a hard job for you?

P: It is hard but I have to do it because the drum has to be full when I irrigate. These vegetables a lot of need water to grow. If not irrigated properly they tend to die. I fetch the water alone; when I go for the second time I already feel tired and force myself.

Observation:
On the 2nd of October the participant harvested a lot of vegetables
Interview: No. G1.2: 02 October 2000

**R:** You harvested a lot of vegetables. Will you finish all of them?

**P:** *It is impossible to finish all these vegetables. I will give some to my neighbours and relatives. These people are very helpful to us. When we are in need of food we can ask from them. This is how we live here. It is good to have a good relationship with your neighbours so that during difficult times you can be able to ask help from them.*

**R:** Do you only give vegetables to your relatives and neighbours?

**P:** *I also gives the vegetables to my friends. Giving vegetables to the people who are close to me assures me of going to ask food from them when I am in need.*

**Observation:**
Most of the times when I visited her I found that the vegetables were big, indicating that they were harvested less frequent

Interview: No: G1.3: 07 October 2000

**R:** Your vegetables grow very fast, why don’t you harvest them daily?

**P:** *We cannot eat vegetables everyday. During month end we buy meat, fish and other things to eat with pap. When we feel that we have had enough meat or fish is then that we eat vegetables. When I serve the vegetables we don’t finish our dishes. Vegetables are only nice when you eat them after a while.*

**R:** What about your child, does he like vegetables?

**P:** *He is still young but you can see when he is so selective, he does not like eating vegetables. When he eats pap with vegetables he does not finish his plate also.*

**Observation:**

In January 8 (2001) all the first crops were harvested and the residues were not removed

Interview: No. G1.4: 08 January 2001

**R:** I expected to see your garden prepared for the following crop

**P:** *I have a young baby. This makes it impossible for me to work in the garden. If it were not for that, I would have prepared my garden. I do not even have some time to remove the residues of the previous crops; it is making my yard look dirty.*

**R:** When will you start working in your garden again?

**P:** *Even when the time that I am allowed to go out of the house has come I don’t think I will cope with the garden and looking after my baby. I must concentrate on my baby. I am the only one who cooks, cleans, washes, and now I have a baby. The woman that you have*
seen here is my relative whom we have just called to help us with other domestic work while I am waiting for my term to stay in my house to pass. She will go back as soon as I start moving out of the house. I like the garden very much but this time I will not be able to cultivate it. When the time comes that I can be able to work in a garden I will tell you and you can help me to start prepare a garden.

R: We have to get a person to take over the garden

P: I can help you to find a person to replace me. I would also give that person the scale that you gave me. The garden needs to be planted as you have told us that it is a project. The people that gave us these irrigation systems can be unhappy when they find my garden not planted. A number of people have asked about how I got this garden. I will send someone to inform one of these peoples about the availability. I promise that by next week I would be having a replacement.

The new participant

The old participant did not find a replacement as early as she had promised. I was introduced to the new participant (Teboho) in March 2001. This garden was not planted because it was too late to plant the summer crops during the time when the irrigation was transferred from the first participant to the new one. The new participants did not know how to grow seedlings; therefore she had to wait for the training for seedling production with other gardeners.

Production period 3: June 2001 to September 2001

Observation:

I noticed that the soil was always moist when I visited her, it seems as if she irrigates with more than the daily recommended water

Interview: No: G1.5: 25 June 2001

R: I can see that you are serious about the garden; the soil in your garden is always moist

P: We irrigate every day. These vegetables need a lot of water. When the soil surface dries up, the crops don’t have water and may die at any time. Many people cannot grow these crops because they are lazy to irrigate. We have a borehole in our yard, so we don’t have a problem of water shortage. My two daughters help me to work in the garden. Every morning we pump water from the borehole. It takes long to fill up the drum because our borehole pump is heavy and it is not deep enough.

R: Do you remember that I have told you that irrigating three times per week with a full drum is enough?

P: The white men whom I use to work for had a vegetable garden. It was irrigated daily. These kinds of crops are very sensitive to lack of water, they are unlike those crops that we grow during summer in our backyard. If the soil surface is dry you will see the vegetables wilting. If you see vegetables growing will it is because of water.
Observation:

In July the participant started going to river to fetch water for irrigation

Interview: No: G1.6: Date: 09 July 2002

R: You told me that now you fetch irrigation water from the river
P: During winter our borehole does not enough water. When we fill up a drum now (morning), there will be no water for the whole day and sometimes even the following day. Therefore every second day we have to go to the river to fetch water and this allows the water table in our borehole to build up.

R: Your crops could grow well even when you irrigate only three times per week

P: I don’t want my crops to suffer from of lack of water. This soil does not hold enough water because it is sandy. If I irrigate today, the following day the soil is dry. These kinds of crops need water always, if you don’t water sufficiently they don’t grow well.

R: Did Lebo (the old participant) tell you that you could also use recycled water to irrigate; it is not dangerous to your crops and your health

P: I know that she was irrigating her vegetables with dirty water and she also advised us to use it to avoid pumping water from our borehole. To be honest with you, I don’t want to use soapy water to irrigate my vegetables. I don’t think that the water is good for the crops and our health as well. The water that has been used for bathing can make us sick because it has germs (pathogens). We only use the water to irrigate trees. I can only use dirty water if the person who said that we must use this water could give us chemicals to clean this water or kill the germs (pathogens). At the moment we rather go to the river than use soapy water.

Observation:

On the 16 July 2001 I saw the participant selling some of the vegetables she harvested

Interview: No: G1.7: 16 July 2001

R: I can see that you have started selling the vegetables

P: We have had enough of these vegetables. We have been eating them time and again since we started harvesting. Now we want to eat something else for a change. These vegetables tasted very nice when we started harvesting but now we have had enough, we no longer desire them. At least it is better when we eat them once or twice in a week, and the rest of the days we could eat meat or other things such as fish.

R: What about the children, they are also no longer have appetite for vegetables?

P: They did not like the vegetables from the beginning. They just eat vegetables because we cannot provide them with other food when we serve vegetables. Our children like to eat meat everyday. They don’t know that meat is expensive. That is why I think that
selling is better because we generate money to purchase other foodstuffs that we prefer. For example bread, meat or fish.

**R:** Are you getting enough money from selling the vegetables?

**P:** Yes, I make a lot of money. If I had no garden I would not be getting this money. I have given some of the money we generated from selling the vegetables to Teboho so that she could pay her debts at the burial club. This garden is helpful to my daughters as well. The money that we generate from the garden motivates them to work hard in the garden. When they want to go to town I give them some of the money that we earn from selling. Most people in our village people need vegetables because they don’t afford meat. We are failing to meet the demand of vegetables in the villages. There is a women who sell food at the mine, she requested us to sell to vegetables to her for R10 every week. There is also one man who was told to eat more vegetables by the doctor. He is our steady customer. The teachers from the local primary school also send children to come and buy vegetables. Sometimes we have to sell the vegetables that we were supposed to eat because of the customers. We are planning to extend our garden, so that we could get enough vegetables to sell and consume at home.

**R:** Some of the gardeners give away vegetables.

**P:** I have not yet given vegetables away, but as time goes on I will give to my relatives. I cannot give the vegetables to my neighbours because I sell them. They know that vegetables are sold. They expect me to give them as they also give some food. I will give them when I have extended my garden. I want to generate money because you see that I am not working. There are also my neighbours who are selling something, and we also we buy from them. Therefore they should also buy my vegetables.

**Production period 4: October 2001 to January 2002**

**Field visit: 12 December 2001**

**Observations:**

The garden is extended (doubled the size). Swiss chard, carrots, beetroot and onions are at the harvesting stage. The green pepper from the previous production season is also being harvested. The tomatoes are still green.

Interview No: G1.8: 12 December 2001

Interview to find out how she irrigates the other part of the garden without the irrigation system.

**R:** You have extended your garden as you told me previously

**P:** This time we have a lot of vegetables than the previous time. I told you that when you come back our garden would be big. Although it is big, the customers are still finishing the vegetables.
R: I think this time you manage to give some vegetables to your neighbours

P: Yes! I only gave them for once when I started harvesting. They know vegetables are sold here. They come and buy.

R: How do you irrigate this section without the pipes?

P: We use a tin. It irrigates nicely although it is tiring to use it. You can see that there is no difference between the area irrigated by the pipes (irrigation system) and a tin. The pipes are good but they have a disadvantage of blocking from time to time. Even when you have just unblocked the dripper by pulling the string sideways, it is soon blocks again.

Production period 5: February 2002 to May 2002

Field visit: 25 March 2002

Observations:

The garden is not planted, the drum is leaking and they are preparing seedlings of Swiss chard, beetroot, onion and carrots seedlings.

Interview No: G1.9: 25 March 2002

R: I thought your garden would be planted

P: There are traditional vegetables that we can eat during this time. When we need vegetables we just get into the home garden and harvest some. We cannot plant our irrigated garden whilst we have plenty of vegetables in the other garden. Another problem is that now it is very hot. I am afraid that the vegetables that we grow in our irrigated garden could die because the sun is very hot.

R: You think it is better to stop cropping your garden during this time

P: Yes, it is better not to plant because there are traditional vegetables that we can eat, in case we need vegetables. Those crops that we grow in our irrigated garden could have a problem because now it is very hot. The sun can burn them. Buying packets of seeds and growing them when it is too hot is risky and could be a waste of money if they die. These vegetables that we grow in our irrigated garden cannot tolerate hot conditions. Big farmers are able to grow them because they have sprinklers that irrigate all the time. When you irrigate when it is hot the soil dry up quickly. This means that a lot of water would be required when we want to grow vegetables in summer, where can we get that water because you can see that water is very scarce here, and our borehole is broken.

R: During the training you were told that some of the vegetables could grow even when it is summer?

P: I understand that, but during the summer period we have a lot of vegetables. Some of the traditional vegetables grow without being planted. If there is a need for vegetables, we
can eat the traditional vegetables during summer. When they are finished in May is then that we can plant our irrigated garden to vegetables. And then plant again in September when we have finished the vegetables that would have planted during May.

R: Do you find it easy for you to continue with your garden in my absence?

P: We don’t have a problem. The white man and you have taught us a lot of things concerning vegetable gardening. We grew these seedlings without you. The most difficult thing about gardening is to grow seedlings. This is no longer difficult for us because you have taught us. When you left in October we transplanted the seedlings and we looked after them until harvesting. Now we will transplant these seedlings, and when we finish we are going to grow other vegetables for November and December. The only time we will stop is during summer because there are other vegetables that we can eat, in case we need any.

Production period 6: June 2002 to September 2002

Field Trip: July 9, 2002

Observation:
The garden is planted with beetroot, Swiss chard, onion and pepper. The irrigation system has been disconnected.

Interview no. G1.10: 9 July 2002

R: I see the pipes are disconnected, were they giving you a problem?

P: The drum is leaking, and we do not know how to seal it. That is the reason why we removed the pipes (irrigation system). We are no longer using them because the drum cannot hold water any longer.

R: How do you irrigate now?

P: We use a bucket (20 l). We irrigate each row with one bucket filled up. The crops are looking better than when we used the pipes (irrigation system). I like irrigating with a bucket although it is a hard job. When using a bucket, after irrigating you are assured that all the crops have got water, you can see that soil is wet in the entire garden. With the pipes you will only see the place where there is an opening (dripper) wet and sometimes even that place near the hole can remain dry when the dripper is blocked.

Exit interview

Interview no. G1.11

Grey water

R: Now that your borehole is broken why don’t you use grey water?

P: This water is not good for our health. It can make us to be sick. I think that even the vegetables they could smell like soap when their have been cooked. We would rather go to
the river for irrigation water than using dirty water. I am making some plans to get money for repairing our borehole. If our borehole is repaired we will be able to plant the entire garden. My husband was supposed to pay for repairing the borehole, but he is not willing to do so. We have been reminding him to repair it since January, when it was broken. When we fix it, we will no longer allow him to sell the water.

R: So now you only rely on river water, is it hard work to go to the river?

P: These days we don’t irrigate every day because we cannot manage to go to the river daily. You have seen it for yourself how difficult it is to fetch water from the river. It is better because this time we have reduced irrigation, and we don’t have to go to the river daily.

Labour

R: Does the garden work not restrain you from doing other domestic jobs?

P: This garden is very small. We are still doing things the way we have been doing before we had this garden. We work in the garden at mornings. The only job that takes some time is fetching water and irrigating. Things such as weeding or cultivation are not done frequently. You will never see our garden with weeds. When we want to cultivate, we do it together (recipient and daughters). When weeds germinate, we remove them immediately. We don’t want weeds to be a lot because they can kill our vegetables.

R: This shows that you like the garden

P: I like this garden very much because it helps us. It is more important than the other domestic jobs. Even my daughters are very keen to work in the garden because they see that they benefit from it. The money we generate helps them as well. My daughter’s assistance in the garden reduces the amount of work.

Advantages of having the garden

R: From the way work in the garden, I can see that it is important to you

P: This garden helps us a lot. We have generated a lot of money from selling vegetables. It also helps us with the fresh. If we don’t have money to buy meat we just harvest vegetables. Now we have a problem because don’t sell the vegetables because we have a little. We were supposed to be generating a lot of money because people are still coming to buy vegetables. They return home empty handed with their money because now we don’t have them.

Changes that should be made in the gardens

R: Are there changes that you think should be made, to make your gardening easier

P: We need a plastic drum because it can last for many years. Now we don’t have enough containers to store water in case there is water in our tap or rain. We will not connect the pipes to the plastic drum. We will irrigate with a bucket, we only need a drum so that we
can have enough containers to store water. Now we are thinking of collecting rainwater for irrigation. If it is possible we would like the white man (Gerrie) to bring us two plastic drums so that when it rains, or there is water in our tap we can store more water.

**R:** Do you prefer irrigating using a bucket to the pipes (irrigating system)

**P:** The pipes are good but sometimes they block. When you are using the pipes you have to keep on checking. Sometimes you will unblock a dripper and after a few minutes it stops again. Using a bucket is a lot of work, but when you finish you know that you irrigated all the crops. When the crops are big it is possible that you don’t see where the drippers are blocked, that is the main problem with the pipes.

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**GARDEN 2**

Production Period 1: August 2000 to January 2001

**Observation:**
During our discussion about irrigation one of our discussions she mentioned that she uses river water for irrigation.

Interview No G2.1: 28 September 2000

**R:** You once told me that you use river water

**P:** I irrigate on Monday, Wednesday, and Friday. That is what the white man has told us to do. If I don’t do so my crops can die. I irrigated with both recycled and river water.

**R:** Why do you have to use river water?

**P:** The used water that I collect in my house does not fill up the drum. In two days I collect half a drum of used water. Water is very scarce here around, so we have to use it carefully. In order to fill up the drum during irrigation I have to get water from the river. I would have made a garden long ago but I was constrained by this problem of lack of water.

**R:** How do you fetch water from the river?

**P:** My two grandchildren do collect the water. They go to the river after school. I am old; I can’t manage to go to the river to fetch water. My grandchildren use wheelbarrows to carry 20 l buckets. I borrow another wheelbarrow from our neighbours so that each of them has one. Each boy carries three 20 l containers each at a time. They go to the river two times a day before I irrigate. With the water they collect I able to fill up the drum and use the remaining water for other things. My grandchildren do most of the work in the garden. I just make sure that when they are working I am there to tell them what to do.

**R:** Do they like to go the river?

**P:** In the beginning they were unhappy about going to the river. Nowadays they are used to it. I don’t have to remind them, when they come from school they take wheelbarrows and
go to the river. They usually go to the river on Sunday mornings, Tuesday and Thursday afternoons so that when I want to irrigate during the following day the drum is full. They only rest when it has rained.

Observation:
On the 9 September 2002 when I visited her she was harvesting. She gave some of the vegetables to her neighbours

Interview: No. G2.2: 13 November 2000

R: You have a lot of vegetables, I see you give some to your neighbours

P: The vegetables are more than enough for us. Even when I harvest the Swiss chard from one row it is a lot for my household, we cannot finish it. We always have surplus. This is why I give the vegetables to my neighbours, relatives, and friends. Despite that I have a surplus, these people also help us. They give us food when we are in need.

R: I think you enjoy eating the vegetables very much because you harvest them regularly?

P: My husband and I enjoy eating the vegetables very much. The problem is with my grandchildren because they don’t like eating vegetables. Children don’t understand that meat is very expensive; all they want is to eat. We enjoy vegetables because we grew up eating vegetables. Nowadays people don’t like vegetables because they are used to meat and other foodstuffs.

R: Don’t you think that you can make some money by selling the produce?

P: The vegetables I produce in this garden are only enough to cook in my house and to share with my neighbours, friends and relatives. I cannot sell the vegetables to these people because tomorrow I am the one who will run to them asking for food. They give me food or help me free of charge.

Production period 2: January to May 2001

Observation:
After finishing harvesting the first crop in January 2001, she planted maize, dry beans and groundnuts.

Interview No. G2.3: 10 January 2001

R: I thought you would grow the crops that you grew previously

P: This is the time to plant summer crops. I think that those vegetables that were planted previously would have a problem because the sun is very hot. Even when I knew how to grow seedlings I would not grow them during this time because it is hot and not suitable for vegetable crops.
**Observation:**

During this period she reduced irrigation to 200 l per week.

Interview no. G2.4: 19 March 2001

R: I see now you don’t irrigate like before

P: These crops that I have planted now are not like the previous ones. We usually don’t irrigate these crops. The previous crops required more water than the current ones. Now I just irrigate because there is no rain, and because the used water that I collect in my house is enough for irrigation.

**Production period 3: May to October 2001**

Observation:

During this period tap water was available once a week in Ga-Molekane. I noticed two drums filled with tap water.

Interview no G2.5: 05 June 2001

R: Are you going to irrigate with this clean water?

P: This time we have water from our taps. The mine has donated diesel to our community. So we get water once in a week in our home taps. When it is a day to get from the pipe I make sure that I store water in two drums (400 l). This time I only use recycled once in a week. I have started to be selective to recycled water. Now I only irrigate with the water that I have used for rinsing, and from the kitchen. This water has no problem with crop growth but I think we can get sick in a long run. It is obvious that used water has germs (pathogens).

R: This means that now you discard some of the water that you have used

P: I will only use the water that has been used for rinsing washing. When there is no water in our tap I will send my grandchildren to the river. Even the white man who said we must use the dirty water will have to understand if he sees me using river water only. I don’t to use dirty water again.

**Observation:**

Goats destroyed the garden.

Interview no. G2.6: 10 August 2001

R: What happened to your garden?

P: I am very disappointed about what has happened to my garden. When we came back from church on Sunday we found goats in the garden. When I went there to check I found that they had eaten up everything. The goats got in through a small hole at the corner of our fence. The fence for the garden was no longer effective because the maize meal bags
that I had used to make the first fence were worn out. The fence that we have made with bushes is only good to prevent the chickens from getting into the garden.

**R:** What are you going to do now?

**P:** I wonder what will the person who gave us this garden say when they come here? All the gardens have vegetables except for mine. The white man will say I am no longer willing to continue with the garden. If I knew how to grow seedlings I would buy seeds and grow them quickly. I know the owners of the goats. We are going to send the women from the neighbourhood to go and inform them about the damage caused by their goats. They must pay us R60-00 for the damage. This money is little compared to the damage. Although I the seedlings were donated I know that they are expensive. The money that we have fined them won’t even buy the vegetables that I would have produced. It is the responsibility of the owners of the animals’ to make sure that they don’t get into the yards. If they don’t pay we will take the matter to the headmen kraal where they will pay even more.

**R:** What will you use the money for?

**P:** The money I have fined them very little. There is not much I can buy with it. I will buy the seeds so that after the training on seedling production I can grow them. If there is money left I will give it to my grandchildren as pocket money to spend at school. I had planned that this time I would sell some of the vegetables so that I can generate money to give to my grandchildren as pocket money. These children are helping me very much. They do most of the work in the garden. They were also very sad about the damage.

**R:** From now until you attend training on seedlings your garden will be fallow

**P:** There will be nothing. There is nothing I can do. We don’t have money to hire a car to take us to the nurseries in Potgietersrust to purchase seedlings. I will have to wait for the training; I want to have some crops but there is nothing that I can do at the moment.

**Production period 4**

**Field visit 12 December 2001**

**Observation:**
The garden was not planted.

Interview no. G2.7: 12 December 2001

**R:** It seems you there was nothing in your garden

**P:** Yes, there was nothing this time. I have bad luck; previously goats destroyed my garden, and now the chickens destroyed the seedlings before I could transplant them. You advised me to make a net with orange bags to protect the seedlings from any kind of damage. I did not do that because I had very few empty orange bags, and I had no other plans to protect the seedlings. What worries me is that all these animals that are destroying my gardens are not ours. I have told my neighbour to watch her chickens, but she did not do so.
R: Now you know how to prepare seedlings, why didn’t you prepare other seedlings

P: The seeds that we were given by the white man during the training were finished. Now I have bought other seeds, but I will start preparing the seedlings after April. Now it is very hot and we will get the vegetables from the home garden where we plant field crops. Next time I will make sure that I protect the seedlings. I have learned a lesson. I will also talk to my neighbour that she watches her chickens. If you come to check on us in winter you will find my garden planted.

Production period 5

Field visit 25 March 2002

Observations:
The garden was not planted

Interview No: G2.8: 25 March 2002

R: I thought your garden would be planted by this time

P: I have told you that I would prepare seedlings during April so that I transplant them during May when it is no longer very hot.

R: During the training you were told that some of those crops could be planted in summer

P: Despite the hot sun, now we have a lot of vegetables from the home garden that is not irrigated. Planting vegetables could be a waste. I will plant my irrigated garden when the summer vegetables are dry.

R: During the summer of every year you are going to stop growing your irrigated garden

P: Yes, there is no reason why I should plant the irrigated garden when there are plenty of vegetables in our field and our yard.

R: Don’t you experience problems now that I am away?

P: I don’t have a problem with your absence. I know that they have sent you to come and teach us how to grow vegetables and you have done that. Now I know most of the things about vegetable gardening. You will see when you come and check on us in winter that there will be vegetables. I will make sure that I make a fence that will prevent the chickens or goats from getting into my garden.
Production period 6

Field visit: 12 July 2002

Observation:
The garden is not planted. Since period three the garden was not planted.

Interview No: G2.9: 12 July 2002

R: I thought your garden would be planted

P: I have given the garden to my grandchild. When you were here he was the one doing most of the work. I like the garden but I can’t work on it because I am old. In fact I wanted to give up this garden and pass it on to anyone who is interested but he (grandchild) said that I must not give it up because he can do all the work. At first he was serious but these days he is no longer serious.

R: Do you help him or tell him to plant or buy seeds for him

P: I have bought seeds so that he could grow seedlings. He tried to grow the seedlings and mice ate them. I have told him to plant again because he had some seeds left but he did not do so. He has lost interest in the garden because of the damages that are continuously occurring.

Interview with the grandchild to find out why he is failing to continue planting the garden

R: Your grandmother told me that the garden is yours, why don’t you plant it

P2: I have tried to grow seedlings but mice ate them. They were looking very good after germinating because I was looking after them very well; watering them daily. One morning I found that the mice had started eating them. They ate them until they were finished within a week. The only thing that was left was onion. The problem is that I had no orange bags to make a net to protect the seedlings from this kind of damage.

R: So how are you going to solve this problem?
P: I want to ask the women at the first garden (garden 1) to help me to prepare seedlings. I want to prepare my seedlings in her garden because there are no mice. When the seedlings are ready I will take them to my garden. In garden 1 they always succeed in growing seedlings.

R: Will they accept that?

P: If they refuse it means that my grandmother will have to buy seedlings. If she doesn’t I will have to stop with the garden because here there is a problem of mice and chickens that eat seedlings. I want a garden but it is difficult for me to grow seedlings because rodents or chickens damage them.
**R:** If your grandmother could assist you will succeed

**P:** She helps me. She tells me what and when to grow, and she buys seeds for me. She tells me how to do things but she does not come and have a look when I am doing things. Even the seedlings that were eaten by mice I had grown them without her supervision.

**Exit interview**

Interview no G2.10

**Labour and the advantages of the garden**

**R:** I feel sorry for because you are unable to continue with the garden because you can’t work in it on your own

**P:** This garden was helping us a lot. Now we are forced to eat meat every day because we don’t have vegetables. When we need vegetables we have to buy instead of harvesting from our garden. I am no longer used to buying vegetables. I feel worried when I have to buy Swiss chard and beetroot leaves from the Mabuza family (Garden 1). I am worried when I buy the vegetables because I know that producing them is cheap.

**R:** I agree that buying vegetables is not good when you could produce them

**P:** If we want vegetables we have to buy at Mabuza (Garden 1). They sell vegetables at a high cost. We buy Swiss chard for the entire family for R5. She (Sylvia) makes a lot of money from selling vegetables. If I had vegetables I would be selling too. My problem is that I can’t work in the garden anymore because I am old. If I work hard I become sick. If I had money I would ask someone to cultivate the garden for me and pay him some money, because my grandchild is not serious. A garden helps a lot. It saves a lot of money.

**Grey water**

**R:** You said another reason why your grandchild fails to grow might be lack of water, why don’t you use used water to irrigate the crops?

**P:** I have seen that used water presents no problem to the crops but I fear for our health. The water is not healthy because it has germs. If I use used water I would rather use the water that has been used rinsing clothes because it is not very dirty.

**R:** This means that you will mainly use river water

**P:** My grandchildren will go to the river. I just hope that our problem of water shortage is addressed. If the people (researchers) that gave us the gardens can supply us with water gardening can be easy.

**Disadvantages and advantages of the irrigation system**

**R:** What do you think about the irrigation system?

**P:** These pipes (irrigation system) are very good. Imagine how difficult it would be if we had to irrigate with a bucket. With these pipes you just fill up the drum and open the tap,
and it will irrigate while I am doing other things. I just have to come and check for the blocked drippers. These pipes make things easy.

**Changes that should be made**

**R:** What are the improvements that should be made in your gardening?

**P:** The pipes are very good; their only problem is blockage. If that can be fixed, they will be perfect. Another thing you can change is the drum because it gets rusty, very soon it will start leaking.

**R:** Are those the only things that should be changed?

**P:** If possible, you can help us to solve the problem of seedlings. You have taught us how to grow seedlings but the process is difficult because there are things that damage our seedlings. Even when you can come and sell seedlings to us when it is time to plant, I am prepared to buy because I know that the seedlings you supplied us with were of good quality.

**GARDEN 3**

**Production period 1: August 2000 to January 2001**

**Observation:**

During the visit on the 18th of September 2000 I found the drum filled to half with used water

Interview No: G3.1: 18 September 2000

**R:** Are you still going to fill up the drum?

**P:** I irrigate three times a week as the white man has told us. But my problem is that I cannot fill up the drum when I irrigate. The water that I collect from my house only fills the drum to half. I collect very little used water because water is scarce. Even when the drum is full I use half of the water and keep the other half for the next irrigation. I always have to think about tomorrow.

**R:** Do you remember that the white man (Gerrie) told you to irrigate three times per week with a full drum?

**P:** I see that the water that I am applying is not sufficient for the crops. I cannot go to the river to fetch water to fill up the drum because I am very busy. I look after my grandchild and I also sell snacks at the school. Sometimes I walk around the village and other villages to sell clothes that I sew with my machine. That is the reason why sometimes you I am not at home when you come to check on my garden. I cannot stay at home and work in the garden only. The money that is sent to me by my husband is not enough to buy what we need. Therefore I have to do something else to generate extra money. My children do not help me in the garden. When my daughter comes back from school she does the cooking,
and during weekends she washes clothes. If the people that gave us the gardens can supply us with water things can be better for me. Things are very difficult because water is very scarce in our village. I cannot afford to buy water for irrigation.

R: Are you going to continue irrigating the way you are doing?

P: The crops are not having a problem with the way I irrigate because they are not dying. Sometimes they wilt during the day and recover in the afternoons. There is nothing that I can do to fill up the drum. I like the garden very much because it has made a very big difference in my house. I would not afford to buy all the vegetables that I get from this garden. I will continue irrigating with half drum. I hope that the government address this problem of lack of water.

Observation:

One the 16th of October 2000 I saw her giving vegetables to someone. The vegetables were harvested more frequently than in other gardens

Interview No: G3.2: 16 October 2000

R: You seem to be enjoying the vegetables because you harvest them frequently

P: This garden helps us a lot with the vegetables. We have no money to buy meat for everyday. Now I buy meat or other foodstuffs at least once or twice a week, the rest of the days we eat vegetables.

R: Most of the children don’t like eating vegetables

P: I know that. My children don’t have a chance to refuse eating vegetables because there is nothing that I can give them when they don’t want the vegetables. Children don’t like vegetables. If I had money I would give them vegetables once or twice per week, and give them meat for the rest of the week.

R: I also see you giving the vegetables to some people

P: When I have harvested a lot more vegetables than we need I give the surplus to my neighbours. These vegetables grow very fast, especially Swiss chard and beetroot leaves. You cannot believe that I am not applying the recommended amount of water.

R: Do you give the vegetables for free?

P: I can’t sell to my neighbours or friends because they also help me with food when I run short. If I sell vegetables to them it means that they also have to sell to me. My neighbours are very kind. Sometimes they give us food without having to ask. If my garden was bigger, I would be selling the vegetables. Now I cannot sell them because they are only sufficient for my house and neighbours and friends.
Second production period: January to May 2001

Observation:

After harvesting the first crop in January, she planted maize and groundnuts

Interview No G3.3: 16 January 2001

R: Now you have changed from the previous crops.

P: I have decided to grow these crops because now it is their time. During summer, we grow these crops here in our village. I also think that the sun can burn the vegetables that I had grown in the previous time because now it is very hot. Even if you can supply us with seedlings, I don’t think they can grow well because of the heat.

R: Do you think summer crops can grow well?

P: Now is time for summer crops. The hot sun can burn the vegetables. I will start growing them (irrigated crops) during the beginning of winter. Every year during this time, we grow maize, pumpkins, beans, are crops things that tolerate the hot sun. Crops have their planting times. If you plant them at the wrong time they don’t give a good yield. I also could not leave the garden unplanted because I volunteered to have it.

Observation:

During this period, irrigation was reduced to one day per week, irrigating with half a drum.

Interview no: G3.4: 09 April 2001

R: This time you don’t irrigate like in the previous time

P: These crops that I have planted now do not need to be watered. We are used to grow maize, groundnuts and beans under dry conditions, only irrigated by rain. They are unlike the vegetables that we grew previously in our irrigated gardens. Those (vegetables) needed a lot of water. You have seen that even though I was watering three times per week it was still not sufficient. Now I irrigate once in a week a drum filled to half. These crops cannot die because of lack of water. When the water is very dirty I just discard it, now I use the water that is not very dirty, for example rinsing water. When it has rained, I can take two weeks without irrigating. If it were raining like other years, I would not be irrigating.

Production period 3: May to October 2001

Observation:

On the 24th of May, I delivered seedlings to her. Her garden was not prepared. When I went to check on her the following day, I found that the seedlings were not yet transplanted
Interview no. G3.5: 25 May 2001

R: I thought you would have transplanted these seedlings by now

P: I have a lot of work to do. I think that it is better to stop with the garden. These days I am very busy than the previous time. During weekdays I either go to school to sell snacks or pension payout points in Ga-Molekane or the neighbouring villages to sell clothes. I sew clothes or buy and sell for profit. You can see that I don’t have time. I like gardening but my problem is that I don’t have time for it. If I can say I will transplant these seedlings, there will be a problem because I will only get time to work at the garden during weekends.

R: You don’t mind passing on the garden to anyone who is interested

P: Yes, I have already made up my mind because I don’t have time. I don’t want to force myself whereas I know that I will not be able to do it. It could be a waste of seedlings. If there were a person who stays at home when I am not around I would continue with the garden. I like the garden, but the problem is that I have to do something to generate money. The money that I get from my husband is not enough to meet our needs. We are short of many things after spending the money that we got from my husband.

R: Do you make good money from selling clothes and snacks?

P: The money that I generate from trading is a lot but it helps us very much. It makes a big difference. When we buy maize meal with the money from my husband there is little money left. We have to buy sugar, tea, meat, fish, soap, washing powder and many other things. The little money that I generate from selling does help to buy some of these things. The garden was also helpful but it can’t generate money from it. Vegetables are expensive to buy, especially tomatoes and onions, which we use everyday. If the whites (researchers) start other projects that can generate money you must not leave me out because you see that I am struggling. I like projects very much. Projects like sewing and baking can help us to generate money. We must quickly find someone to replace me.

The new participant

With the help of the recipient of garden five I found a woman to take over the garden from me. The new participant took the seedlings and the irrigation system on the 30th of May and transplanted the seedlings on the following day. The seedlings were damaged during their storage and transportation from the previous garden to the new one. As a result, very few plants were planted in the new garden.

Observation:

On the 4th of June 2001, I realized that she irrigates with half a drum, and she uses a bucket instead of the irrigation system.
Interview no. G3.6: 04 June 2001

R: Do you remember that I told you to irrigate three times a week with a drum full?

P: Even Daphney (garden 5) told me to do so. Her garden is entirely planted, and mine is not. I can’t irrigate like her. If my garden was fully planted I would irrigate with a full drum three times a week. Irrigating with a full drum wouldn’t bother me because I don’t have a problem of lack of water. My borehole pump is run by electricity, so I don’t have to pump manually. If I knew where seedlings are sold I would buy them because I don’t know how to grow them.

R: Why do you irrigate with a bucket instead of pipes?

P: I can’t use the pipes because there are no plants near some of the openings (drippers). Therefore, it will be a waste of water to irrigate with the pipes. I will use the pipes when I have planted the entire garden.

Observation:

On the 9th of July I found her irrigating, her drum was filled to half with clean water

Interview no: G3.7: 09 July 2001

R: You can save more water from your borehole by using recycled water

P: I don’t have a problem of lack of water. That is why I don’t use used water for irrigating my garden. I remember that you told me to use soapy water. Soapy water can make us to get sick when we eat the vegetables irrigated by it. Soapy water is also not good for the crops. We use it for fruit trees only because by the time it reaches the roots it is cleaned by the soil. I cannot be happy to eat the vegetables irrigated with soapy water.

R: Some gardeners use grey water

P: They use soapy water because they don’t have boreholes and there are no other sources of water available. Lack of water is a problem to many people in our village. They even struggle to get drinking water.

Observation:

On the 10th of September 2001, I found her harvesting beetroot. She harvested seven beetroot, which according to me were more than they need.

Interview no. G3.8: 10 September 2001

R: Are you going to finish these beetroot?

P: No, I want to give some to my neighbours. I have only given them Swiss chard on one occasion when I have started harvesting. If I had vegetables like Daphney has (Garden 215...
five) in the first planting I would have given them more than this. They are not worried because they have seen that my crops are very little.

**R:** You have a good relationship with your neighbours?

**P:** We help each other. They give us food when we don’t have. It is not good to be selfish. If you expect people to give you things you must also give them.

**Production period 4**

**Field visit: 12 December 2001**

**Observation:**

Planted Swiss chard, beetroot and onions. The garden was planted, so there was no interview conducted.

**Production period 5**

**Field visit 24 March 2001**

**Observation:**

The garden is not planted

Interview no. G3.9: 24 March 2001

**R:** I expected your garden to be planted

**P:** I have tried to grow some seedlings but the sun burnt them. Now it is very hot, these vegetables cannot tolerate this temperature. I have to wait until the sun is no longer hot; then I will start preparing my seedlings. It would be a waste of seeds if I can try to grow seedlings now because I have seen what happens when I grow seedlings during this time.

**R:** Do you remember during the training you were told that some of the vegetables could grow even when it is hot?

**P:** It is also good to stop growing the irrigated vegetables because there are vegetables that we get in the other home garden (garden for field crops). During this time of the year, we prefer eating traditional vegetables. Even when we had Swiss chard we would not be eating it because now there are vegetables that we prefer traditional vegetables during this time. If I can grow summer crops in the irrigated gardens they can make me to be late for growing the irrigated vegetables when winter comes. I finished harvesting in late January so if I had planted these summer crops they would clash with my schedule because I want to plant in early May, this would make to harvest the summer when they are not fully ready.
R: Your garden will be fallow during summer

P: Yes, I will leave my garden unplanted in summer. When winter comes I will buy Swiss chard, beetroot, onion and cabbage seeds. I know that vegetables will grow well during winter. When I finish harvesting in August or September I will plant again for December.

R: Do you find it difficult growing the vegetables when I am not here to check on your garden?

P: I don’t have a problem. I can still remember the things that you taught me. Now I have knowledge on gardening and Daphney (garden 5) helps me because she knows most of the things.

Production period 6

Field visit: 12 July 2002

Observations:
The garden was not planted.

Interview no. G3.10: 12 July 2002

R: I thought your garden would be planted, why didn’t you?

P: We have contributed some money in a group of four people, Daphney (garden five, two other ladies that are not having the drum and drip micro-irrigation system and myself). We sent a certain man to buy us seedlings in Potgietersrust town. He bought us very few seedlings. The seedlings were insufficient to have all four gardens planted in full. We decided to plant them in two gardens, Daphney’s and the other women’s. Even their gardens are not entirely planted. When the vegetables are harvested we are going to share them.

R: What did you do as a solution?

P: We have contributed other money to buy seeds. Now we want to grow our own seedlings. We planted them three weeks ago, they have germinated and I hope they will be ready very soon.

R: Are you also growing the seedlings as a group?

P: Yes, we are growing them in one of the woman who is in our group. She has a borehole, we just help her to pump and irrigate. When seedlings are ready to be transplanted we are going to take them to our respective gardens.
Exit interviews

Interview No: G3.11

Advantages and disadvantages of the irrigation system

R: Have you experience any problem with your irrigation system?

P: These pipes are very good because when the drum is filled up I just open the tap and do other things while they are irrigating. The only problem is that sometimes they block.

R: I have shown you how to unblock them

P: The problem is that when I have a lot of work I don’t have time to stay in the garden and check for the blocked drippers. This means that after irrigating with the pipes I have to pump water and irrigate those portions left out by the drippers using a bucket.

R: Is blocking of the drippers the only problem?

P: Not only blocking, the drum has holes. I wonder what I am going to do when I have planted because you see that it can start leaking at any time. Maybe even now it leaks. If it leaks I don’t know how I will seal it. I will have to use a bucket to irrigate if it starts leaking.

Labour

R: Does the garden not disturb you from doing other domestic jobs

P: I don’t have a problem with working in the garden. I have a lot of time because I am unemployed. Even when the garden was bigger than this, I would manage to work on it and also do other domestic jobs. This garden is more helpful than the other domestic jobs that I do, I give it the first priority. Before I do many things in the morning I work in the garden first. I would rather stop doing certain things if the garden work is a lot. I am very worried that at the moment I have not planted because of failing to get seedlings in time.

Advantages of the garden

R: The way you are serious about your garden it shows that it is really helpful to you

P: Yes, if I had no garden I was suppose to buy vegetables, whenever there is a need. I purchase maize meal, meat, soup, washing powder and many things with the money I get from my husband. I am also supposed to buy vegetables with some of the money, but now I don’t have to buy because I have now have grow them in my irrigated plot. When there is no meat I just get to the garden and harvest Swiss chard or beetroot leaves.

Changes to be made

R: What can improve the current situation of your gardening
P: The first thing that can help is changing the drum of the irrigation system. This drum would be leaking very soon because it is rusty. If you can bring me a new drum, but this time I will make sure that it is painted in the inside to prevent it from rusting. If painting is a problem just supply us with plastic drums. Other things that should be changed are the pipes; they have a problem of blocking. It gives me another work to check after irrigation if all the plants have got water, and then irrigates those portions left out by the blocked drippers.

R: I have shown you how to unblock them

P: I know that when they are blocked you move the string to both sides to unblock them. If the crops are big it is difficult to identify that the dripper has not irrigated the plants. Which is why I think they should be fixed.

R: Those are the only problem you have in gardening?

P: Another thing that is important that I nearly forgot is obtaining vegetable seedlings. This process of producing seedlings is very difficult to me, which we started an idea of buying seedlings as a group. If you can arrange with a seedlings grower to supply us with seedlings when it is time for planting. I am prepared to pay for the seedlings than growing them.

GARDEN 4

Production period 1: August 2002 to January 2001

Observations:
When I visited her on the 25th of September 2000, I noticed that her drum was filled with clean water.

Interview no: G4.1: 25 September 2000

R: You are serious in our garden. Every time I check your garden, the soil is wet

P: I irrigate the way the white man has told us. I make sure that I irrigate on Monday, Wednesday and Friday. We pump water from our borehole every evening before the day that I irrigate. My younger sister helps me to pump water in the evening. When I wake up, I just open the tap of the irrigation system.

R: The white man said you could use recycled water when you like

P: I cannot use recycled water. This dirty water smells bad where we discard it. This means it will also make the soil in my garden to smell badly. And also, I cannot use the dirty water to irrigate the crops that I will eat. I see that the water can make us sick or even destroy my crops. It is hard work to pump the water from my borehole but I will do it because I need my crops to grow well. Even when I had no borehole I would not use dirty water. If I have a problem with pumping of water I will ask someone to do it and pay that person for that.
Observation:
During my visits, I noticed that the vegetables are big, showing that she does not irrigate frequently.

Interview no. G4.2: 23 October 2000

R: Your vegetables are growing fast; you can harvest them daily

P: **The vegetables are a lot for us. Even if we can eat them daily we can’t finish them. You know that we stay being two in my house. We are only three when my husband is back from where he works during month-end.**

R: Do you harvest the vegetables daily?

P: **During month-end I buy meat that we can eat for the whole month. I buy chicken, beef, fish, mutton and other foodstuffs. Some of the foodstuffs we don’t finish them by the end of the month. So we eat morogo (vegetables) when we have had enough of meat. It is not good to eat meat only. So at least two days per week we eat vegetables. I did not accept this garden because I can’t buy meat. I am a person who likes vegetable gardening.**

Observation:
On 6th of November 2000, I saw her giving some vegetables away

Interview No: G4.3: 06 November 2000

R: I see you giving away some vegetables.

P: **I give some of the vegetables to my mother. She stays at her residential site. She likes vegetables very much. When I give her Swiss chard, she becomes very happy. I also give some of the vegetables to my neighbours. Our neighbours that are staying on our left hand side are poor. I make sure that I give them vegetables most of the times when I harvest. I also give some vegetables to my neighbours who stay in the front opposite of our house. They are the people to whom I run whenever I need help.**

R: Why don’t you sell or preserve the vegetables?

P: **I cannot sell these vegetables to my neighbours and relatives. Some of the people that I give they don’t have enough money to buy vegetables for themselves. I heard you asking why don’t I dry them. I have never seen vegetables like these dried. If they are dried, I can do it because they can help us when we have no fresh vegetables. Even if my garden was bigger, I would not sell the vegetables because I have a lot of friends and relatives that I should give.**

Production period 2: January to May 2001

Observation:
After finishing harvesting the first crops in January 2001, she planted maize and beans in her irrigated garden.
Interview no: G4.4: 12 January 2001

R: You have changed from the vegetables you planted previously. Don’t you like those vegetables?

P: I decided to grow these crops because you said you would not supply us with vegetable seedlings. I thought it would be better if I grow these crops rather than leaving my garden unplanted. What will the white men (Gerrie) say if he finds my garden unplanted? Another reason is that I don’t think that the nurseries have vegetables because now it is hot. If it was winter season I would go and buy seedlings from the nurseries in Potgietersrust. Growing maize is simple for me because it is not grown from seedlings. Every year we grow these crops and they don’t give us problems except when there is no rain. Growing vegetable seedlings need someone who has knowledge, and equipment such as a net, chemicals and trays to plant the seeds in. I know this from the books I read concerning gardening.

R: You grew summer crops because you don’t know how to grow vegetable seedlings

P: Yes, it is unlike when my garden was fallow. We are going to eat green maize. Moreover, my yard is small. Therefore, it is good to utilize the irrigated garden to grow summer crops. When it is time for winter crops I will purchase the seedlings of vegetables and grow them.

Observation:
During this production period irrigation was reduced from 600 l per week to 200 per week.

Interview no. G4.5: 16 April 2001

R: These days you are relieved from pumping water to fill up the drum

P: Now I irrigate whenever I like. Sometimes I irrigate once a week or don’t irrigate at all. These crops are unlike the first crops when it comes to amount of water requirement. We grow summer crops under without irrigation. Even when I can stop irrigating them they can grow. These crops can tolerate the sun. During the day they can wilt but in the afternoon they will recover. The vegetables that we planted previously need to be watered every time.

Production period 3: May to October 2001

Observation:
On 28 May 2001, she told me that she irrigates daily.

Interview no. G4.6: 28 May 2001

R: Your crops look very good; it shows that they get enough water

P: I water them daily because you see that they are still small. When they are big I’ll water them three days per week. These crops need to be watered daily when they are small. The kraal manure that I have applied also contributes to making my crops grow well.
R: Are you able to fill the drum every day?

P: I still pump water as usual. The only different is that when I fill up the drum, I can irrigate for two days. I irrigate with half a drum everyday. I only skip Sundays. The problem is that when the crops are still small they need water every day so that they can adapt well to the conditions here. In the nursery, where they are from they were irrigated every time with sprinklers. If I don’t water them every day it could be difficult for them to acclimatize to these conditions, and that can lead to some of them dying. When they are big I will start irrigating as the white men have told us.

Production period 4

Field visit: 12 December 2001

Observations:
The garden is neglected. The crops are dry and there are weeds. It seems the crops stayed for a long period without irrigation. The recipient visited her husband in Johannesburg. I interviewed the participant in January 2001.

Interview no. G4.7: 08 January 2002

R: Your garden is no longer looking good like before

P: These vegetables were growing well. The problem started when I was away during the school holidays. I went to visit my husband in Johannesburg. When I came back, I found that my crops were dead. You can see that since I left it is clear that these crops were never irrigated. My younger sister agreed that she would look after the garden while I was away, but she did not do so. It worries me to see my vegetables, dying because of lack of water whereas there is a borehole in my yard.

R: Why don’t you replace these crops?

P: I only have beetroot seeds. Therefore, I will buy some more seeds of tomatoes, carrots and Swiss chard. Now I want to try out carrots because the beetroot have been doing very well, so it means carrots can do well because they are related. I am thinking of not preparing the seedlings now because it is very hot. I will start preparing them in late April. Even when I can grow them now, the crops can die because it is very hot. This year it is very hot, even the maize, which is used to hot conditions it is not growing. Those seedlings that you were giving us they would grow well because they prepared by people who knows it. Whites have special houses where they prepare seedlings. Now I will stop with the irrigated garden, and start growing again in winter when it is no longer very hot.

Production period 5

Field visit: 25 March 2002

Observation:
The garden is not planted
Interview no. G4.8: 25 March 2002

**R:** You meant it when you said that you would stop planting the garden summer

**P:** It is very hot, so I have decided to stop planting my irrigated garden this time. If I can plant the sun could destroy my crops. I have bought seeds in town. When it is no longer hot I will prepare seedlings for the wintertime.

**R:** In a year you will only plant twice only?

**P:** Yes, it is better to stop planting the irrigated gardens because during winter and spring I have seen that these vegetables grow well. I don’t have a problem with vegetables because traditional vegetables are available. During this time it is unnecessary to plant the irrigated gardens. We prefer to eat these traditional vegetables because we take almost the whole year without eating them. Every time when the rain starts, we become happy because we know that traditional vegetables will germinate.

**R:** Why don’t you plant traditional vegetables in your irrigated garden?

**P:** We have enough traditional vegetables. We cannot grow the irrigated vegetables while there are traditional vegetables. Although my garden for summer crops is very small, we have a wide range of traditional vegetables.

**R:** I thought you would have difficulties to continue with your garden in my absence.

**P:** I don’t have a problem with that. I know how to start my seedlings. If I get a problem with producing seedlings, I can go and buy them in town.

Production period 6

**Observations:**
The irrigation system has been removed. She planted vegetables in five rows (Swiss chard, beetroot and green pepper). The rows were extended (about 12 m long)

Interview no. G4.9: 12 July 2002

**R:** Your garden looks very good, where did you get the seedlings?

**P:** I have bought the seedlings in town and transplanted them during May. The seedlings were very good; they were like those that you gave us in May last year. Now I am harvesting Swiss chard and beetroot leaves. You have taught us how to plant seedlings but it is a very long and difficult process.

**R:** Why did you remove the pipes?

**P:** The drum was leaking. I realized that the drum is leaking before I transplanted my seedlings; I have tested it before because I suspected that it leaks because of the rust. I can’t seal it because it has many holes.
R: And now, how do you irrigate?

P: I use a bucket to irrigate. When they were small, I was using a tin with holes at the bottom so that the crops are not damaged. Although, irrigating with a bucket is tiring, I like because when I finish irrigating, I am sure that all the crops have got water.

Exit interview

Interview No: G4.10

The drum and drip irrigation system

R: Apart from the fact that the drum is leaking are there other problems that you have encountered with it?

P: The other problem with the irrigation system is that the pipes (dripper lines) are very short. I prefer long rows. Look now that I am no longer using the pipes (irrigation system) I have made long rows. A big space was not utilized because the pipes are short. Another problem is blocking of the openings. These pipes were blocking continually. Even when I have pulled the string sideways, they blocked again. Blocking made my crops not to grow at the same size. Using a bucket is a tiring work but it produces better crops than when I use the pipes (irrigation system).

Labour

R: You are serious about garden because you work on it on the afternoon instead of resting

P: I like gardening very much. It requires hard work, and sometimes I sacrifice other things that I should do for the garden. I don’t mind doing this working in the garden because it helps me. If I don’t have time to work in the garden, I ask some boys from my neighbours to pump water and irrigate for me, and then I pay them some money. My younger sister does not like working in the garden. You know that girls don’t like working in the garden. They say that gardening is for old women.

Advantages and disadvantages of having the garden

R: Has the garden made a difference to you?

P: This garden helps us a lot. That is why I don’t mind sacrificing other things for it. Look now I will have beetroot and green pepper every Sunday. I use these vegetables almost every Sunday. Having them will save me a lot of money since I had to buy them. When we have had enough of meat we just harvest the vegetables.

The changes that should be made

R: What do you think should be done to make your gardening easier?

P: The first thing I want is a new drum. If you can supply me with a drum, I can paint it in the inside so that it does not get rusty. The other things that I want are long pipes. These pipes are very short; they restrict me from making long rows. I want to plant in long rows.
I do not mind having three rows if they are long like the rows I have (about 12 m). I need another drum for storing water after pumping. I don’t mind irrigating with a bucket because my crops grow well.

R: Other gardeners have problems with growing their seedlings

P: Obtaining seedlings is not a problem to me because I buy them from a certain nursery in Potgietersrust. You have taught us how to grow our own seedling but I find it difficult and risky because the seedlings can die because we don’t grow them in the houses (green houses). Seedlings from them nurseries are always perfect. The people in the nurseries know how to grow seedlings because it is their business. They grow seedlings in houses (green houses) so that they are safe in case of a harsh weather. We don’t have green houses so our seedlings can just die at any time.

GARDEN 5

Production period 1

Observation:
On 9 October 2000, I found the participant filling the drum with clean water.

Interview no. G5.1: 09 October 2000

R: It seems you don’t use grey water

P: I don’t have a problem of lack of water because I have borehole. The only problem is that it is pumping is hard job because I have to fill up the drum three times per week. No one helps me to pump. It takes me two hours to pump water to fill up the drum. The hand pump of my borehole is hard.

R: It is hard work to pump water, why don’t you use used water?

P: I cannot use this water to irrigate my crops because it is dirty. Pumping is a hard job but I would rather do it than using dirty water. Eating vegetables irrigated with dirty water is like drinking dirty water.

R: I think using recycled water would to relieve you from pumping.

P: I have told you that I don’t have a problem because I have a borehole. There is no need for me to save water because I don’t sell it. Even when this water is not harmful when used for irrigating crops, I cannot feel happy to eat vegetables that I know were irrigated with dirty water.

Observation:
During my weekly visits, I realized that the crops were always big, indicating that they are not irrigated frequently.
Interview no. G5.2: 16 October 2000

R: Most of the times when I come here your vegetables are big, why don’t you harvest them daily or every second day?

P: We don’t eat vegetables everyday. We eat vegetables once or twice per week. Sometimes we can talk the whole week without eating them. During month end we buy meat and some more foodstuffs. The vegetables that we need daily are onions and tomatoes. These are used to make sauce. That time when we had no garden, we use to take a month without buying leafy vegetables.

Observation:
On 6 November 2000, I arrive when she harvesting, she gave some of the vegetables to the neighbour.

Interview no. G5.3: 6 November 2000

R: You have good relations with your neighbours or you just give them vegetables for free

P: They also give me food when I don’t have. When I run out of salt or sugar I ask from them. When I arrive while they are eating, I eat with them if I am hungry. They do the same when they come to my house.

R: Why don’t you sell or dry the vegetables

P: This garden is very small. I cannot get a surplus after consuming the vegetables at my house and giving away some to my relatives, neighbours or my friends. Many people would like to buy the vegetables, but I can’t sell them because they are little.

R: Why don’t you preserve the surplus vegetables?

P: These kinds of vegetables are not dried. We dry traditional vegetables, and at my house we don’t prefer dried vegetables because their taste is not good.

Production period 2

Observation:
After harvesting the first crops, the garden was planted to maize, groundnuts and dry beans instead of the recommended vegetables.

Interview no. G5.4: 15 January 2001

R: You decided to change from the previous vegetables

P: I like the previous crops but now it is the time for summer crops. I will plant those crops when I have harvested these ones. During summer, we grow these crops here in our village. You can see when you move around in this village that almost everybody has planted these crops.
R: Is that the reason that caused you to change the crops?

P: *Another thing is that I cannot produce vegetable seedlings, and I don’t know where to get them. Maize and beans do not require to be planted from seedlings. You just cultivate the soils and plant the seeds. I know how to grow these crops because every summer we grow them.*

Observation:
Most of the times when I visited her I found that her drum is empty.

Interview no. G5.5: 19 February 2001

R: It seems this time you don’t irrigate like previously

P: *These crops that I have grown now do not require water like the previous crops. We normally grow summer crops without irrigation. Look at the maize in other gardens; it is growing well without irrigation. I only irrigate these crops because this year there is no good rain.*

Production period 3

Observation:
On September 24, 2001, I noticed that chickens had eaten beetroot, Swiss chard and cabbages.

Interview no. G5.6: 24 September 2001

R: Your crops were growing well the previous week, what had happen now

P: *The chickens from my neighbour got into my garden when I was away from my house. When I came back, I found that the chickens ate my crops. I gave the owner of these chickens a fence so that he makes a house for his chickens. He was keeping them in that house but now he allows them to move out because he doesn’t have feeds to give them. When people were passing, they use to appreciate my garden, especially when I have kept them for a long time without harvesting. This time I will not even give some vegetables to neighbours and friends. They will have to understand it. I am only left with green pepper and onions only.*

R: Why don’t you make sure that your residential fence is tightly closed?

P: *My neighbour is responsible for watching his chickens. I cannot make sure that the fence is tight because the small chickens can still go through. Now I tell him to unroll the fence and give it back to me so that I fence off my garden. He has apologized for this damage but that will not bring back my crops.*

R: How are you going to replace the damaged crops?

P: *I will just leave them as they are. Maybe they can recover because you see that Swiss chard and beetroot shows that they are not yet dead although they are damaged. If they don’t recover I will replace them when I have harvested all the crops that are left. I want*
my crops to grow at the same size. I cannot tell him to give me money for the damage because he is not working.

Observation:
On 1 October 2001, she told me that she irrigates with half a drum instead of a full drum. Interview No: G5.7: 01 October 2001

R: I heard you saying that you irrigate with half a drum instead of full drum

B: I irrigate with half a drum because some of my crops are damaged. I am only left with a row of green pepper and onion. It will be a waste of water to fill up the drum and irrigate two rows. If the damaged crops could recover, is then that I will fill up the drum when I irrigate. I know that the white men said we must irrigate three times per week with a drum full but I can’t do so because I only have two rows of plants.

R: I think if you can irrigate with a full drum your crops could recover

P: I will start doing that when they show signs of recovering. For now, I will be irrigating with half drum. I don’t know whether they will recover or not. That makes me to be reluctant to irrigate with a full drum.

Observation:
The Swiss chard and beetroot recovered, on the 8th October 2001, she harvested Swiss chard and gave away some

Interview no: G5.8: 08 October 2001.

R: I thought this time you will not give vegetables because you have very few

P: If it weren’t for these chickens I would be harvesting more vegetables than these. My Swiss chard and beetroot have recovered but they are no longer looking like before.

R: If I were you I would not give away the vegetables because they are not much this time

P: It is good to share with my neighbours. Even though I don’t have much I have to give them a little. If I give them a little they will see that I am not selfish. My neighbours are so helpful to us. Sometimes you can think that they are my relatives. They always help me, especially when it comes to food. My husband is working as a teacher but we sometimes run out of food.

Production period 4: October to January 2002

Field visit: December 2001

Observations:
She is harvesting beetroot leaves, Swiss chard and green pepper. The tomatoes were not yet ready to be harvested

Production period 5: January to May 2002
Observation:
The garden was not planted

Interview no. G5.9: 12 March 2001

R: Why is the garden not planted, is there a problem?

P: I don’t have a problem. This time there are plenty vegetables (traditional vegetables) growing in the other home garden that is not irrigated? Planting the irrigated vegetables would be a waste because we would not eat the traditional vegetables. In summer we prefer summer vegetables.

R: This means that during summer you will not plant the irrigated garden

P: It is not necessary to plant irrigated vegetables because there are traditional vegetables during this time. When these vegetables are finished, is then that it be necessary to plant the vegetables in the irrigated garden. In winter and spring we can get vegetables from the irrigated garden, and in summer from the other garden.

R: Is it difficult for you to continue with your garden because I am not around to help you?

P: That is not a problem. Even when you were here I would not have planted because now there are traditional vegetables. Now I can run my garden without you because you have taught us a lot of things about gardening and you have given us books to read, in case we have problems. Gerrie has also taught us a lot of things.

R: During winter are you going to plant your irrigated garden?

P: Yes, I will grow vegetables. I have already bought some seeds in town (Potgietersrust) because those that you have given me are finished. I am only waiting for April so that I prepare my seedlings; I know that by that time it will not be hot and the traditional vegetables would be finished.

R: Are you also going to plant after winter?

P: Yes, when I finish harvesting I will plant again. I will prepare seedlings in August so that when I harvest I will have seedlings ready to be transplanted. I will plant twice a year. This will also enable us to have vegetables during Christmas time.

Production period 6

Field visit: July 12, 2002

Observations:
The garden is planted, but the crops were not planted at the same time. Swiss chard and onions planted in two rows are nearly ready to be harvested (planted early) and crops in four rows are still small.
Interview no: G5.10

**R:** It seems as if you did not grow your crops at the same times

**P:** When it was time for preparing seedlings I was not at home. I arranged with my neighbour (garden 3) that she should prepare seedlings for me. My husband had agreed that he would look after the crops when I am away. Instead of preparing seedlings, my neighbour got two ladies that were intending to start gardens, and they agreed to contribute some money to buy seedlings from a nursery in town. They informed my husband about it. He also gave them money. The person that they sent to buy seedlings bought very few seedlings with that money (R80). They only planted in these two rows.

**R:** Where did you get the small seedlings?

**P:** We have contributed money and bought seeds. Now we are preparing our seedlings as we have seen that buying seedlings has failed.

**R:** Are these some of the seedlings that you have prepared by yourselves?

**P:** These ones I have asked from a friend who is also having a garden. When our seedlings are ready, I will have to extend my garden because I will be having many vegetables.

**R:** How will you irrigate your garden if you extend the rows?

**P:** I will use a bucket. Even now, I have stopped using the pipes because my drum was leaking. My husband tried to seal it but he failed because it has many holes. It cannot hold water any longer.

**Exit interviews**

Interview No: G5.11

**Labour**

**R:** Don’t you feel that the work that you do in the garden is a lot

**P:** This garden is very small. I spend very little time working on it. I have water in my yard, so I do not have to fetch water from elsewhere. The only job that I do is to pump and irrigate. Even when the gardening job was difficult for me, I could not think of stopping because it helps me very much.

**R:** Do you still have time to perform other domestic jobs?

**P:** I am still doing things the way I was doing them before I had the garden. I still have time to relax. It is only when there is a lot of work in the garden that I do not do other domestic works. This happens after a long time, for instance, during soil preparation.
Grey water

R: If you can use recycled water for irrigation, it can make things easier for you because you will no longer have to pump water from your borehole.

P: I cannot use the water that I have used for bathing or washing dirty clothes to irrigate the crops that I will eat. If I am very busy to pump I can just leave the crops without water rather than using dirty water. This water has a lot of germs and soap. Therefore, it is not good to eat food irrigated by this water because we would get sick. I have told you since the beginning, I cannot use that water. People would be surprised to see me using dirty water to irrigate vegetable crops.

Advantages of having a garden

R: Do you find the garden helpful to you?

P: This garden helps me very much. Now that we do not have vegetables things are difficult. When we don’t want to eat meat, we have to buy vegetables. If there are vegetables, I save money because I do not have to buy. Now when we cook rice on Sundays we have to buy beetroot and carrots because we do not have them. Now I buy tomatoes and onions almost daily.

Advantages and disadvantages of the irrigation system

R: What can you say about the irrigation system, are there problems that you have encountered when using this irrigation system?

P: These pipes (irrigation system) are good. Their only problem is that the drum is not strong and the pipes become always blocks. During the time when I was using them, I just filled up the drum and opened the tap to irrigate while I do other things. The problem was that when I was very busy and had no time to check for blocked openings. I would find that some of the drippers had not watered certain crops. This meant that I had to irrigate those portions using a bucket.

R: I think things are difficult because you do not use the pipes.

P: Now it is difficult because I have to pump and irrigate using a bucket. Pumping is a tiring job, and irrigating with a bucket has made the job even more tiring. It was good to fill up the drum and open the tap to irrigate. It was saving me time and making the work easy. Although the bucket is tiring, it has its advantages. When you use it you are assured that all the crops have got water. But with the pipes sometimes some crops are left out.

Changes to be made

R: What do think should be done to improve the current situation of your gardening?

P: Now my big problem is the drum, which is leaking. That is why I have stopped using the pipes. A new drum could work but I would need to paint it in the inside to prevent it from getting rusty. If painting does not work it would be better to have a plastic drum. Plastic drums last longer because they do not get rusty, it can last for more than 10 years.
If the problem of the drum is solved, then we can start thinking about the blocking pipes. That is not a big problem because I was coping with it. I can just make sure that after irrigation I water those portions left out by the pipes using a bucket.

R: Other gardeners have a problem with growing seedlings

P: That is my problem also. You have taught us to grow our own seedlings but we cannot grow better seedlings than those that you gave us. When I transplant the seedlings that I have grown on my own, most of them they die. Therefore, I have to prepare a lot more so that I can get replacements. If you can arrange with the seedlings suppliers so that when it is time to grow our gardens they can supply us with seedlings. We can make an order as a group and pay for those seedlings.

GARDEN 6:

Production period 1

Observation:
On 20 September 2000, I saw her carrying water for irrigation

Interview no: G6.1: 20 September 2000

R: I see you are coming from fetching water.

P: I am from the spring.
R: Why do you have to go to the spring whereas you were advised to use grey water?

P: The recycled water that I collect from my house in two days only fills half of the drum. That white man said we must irrigate with a full drum three times a week if we need our crops to grow well. When tap water is available in our tap I irrigate with it. When tap water is unavailable I fill the drum to half with used water, and I go to the river to collect water to get the other half of the drum filled.

R: I think it is a hard job to fetch water from the spring

P: It is tiring. In the morning I have to carry recycled water from my house to the garden (garden was not set up in the residential site of the participant). This is my uncle’s residential site. I could not set up a garden in my yard because the fence is not good enough. And you can see that there is only one person staying in this house. Therefore, I have to bring recycled water from my house because the person who stays here recycles very little water. When there is no tap water I have to bring used water from my home, and then go to the spring because the water that I recycle from house does not fill up the drum.

Observation:
On 4 October 2000, I saw her giving some vegetables to the neighbour
R: Your vegetables are plenty, because you are giving to other people

P: Giving away vegetables do not mean that I have a lot. I have to give my neighbours because they also give us food. When we don’t have food we run to them for help. If I don’t give them, they won’t help us if we are in need.

R: You seem to be enjoying the vegetables because you harvest them frequently.

P: This garden helps me a lot. We don’t enjoy vegetables as much as you think. We eat vegetables frequently because we can’t afford to buy meat daily. Sometimes the children don’t like to eat the vegetables. Most of the times I have to force them to eat because I can’t provide them with meat.

production period 2

Observation:
After harvesting all the crops in January 2001, she grew maize in her irrigated garden.


R: I thought you would grow those crops that you had grown previously

P: I cannot grow those crops because I don’t know how to prepare their seedlings. For that reason I decided to grow summer crops because I know how to grow them. I thought that you are going to supply us with seedlings as the white man has done when we started with our gardens. Seeing that you don’t give us some I decided to grow these crops. Growing these crops is very easy because we always plant them during the summer. They don’t require to be grown from seedlings.

R: That is the reason why you grew these crops?

P: Another reason is that I was afraid that if Gerrie could come and find my garden unplanted he would think that I am not serious. Now when he comes at least he will see that I want the garden.

Observation:
On 21 February 2001, she told me that she only irrigate once per week.

Interview no. G6.4: 21 February 2001

R: Why don’t you irrigate like in the beginning?

P: These crops are not like the previous ones. Usually we don’t irrigate them. This year it is very hot and the rain is not good. That is the reason why I irrigate them.

R: You are relieved from going to the spring

P: At least now it is better because I don’t have to go the spring, and I don’t have to use the tap water. The tap water that I used for irrigation in the previous was supposed to be
used for other things. We only get tap water once every fortnight, so we have to make sure that we don’t misuse it. The used water that I collect in my house now is enough to make my garden moist. I also discard some of the used water if I feel that it very dirty. This time I irrigate two times per week with a drum filled to half. These crops tolerate dry conditions, even when I irrigate them twice per week they can’t wilt.

Production period 3

Observation:
On the 30 May 2001, I noticed that her drum is filled to half.

Interview no. G6.5: 30 May 2001

R: I thought you would increase irrigation because you have planted vegetables

P: Now I irrigate daily, using half a drum.

R: Why do you irrigate daily

P: My soils do not hold water. When I irrigate the water moves into the soil and during the following day the soil surface is dry. Therefore, in the next day the crops don’t have water. That is the reason why I irrigate daily instead of irrigating three times per week. I would start irrigating the way the white man has told us when my crops are bigger.

Observation:
On the 4th July 2001, she told me that she does no longer use grey water

Interview no. G6.6: 04 July 2001

P: You told me that you no longer use grey water

R: This time tap water is available more frequently than the previous time. During the previous time I had to use the soapy water because there was no proper supply of tap water. This time we also get water from the tanks (water supplied by government water tankers). I use the water from the tank only for cooking and other domestic uses and the water from the tap for irrigation.

R: If you can stop going to the spring and use tap and recycled water, I think it could be better

P: Recycled water is not good. It makes the soil in my garden to smell badly, and make the soil surface to turn white. Besides that, this water can make us sick. I have seen it that the water that has been used is not harmful to the crops but it can kill us.

Observation:
On 18 July 2001, I noticed that her drum is filled to quarter of a drum.
Interview No: G6.7: 18 July 2001

**R:** You said you would increase irrigation when your crops are big

**P:** My crops are not growing well (crops have stunted because of lack of nutrients). It is a waste of water to irrigate these crops because they are not growing like in other gardens (garden 7 & 8). The other gardens are good because you stay with one of gardeners (garden 7) and the other one is your neighbour, so you help them with ideas. I am disappointed with the way my crops grow. People will laugh at me if they compare our gardens. This time I can’t even give some vegetables to my neighbours because they are not even enough for my family. My neighbours will think that I am selfish if I don’t give them because they know that I have planted vegetables.

**R:** I have advised you to apply kraal manure before planting

**P:** The problem is that I don’t have relatives or friends with kraals. I don’t know where I can go to ask for kraal manure. I know that people give it for free but most of the people that have kraals they are either my friends or relatives. I will try to ask from one of the people with kraals. I will promise to give the person, who will assist me vegetables, when start harvesting.

**Production period 4: September 2002**

**Field visit: 12 December 2001**

**Observations:**
She is harvesting Swiss chard and beetroot leaves and the other crops; onion and cabbages were still growing (not yet ready to be harvested).

**Production period 5: January to May 2002**

**Field visit: March 12, 2002**

**Observations:**
The garden is not planted

Interview: No G6.8

**R:** I thought your garden would be planted during this time. Do you have a problem?

**P:** No I don’t have a problem. Now traditional vegetables are available in the residential garden. I will plant my irrigated garden when the traditional vegetables are finished. There is no need to irrigated vegetables when there traditional vegetables are available.

**R:** Why don’t you grow tomatoes and onions because you need them daily?

**P:** We usually buy those vegetables. There families who sell these vegetables. It is vegetables such as Swiss chard and beetroot that are not usually sold in our village. If we need such vegetables we have to buy them in town.
R: I thought maybe you did not plant your garden because I am no longer here

P: I don’t have a problem with your absence. I did not plant because traditional vegetables are available. When these vegetables are finished I am going to plant my irrigated garden. Now I know most of the things concerning the production of vegetables.

Production period 6

Field visit: 12 July 2002

Observations:
She planted beetroot, Swiss chard carrots and tomatoes but two rows were unplanted

Interview no. G6.9: 12 July 2002

R: Why don’t you plant the entire garden?

P: I ran short of seedlings. I had prepared more seedlings but most of them died when I transplanted. Almost all my Swiss chard and beetroot died. The seedlings were looking very good before transplanting. When I transplanted them, they started wilting, and then died.

R: These are the crops that have survived from those that died

P: Only tomatoes survived. Very few plants of Swiss chard and beetroot survived, I can even count them by hand. Maggie (garden 7) gave me some seedlings. She helped me very much.

Exit interview

Interview: G6.10

Grey water

R: You don’t seem to like recycled water.

P: The water was making my soils to turn white and dry. This made the water not to infiltrate the soil easily. When I use used water I have to cultivate my soils frequently so that infiltration can be improved.

R: Is that the only problem that you have with recycled water?

P: The other thing is that this water has germs. It can make us to be sick. It is obvious that the water that was used for washing dirty clothes or bathing has germs. We will fall sick if we continue using it.
Labour

R: I think the garden does not disturb you from doing other domestic jobs

P: Gardening is giving me a lot of work. I have to prepare the soils, grow seedlings, transplant them, remove weeds and irrigate. I work alone in the garden. The other gardening jobs are easy, but when it comes to irrigation, things are very difficult for me. This is because I have to go to the spring. I carry (20 l) water bucket on my head. I have to go to the spring four times during irrigation days. Things are easier now because I have not planted the entire garden.

R: So, do you think of giving up?

P: It is difficult but I cannot give up because the vegetables that I get are helping me a lot. I am not working, where would I get the money to buy the vegetables that I get from the garden. If I was not having these garden I was suppose to buy them, or other foodstuffs.

Advantages and disadvantages of the irrigation system

P: I think the irrigation system makes gardening easier because you don’t have to use other methods that are labour intensive

R: Yes, it helps but now I have stopped using the pipes because I have not planted the entire garden. Therefore, it would be a waste because if I use the irrigation system because it will irrigate the unplanted areas.

R: You stopped using because your garden is not entirely planted

P: These pipes are very good. When they were new they were very good because they were not block. Now they block very often when I use them. Blocking of the pipes makes my crops not to grow at the same size.

R: Gerrie showed you how to unblock the drippers?

P: Yes, I know how to unblock these pipes, but my problem is to identify a blocked dripper when the crops are big. It also frustrates me to keep on unblocking the drippers because they block again quickly.

R: How do you irrigate now?

P: I use a bucket, it is tiring, but it irrigates much better than the pipes. After irrigating I am assured that all the crops have water.

Changes that should be made

R: What do you think should be changed to make your garden easier?

P: My crops are not growing well because these soils are not good. They are very sandy, and when you dig, they are stony. I want to transfer my garden to my residential site (garden was not at her residential site). I will first try to get a fence because chickens
could give me a problem. In my residential site, the crops will grow well because the soils are fertile.

R: What about the irrigation system?

P: If the drippers could be fixed, the system could be very useful. You must teach me how block unused dripper lines, in case I have not planted the entire garden. If I have not planted the entire garden stop using the irrigation system because it will waste water.

R: Most of the gardeners have a problem of producing seedlings?

P: That problem also affects me. I have failed growing my own seedlings using the procedures that you and the white man taught us during the training. The better option for me is to buy seedlings. If you can show me the place where you were buying them, I will buy them when it is time for planting.

GARDEN 7

Production period 1: August 2000 to January 2001

Observation:
On 11 October 2000, I saw her going to the spring to fetch irrigation water

Interview no. G7.1: 11 October 2000

R: Gerrie advised you to use grey water to avoid going to the spring

P: The used water that we get in my house in two days can hardly fill the drum. In two days the used water that I collect fill the drum to half. The white man said I have to irrigate three times a week with a drum full of water. When tap water is available I use it to fill the other half of the drum, and when there is no tap water I have to go to the spring to get water to fill the other half of the drum.

R: I think going to the river is a hard work

P: It is hard work, but this is what I have to do to keep my crops growing well. If I don’t do as the white man has told us I something can go wrong with my crops.

R: How do you carry water from the spring?

P: My mother helps me to fetch water from the spring. Each of us carries a 20 l container at a time. We usually go to the spring three times in order to fill up the other half of the drum.

Observation:

On 1 November 2000, I saw her giving away some vegetables.
Interview no. G7.2: 01 November 2000

R: I can see that you have produced a lot of vegetables because you give some to people

P: Yes, I have produced a lot of vegetables, which is why you see me giving some of the vegetables.

R: You give the vegetables for free

P: I give vegetables to the peoples who are either my relatives or my neighbours. These people also help us. When we are in need of food we always run to them. They do not only help us with food but with other things as well. For example, sometimes one of my neighbours helps me to carry water from the spring when my mother is not around. It will not be fair if I don’t give vegetables when we harvest.

R: Why don’t you sell or preserve the vegetables?

P: I cannot sell the vegetables to my neighbours or relatives because they also help us when don’t have food. Only my mother prefers dried vegetables. For that reason we cannot preserve them.

Observation: Most of the times her vegetables were big because they were not harvested frequently

Interview no. G7.3: 23 November 2000

R: Your vegetables are growing fast; you can even harvest them daily if you want.

P: When I have harvested, my garden does not look good. When the vegetables are big my garden looks very beautiful. My neighbours and the people that pass by house appreciate my beautiful garden when the vegetables are big and green.

R: If you can just harvest a small amount of vegetables daily the good looks of your garden will be retained

P: We can’t eat vegetables daily. Most of the time we eat meat. These vegetables taste nice but when we eat them more frequently we would start to dislike them. We are not used to eating vegetables daily.

R: In most of the families with the irrigated gardens children don’t like vegetables

P: Even here there is the same problem. In our house the only person who likes vegetables is my mother, the rest of us don’t like it that much. My child does not like vegetables at all. If we eat vegetables I have to provide something else for here.
Production period 2: January to May 2001

Observation:
After harvesting her first crops she planted beans and groundnuts in her irrigated garden

Interview no. G7.4: 10 January 2001

R: Now you have changed to the summer crops; don’t you like the crops that you had previously?

P: I like the crops that I had in the first time. The problem is that I don’t know how to grow their seedlings. Therefore, I decided to grow these crops, because I know how to grow them. In addition, the previous crops could only grow well in winter and spring.

R: Are those the only reasons that made you to plant these crops?

P: Yes, It is better than living this garden unplanted. What will the people who gave us the gardens say when they come to check on the gardens? These gardens should always be planted so that when they come they can see that I care about it.

Observation:
On 7 February 2001 she told me that she irrigates only once per week

Interview no. G7.5: 07 February 2001

R: You told me that you irrigate only on Wednesdays

P: These crops are very good because they don’t require a lot of water as compared to the previous crops. I only irrigate once or twice with a drum filled to its half. These crops can grow without water; we usually plant them in dry conditions. If I was not using recycled water I wouldn’t be irrigating them because it would be a waste of time to go and fetch water from the spring to irrigate these crops. People often obtain good yields without irrigating them.

Production period 3: May to September 2001

Observation 1
On 29 August 2001, she told me that she stopped using grey water

Interview G7.6: 29 August 2001

R: One day you told me that you no longer use grey water

P: I have decided to stop using grey water. Since the start of this growing season I used very little used water. When I irrigate I make sure that I use only a quarter of used water and dilute it with tap or spring water. I do this to reduce the soap content in the used water. The soap content makes my soil to be dry and white, when I irrigate the water cannot penetrate the soil easily.
R: But the water did not have any impact on your crops during the first period

P: It caused my soil to be white and hard. I never liked this water from the beginning. I used it during the first planting because Gerrie advised us to use it. I thought it would not change my soil. Besides turning the soils white and making it hard, it is worrying to eat vegetables that were irrigated using dirty water.

Observation:
On the 12 November 2000, I saw her selling the crops.

Interview no. G7.7: 12 November 2001

R: You have decided to generate some money by selling the vegetables

P: I am not selling the vegetables in order to generate money. Some people whom we don’t share things (either friends, relatives nor neighbours) with came to ask for vegetables. I could not give them for free because they will never give me anything in return. I only give vegetables my friends, relatives or neighbours and the people that helped me with kraal manure and borehole water. I will always give vegetables to these people because they help me a lot; the other peoples have to pay for them.

Observation:
On 19 September 2001, I saw her irrigating with a bucket and her drum was filled to half.

Interview no: G7.8: 19 September 2001

R: These days you irrigated with a drum filled to half

P: I don’t have a shortage of water. Now I have stopped using the irrigation system because it was not irrigating evenly. The main problem with the irrigation is that the drippers always blocks. When I irrigate with a bucket, the soil remain wet for two days. It is also possible to irrigate all the crops sufficiently because I just you throw a little amount near a crop. When I use the irrigation system, I fill up the drum but some of the crops are left out.

R: I see that using a bucket is better

P: Yes, irrigating with a bucket is better because when I was using the drum I was forced to fill up the drum. Now when I have a small amount of water I can manage to irrigate the entire garden using the bucket. Now my crops are growing at the same size because they get water equally.

Production period 4

Field visit: 12 December 2001

Observations:
The garden was planted with tomatoes, onions, carrots, and cabbage.
Production period 5

Field visit: March 2002

Observation:
The garden was not planted

Interview No: G7.9: 22 March 2002

R: I expected your garden to be planted

P: Now the sun is very hot. I have decided to stop planting because the sun can burn the crops.

R: Gerrie, told you that most of those vegetables could grow well in summer

P: I remember that he said that some of the crops could grow during this time, but the problem is that they would require more water than in spring and winter. Only a person with borehole can manage to have vegetable crops during summer times because that person can irrigate at any time. If I plant now where will I get water to irrigate frequently? You know that our soil do not hold much water even during winter. It is obvious that this problem would be worse in summer.

R: Do you stop because the water requirements will increase?

P: No, another thing is that now traditional vegetables are available from our home garden. It will be a waste to plant vegetable crops whereas there are other vegetables that we can consume.

R: Don’t you have problem continuing with your garden in my absence

P: Now I know most of the things about concerning the growing of vegetable gardening. I even know how to grow my own seedlings. The only problem is that I can’t control pests and diseases although we have been taught. I promise you that my garden will be planted during every winter and spring.

Production period 6:

Observation:
The entire garden was planted (beetroot, carrots, onion and Swiss chard).

Exit interviews

Interview No: G7.10

Advantages and disadvantages of the irrigation system

R: Despite blocking of the drippers of the irrigation system, do you see any thing wrong about it?
P: Blocking of the drippers was the main problem I have experienced with the irrigation system. I have stopped using it because of this problem. It irrigates unevenly because it always blocks. Now that I use a bucket my crops grow well because they get water equally.

R: I think irrigating with bucket is a hard job

P: It is hard work, but I am prepared to do it like that because my crops grow very well. The drum was only helping me to contain water before it started leaking.

Grey water

R: I think you are experiencing water shortage because you stopped using grey water

P: Water is scarce here as you know, but I am trying to get water from other sources. When water from other sources is unavailable, I would rather stop with the garden than using grey water. This water makes my soil dry and it is unhygienic to use it. In addition it irritates to eat vegetables irrigated with used water.

Labour and advantages of the garden

R: It seems you don’t to work in the garden and leaves other domestic jobs

P: I don’t do much in the garden because my mother helps me. Going to the spring is the only job that is difficult. My mother helps me to fetch water from the spring. When I am finished I irrigate, and then start doing other jobs.

R: Does the garden help you?

P: The vegetables that I get from the garden help us a lot. We don’t eat them daily but some, such as tomatoes and onion we need them daily. If we have these vegetables in our garden we save a lot of money. Now that I know how to produce vegetables, I fell unhappy when I have to buy. There is also an opportunity for me to sell vegetables because people keep on coming even when I tell them that I don’t sell. Most of the people can not afford to buy meat everyday. The only problem is that the garden is very small and water is scarce.

Changes that should be made

R: What should be done to improve the way you produce the vegetables?

P: The drum should be changed because it leaks. I have tried to seal it but I failed. Although I am no longer using the pipes (irrigation system), the drum was necessary to contain water. I don’t have problems with other things. I will use the bucket to irrigate because it works better than the pipes. It is a hard work to use a bucket but I will stick to it.

R: Other gardeners have a problem of producing seedlings
**P:** I don’t have a problem because I know how to grow my own seedlings. My only problem is when my crops are attacked with pests or diseases. I can’t control pests and diseases. I am thinking of stopping growing cabbage because many diseases attack it.

**GARDEN 8**

**Production period 1**

**Observation:**
On 30 September 2000, I noticed that her drum is filled with only clean water.

Interview no. G8.1: 30 September 2000

**R:** I see you use borehole water only to irrigate your garden. Do you remember that the Gerrie said you could use used water?

**P:** I cannot irrigate my crops with water that has been used for washing or bathing. I have a borehole.

**R:** By using recycled water you could save water for selling and avoid pumping

**P:** I am selling the water to help people. I sell after I have satisfied all my water requirements. My main aim for selling is not to generate money. I sell water to help the people. If I don’t sell the water it means people will have to use water from spring for cooking and drinking. Water is very scarce here. I let the people pay so that I can have money to repair the pump in case it gets broken.

**R:** Using grey water can help you to avoid pumping.

**P:** I don’t worry about pumping; my children help me to pump. This drum is always full of water. When I finish irrigating, they immediately fill it up. It is their duty and I don’t have to remind them. I will never use dirty water because it is not a healthy practice. Even the vegetables can smell soap when I eat them.

**Observation:**
The vegetables were always big because she did not harvest them often

Interview no: G8.2: 11 October 2000

**R:** Your vegetables are growing very fast, why don’t you harvest them more frequent?

**P:** I can’t harvest them daily. If can do so I could end up eating them alone because my children don’t like vegetables. If I give them vegetables two days in succession, the second day they refuse to eat. I sell meat (chicken pieces). If they refuse to eat vegetables I am forced to take the meat that I sell and cook it for them.

**Observation:**
On 25 October 2000, I saw her giving away some of the vegetables
R: You have produced a lot of vegetables. I see you also give some to your neighbours.

P: I am not giving away because I am harvesting a lot of vegetables. I give the vegetables to my neighbours and relatives because they also help me when I am in need of food. They give me food also.

R: Why don’t you sell?

P: We were not given these gardens for business, but instead to produce vegetables for home consumption. If there is surplus, then I can give that away to my neighbours and relatives. I cannot sell things to these people because they also help me. If I sell vegetables to my neighbours they can’t help me when I am in need.

Production period 2: January to May 2001

Observation:
During the second production period she replaced her first crops with beans, maize and groundnuts

Interview no. G8.4: 17 January 2001

R: You have decided to change to these crops; do you prefer them to the previous ones?

P: Now it is time to grow summer crops. Those crops grow well in winter and spring. During summer they cannot grow well because it is very hot.

R: I see that it hot

P: Despite the hot weather I have a problem with planting those vegetables because I don’t know how to grow their seedlings. The crops that I have grown now do not give me a problem because they don’t require seedlings.

Observation:
When I visited her on 31 January she told me that she irrigates twice a week.

Interview no. G8.5: 31 January 2001

R: You told me that you only twice per week

P: We usually don’t irrigate summer crops; we always grow them under dryland conditions. Summer crops tolerate dry conditions. That is why everyone is able to grow maize and the other summer crops. With the previous crops I had to irrigate the way the white man has told or even more than that because I did not do so my crops would have died.
Production period 3: May to September 2001

Observation:
On 6 June 2001 I found her irrigating, the drum was only half filled.

Interview no. G8.6: 06 June 2001

R: This time you irrigate with half a drum

P: These crops have just been transplanted, so I water them everyday so that they can quickly adapt to these conditions. If I don’t do so they can wilt or die because they are used to getting water every time.

R: The first crops grew well when they were irrigated three times per week when they were small.

P: The seedlings of the first crops were bigger, they could not die easily. These ones are small and my soil does not hold water. If I miss out a day without irrigating, my crops could die. Maybe I will start irrigating three times per week when they are bigger. I don’t have the problem of lack of water because I have a borehole. My children are pumping and irrigating is not laborious because I just open the tap of the irrigation system.

Observation:
On 22 August 2001, I saw her selling vegetables.

Interview no. G8.7: 22 August 2001

R: I see you have started selling the vegetables; I think you will make some money

P: I am not selling because I want to generate money. I am using these vegetables for home consumption and to give my relatives or friends. I have only sold them to one person who came and asked me to sell the vegetables. I have told her that these vegetables are not for sale.

R: Why didn’t you give her because you give some people?

P: I can’t give the people that are not my neighbours, relatives or friends for free because they will not give something in return. If I give to my relatives or neighbours I know that I will get something back. They also help me when I need something.

Production period 4:

Field visit: December 2001

Observation:
The garden is planted and the crops are at the harvesting stage.

Production period 5
Field Trip: March 2002

Observation:
The garden is not planted.

Interview no: G8.8: 22 March 2002

R: You have told me that now you spend most of your time at Johannesburg, is that the reason why your garden is not planted?

P: My daughter can do all the garden work when I am not at home. I have told her to go to Maggie (garden 7) if there is something that she does not know. She knows many things because when I was working she was with me.

R: Why didn’t she plant?

P: I have told her not to plant because there are traditional vegetables in the residential garden. When these (traditional) vegetables are finished is then that she will plant. I will give her money to buy seeds and my neighbour (garden 7) will help her to prepare the seedlings. I think the vegetables in the other garden will be finished by late April. She will start preparing the seedlings during the middle of April so that they are ready by May.

R: I thought your garden is not planted because I am no here to check on you

P: Even when you were here my daughter would not have planted because there are traditional vegetables in the other garden. If my children need vegetables, they will eat those. My daughter will plant the garden again when the traditional vegetables are finished.

R: You will tell your daughter to stop during summer and grow vegetables during winter

P: I will tell her to grow vegetables in winter and in spring so that during the Christmas time we could have vegetables such as beetroots or carrots.

Production period 6: May 2002 to September 2002

Field trip: 12 July 2002

Observations:
The participant is no longer staying at home. She is staying in Johannesburg with her husband. She left the garden to the care of her daughter. Only three rows are planted (beetroot and Swiss chard), and the other three are unplanted

Interview no: G8.9: 12 July 2002

R: I expected this garden not to be planted because your mother is not home

P2: My mother told me to work in the garden when she left. I also like working in the garden but the problem is that I do not know how to do some of the important things. I used to work with my mother but I was not concentrating. Now I have a big problem, I
can’t even grow seedlings. Before she left, she bought seeds and made sure that there is everything.

R: Where did you get these seedlings?

P2: I have asked them from my neighbour (garden 7). She had more seedlings than she required. The seedlings that she gave me only covered three rows. If I knew how to grow seedlings I would have done it so that I could have the empty rows planted.

R: Your mother was using the pipes to irrigate, are you also doing so?

P: I am not using these pipes because some rows are not planted. I don’t want to waste water by irrigating empty rows. I use a small bucket (5 l) to irrigate.

R: You seem to enjoy working in the garden, or you are doing it because your mother told you so?

P: I like working in the garden but my problem is lack of knowledge. When my mother is at home to see us she does not help me. She is no longer interested in the garden because she does not stay here any more. I will ask my neighbour (garden 7) to teach me some of the things. When she is doing something that I do not know, I will go and watch her when she is doing that particular thing. Next time when you come you will find this garden entirely planted.

GARDEN 9

Production period 1
The original recipient gave this garden to a male. This happened before I informed the participants that if they wished to stop participating they were supposed to give back the irrigation system, so that I could get a female replacement.

Observation:
On 13 September 2000, I found him irrigating, with drum a drum filled to half

Interview no. G9.1: 13 September 2000

R: Did Ellah tell you that you could use grey water?

P: Yes, she (the original recipient) told me all the things they were taught when they were given these gardens. I do most of the things told me. I irrigate on Mondays, Wednesdays and Fridays. The problem is that I cannot fill the drum with water when I irrigate. I only use the used water that I collect from my house. I stay alone. I use very little water. I don’t even have a borehole or a tap. The used water that I collect only fill the drum to half.

R: Why don’t you go to the spring to fetch water?

P: I don’t have time to go the spring. I am not employed. I do many things to generate income. I sell firewood, and I also look after the cattle. Sometimes people ask me to do odd jobs. I don’t have time. I like the garden because I know it will help me with vegetables.
Observation:
I noticed that most of the times when I visit him the vegetables are big, indicating that they
are not frequently harvested,

Interview no. G9.2: 08 November 2000

R: Why don’t you harvest the vegetables more frequently, don’t you enjoy them?

P: I harvest frequently, it is just that I harvest enough for myself. Even this morning I
harvested Swiss chard but you can’t notice that. I only I harvest a lot is when I want to
give to Ellah (the person who gave me the garden) or my neighbour, who is also my
relative.

R: Did Ellah demand to be given vegetables?

P: She did not demand. I give her willingly. She gave me the garden, so I must return the
favour by giving her vegetables. If it were not for her, I would not be having this garden.
My neighbour who is my brother’s wife helps. She sometimes gives me recycled water.

R: It means you enjoy vegetables because you said you harvest daily

P: I don’t hate vegetables like many people do. When people go to the pension payout
point, you will see them carrying chickens. They don’t buy vegetables. I grew up eating
vegetables because I am from a poor family. I don’t mind eating vegetables for the whole
week. Vegetables are good because when you have them you save because you don’t have
to buy meat.

R: I heard you saying that you give your vegetables to Ellah and your neighbour why don’t
you sell the vegetables.

P: My vegetables are a lot for me. If I were not giving Ellah I would be selling. People
who can afford buying meat regularly are in need of these vegetables. Most of the people
came to ask if I could sell them the vegetables.

Production period 3: January to May 2001

Observation:
After harvesting the first crops he grew maize and groundnuts in his irrigated garden
Interview no: G9.3: 24 January 2001

R: Did you have a problem planting similar vegetables as the previous ones?

P: I know everything about vegetable gardening. I once worked in a farm. I know how to
grow vegetable seedlings. The reason why I have not vegetable vegetables is that now it is
not the right time for those kinds of vegetables because it is very hot. When it is winter you
will see me growing vegetables form my own seedlings.

R: You were suppose to try them out
**P:** No, I can’t waste seeds because I know that my vegetables will not grow well. In summer we grow these crops and during winter we grow the vegetables that we grew previously. Summer crops cannot grow during winter. All these crops are grown in their specific times.

**Observation:**
When I visited him on 7 March 2001 I found that the soils were dry

Interview no: G9.4: 07 March 2001

**R:** The soil is very dry. It seems you don’t irrigate sufficiently

**P:** I irrigate only once or twice per week with a drum filled to half. These crops do not require to be irrigated at all. I am just irrigating because I want to utilize the used water that I collect from my house. Even when I irrigate with half a drum for the whole week there is no problem. These crops can withstand dry conditions. The previous crops that I grew did not grow well because I did not irrigate the way that I should have.

**Production period 3: May to September 2001**

**Observation:**
When I visited him on 13 June 2001, I found him collecting borehole water from his neighbour. He filled the drum half way and started irrigating

Interview no: G9.5: 13 June 2001

**R:** This time you don’t use used water for irrigation

**P:** I have decided to stop using used water. I don’t feel happy when I use dirty water to irrigate vegetables. Even my neighbour was not happy when I gave her the vegetables. This time I wake up early in the morning and go to the spring when it is a day to irrigate. It is a hard job but I would rather do it instead of using used water.

**R:** Why don’t you mix water from the spring with used water?

**P:** I am not irrigating like the other people but my crops are growing faster. This time I have applied more kraal manure so that the soil can hold water for a long period. There is no need for me to irrigate with a full drum. I will only use spring water.

**R:** If the spring dries up, what will you do?

**P:** My neighbour, who is my sister in law, gave me permission to collect water from borehole. She also told me that this water could make us to fall sick., and there is a reason to believe her.

**Observation:**
On 18 July 2001, I arrived when he was harvesting. There was a child coming to buy vegetables.

Interview no. G9.6: 18 July 2001

**R:** Do you still give Ellah some vegetable?
P: I am no longer giving to her. The vegetables that I gave her during the first planting were enough. The only person I give to is my brother’s wife because she helps me with borehole water. Now it is time for me to sell the vegetables. I want to generate money.

R: Are you a making a reasonable income from selling?

P: I generate a lot of money. Last week I made more than R20. People know that I sell vegetables. Sometimes they force me to sell the vegetables that I am supposed to eat. I am not giving my brother’s wife enough vegetables because of selling.

R: What do you do with the money you get from selling?

P: I use the money to buy meat and things like cooking oil. When I have more money I use some to buy cigarette and liquor.

Production period 4: September 2001 to January 2002

Field visit: 12 December 2002

Observations:
The garden was planted with tomatoes and onions

Production period 5: January 2002 to May 2002

Field visit: March

Observation:
Garden was not planted

Interview no. G9.7: 22 March 2002

R: I expected your garden to be planted by now?

P: I will plant in winter because now I have traditional vegetables are available. I have two residential plots that I plough, and there are traditional vegetables in both gardens. It is a waste to grow vegetables in my irrigated garden when there are vegetables in the other garden (not irrigated). My customers are also having traditional vegetables. So if I can plant now I won’t get people to buy my vegetables.

R: When do you think you are going to plant?

P: I will start preparing seedlings in April because these vegetables will be dry towards the end of April. Now I will not grow Swiss chard, tomatoes and onions so that I change (rotate) my crops. I will grow different crops so that pests and diseases do not attack my crops.

R: You will only grow once a year
P: I will plant my irrigated garden two times a year, in winter and in spring. I normally start harvesting traditional vegetables in late spring. Therefore I need vegetables in winter.

Production period 6

Field visit: 12 July 2002

Observations:
Only two rows were planted to beetroot and Swiss chard

Interview no. G9.8: 12 July 2002

R: Are two rows of vegetables enough for you

P: I was not intending to plant two rows of vegetables. I had prepared more seedlings but they started dying before I could transplant them. The seedlings that were left were very little that they only covered two rows.

R: Why didn’t you prepare other seedlings so that you could plant the entire garden?

P: The seeds were finished. I have never bought seeds since the white men gave us during the training. I have been using the seeds since we were given them. I take a long time without going to town, which is why I have not bought seeds. When I get someone who is going to town and reliable I will send that person buy me seeds.

R: What will you do to avoid what happened to your seedlings previously?

P: I will no longer plant them in these drums. They were too many, so they did not get enough water and fertilizers (nutrients). They were also over populated. Now I will make seedling beds. Few weeks after they have germinated, if they are too many, I will carefully try to remove some of them and plant them at the other seedling bed. This time I will avoid planting too much seedlings in a small area.

R: How do you irrigate because you only have two rows planted

P: I use a bucket. I can’t use the pipes because they will irrigate unplanted rows, and that will be a waste of water. I will start irrigating with the pipes during the following period because I would plant the entire garden.

Exit interviews

Interview No: G9.9

Disadvantages and advantages of the irrigation system

R: Are there any problems that you have experienced when using this irrigation system except for blocking of drippers?

P: These pipes are good; the only problem with them is blocking. When I irrigate I just fill the drum, open the tap in the morning, and go away. I have many things to do. Most of
the times, I am looking after cattle or doing piece jobs. When I come back in the afternoon I find that there are spots that are still dry because the holes (drippers) were closed. That is a problem, I’m unable to be here and checking if the pipes will block.

R: I think the pipes make your job easier although they block

P: They are good because you just need to fill up the drum, once the drum is full I can leave the tap open. It is very good for people like me, people who are very busy. The problem is that I need to make sure that I check where it did not irrigate.

Grey water

R: Now that you have planted two rows I think you don’t have a problem of the lack of water. The used water that you get is sufficient

P: I am no longer using recycled water at all. I don’t feel happy to consume vegetables irrigated by water that was used to wash dirty clothes or bathing. If don’t get borehole water from my neighbour (relative), I go to the spring. People won’t buy my vegetables if they find out that I use used water for irrigation.

Advantages of having the garden

R: I see that the garden is helpful to you

P: I have generated a lot of money by selling vegetables. People who cannot afford meat prefer buying vegetables because they are cheaper. It is unfortunate that I have not planted my entire garden at the moment. This time people that come to buy return home without vegetables because I don’t have enough to sell. The vegetables are not even sufficient for me.

R: I see that the garden is good for you

P: It also helps me with the vegetables that I consume. I was supposed to buy these vegetables. Where would I take the money to buy these vegetables because I don’t have a reliable source of income? Most of the time I eat these vegetables because I can’t afford meat. When I don’t want the vegetables I sell them to get money to purchase meat or fish.

Labour

R: I think the garden does not stop you from doing the other jobs that you are suppose to do

P: The garden is also important to me because it get vegetables to eat, and also generate some money buy selling. For those reasons I can’t do without it although it has a lot of work. It sometimes stops me from doing other things. For instance when I am transplanting I take me a long time doing it, because it need to be done carefully. At times I have to work in the garden even when I am tired.
Suggested changes

R: What do you think should be done to improve the way you do things in your garden

P: The big problem for me is only with the pipes because they always block. I think these strings are the ones that make these pipes to block. They should be removed because they block water. I know there are special things (dripppers) that are supposed to be fitted here. I have tried to remove one string; the water was dripping in a good way and even faster. I want my pipes to be fixed so that I can start using them during the next planting time.

R: Most of the drums have a problem of leaking.

P: I don’t have a problem with the drum. It does not leak. It is just rusty because I am no longer using it.

R: Growing seedlings also give some people problems does this apply to you as well?

P: Producing seedlings is also problematic to me. I have tried all I know but I failed to grow good seedlings. This causes me not to plant the entire garden. Failing growing seedlings will not stop me from growing the vegetables; I will keep on trying to grow my seedlings.

GARDEN 10

Production period 1: August to January 2001

Observation:
When I visited her on 27th of September 2000, she told me that she fills the drum with used and tap water

Interview no. G10.1: 27 September 2000

R: You said that you use your tap water for irrigating. Why don’t you use grey water only?

P: I cannot manage to fill up the drum three times a week with grey water only. In two days I collect half a drum (100 l) of recycled water from my house. The only time I get more water is when I have done a lot of washing.

R: You don’t mind using your tap water

P: I am worried because you can see that water is very scarce here. We only get water twice a month. Sometimes I have to buy cooking and drinking water during the second week because we have used the water for irrigating the crops. I just use it because the white man said we must irrigate three times with a drum full. I have to follow the white man’s instructions all my crops could die.

R: What do you do when there is no tap water because it is only available occasionally?
P: My grandchildren go to the spring. During the week when tap water is not available, I make sure that I store water in 20 l containers so that I can use it for irrigation. This water helps us throughout the week. If I had many containers, I would store water for two weeks so that my grandchildren are relieved from going to the spring.

R: Are your grandchildren happy to go to the spring?

P: Young people don’t like to work. I am old; they have to go to the spring. They have to do the work because they are going to eat the vegetables from the garden. In fact I am doing this garden because of them, if I were alone I would not bother because I would be able to buy enough food for myself with my pension money.

Observation:
On 25 October 2000, I saw her harvesting the vegetables; the vegetables seemed to be more than she could cook


R: Will you finish all these vegetables?

P: No, I have harvested more so that I could give some to my neighbours.

R: You are very helpful to your neighbours

P: Yes, I am because the people whom I give also help me. I give to my neighbours. We are poor and most of the time they give me food. When our maize meal is finish, I go and ask from them. They have been very helpful to me. If I don’t give them vegetables I will not be able to go and ask food from them.

R: I think you could make generate money by selling the vegetables

P: I am thinking of selling the vegetables but not at the moment. I have to extend my garden first. If I can do that I will be able to sell. If I start selling now, many people will come and we won’t have enough vegetables to eat here at home. If the garden is bigger I will be able to give some vegetables to my neighbours, eat and then sell what is left.

Observation:
The vegetables were not harvested frequently. Usually she harvested two days per week

Interview no. G10.3: 01 November 2000

R: Why you stay long without harvesting your vegetables?

P: I want to harvest the vegetable more frequently than now but I can’t do so because I will harvest vegetables that are very little for all of us to eat. You know that our family is quite large. I have to wait for some few days so that when I harvest everyone at home can eat the vegetables, and also have something to give to my neighbours.

R: Children in most of the gardens don’t like vegetables
**P:** I have the same problem here. My grandchildren don’t like eating vegetables. When I cook vegetables they are not happy. I have to force them to eat because I can’t provide them with something else. I don’t have money to buy meat everyday. I tell them that if they want meat everyday we have to extend the garden so that we could get vegetables to sell and generate money for purchasing meat.

**Production period 2: January to May 2001**

**Observation:**
After harvesting all the crops she grew maize and beans

Interview no. G10.4: 10 January 2001

**R:** You have changed to these crops; don’t you like the previous ones?

**P:** I want them because they are very good but now it is not their time. Those are winter crops. If I can grow them now they won’t grow well because it is very hot. Previously they grew well because we planted them in August. By then it was not hot. Now it is hot, they won’t survive.

**R:** Some of the people did not plant the previous crops because they didn’t know how to plant vegetable seedlings.

**P:** I know how to grow my own seedlings. I know vegetable gardening because I have once stayed in a farm where my husband was working. I used to have a very beautiful garden. If I finish harvesting these crops in May I will start preparing seedlings.

**Observation:**
On the 11th of April 2001, she told me that she irrigates once a week and not three times

Interview no. G10.5: 11 April 2001

**R:** Why don’t you irrigate as you were doing in the previous period?

**P:** These crops are normally not irrigated. They survive without irrigation. They can stay for a long period without water, sometimes longer than a month. They are unlike the crops that we planted previously. Those crops need to be watered frequently. I don’t irrigate them they could die. That is why the white man advised us to irrigate three times per week.

**R:** It means that even when you can stop irrigating they can still grow

**P:** I irrigate because I don’t have to send my children to the spring. I use the used water I collect from my house.

**R:** Your children are relieved from going to the spring

**P:** Now they are relieved. They wish that I would grow these types of crops all the times. When we grow irrigated crops during winter they will have to start going to the river.
**Production period 3: May to September 2001**

**Observation:**
On 18\(^{th}\) of July 2001, I found her irrigating; she only used water from the spring to irrigate

Interview no. G10.6: 18 July 2001

**R:** I see you have filled up the drum with spring water; you are no longer using grey water

**P:** I still use grey water, but now I only use the water that have been used to rinse the washing. That water is not good for our health.

**R:** The water did not affect your health in the beginning.

**P:** The water will make us to be sick in the long run. This water is not good. If there were serious shortage water I would rather stop with the garden than using grey water.

**Observation:**
On the 28 August 2001, I found that chickens had eaten all the crops.


**R:** What happened to your garden?

**P:** The chickens got into the garden and ate up everything on Saturday. I am worried about this damage. Now I don’t know what to do about it. Before I planted I had removed the big wings of the chickens so that they couldn’t fly over the fence. I don’t know how they got in. In the first time when we planted I slaughtered two chickens that were leading all the chickens into the garden.

**R:** Why don’t you keep them in their house?

**P:** The problem is lack of feeds. I can’t keep them in the house because I have no feeds to give them. I don’t have money to buy feeds. I also can’t slaughter all of them.

**R:** Are you going to replace the crops?

**P:** I have lost these vegetables and they can’t recover. I am no longer going to irrigate them because it will be a waste of water and time. I have to wait for the white man because you said that when he comes he would supply us seeds and teach us how to grow seedlings. If I had seeds I would start preparing seedlings because I know how to do it. When he comes to check the garden you must tell him that chickens damaged my garden because he can take it away from me.

**R:** I can see that this is a big loss

**P:** It is a very big loss especially when I think of how hard my grandchildren have worked. They were very disappointed about this damage. I am worried because now I will have to buy meat and vegetables. I was saving the money because I was no longer buying meat and
vegetables like before I had the garden. I will have to wait for the white man (Gerrie) to give me seeds because I don’t have money at the moment.

Production period 4

Field visit: December 2001

The garden was planted to tomato, beetroot, carrot and Swiss chard

Production period 5

Observation:
The garden was planted to tomato, beetroot, carrot and Swiss chard

Observation:
She grew maize groundnuts and bambara groundnuts

Interview no. G10.8: 22 March 2002

R: You seem to prefer field crops during summer

P: Yes, because it is their time. I will plant vegetable crops during winter and spring. This time the vegetable crops will require a lot of water because the soils dry up very quickly. If I grow them I will need to increase irrigation, where will I get water?

R: I think vegetables can grow well without increasing irrigation

P: I know that they might grow well but now I want to grow these crops because it their time. This period is called selemo (time for summer crops). Everyone wants to grow these crops. You can also see that my yard is very small and this year I did not cultivate my arable land because I have no money. My children like eating green maize so it would not be good to grow those crops because I know that this time they need green maize, groundnuts and bambara groundnuts. The crops I have planted are few, but it is better than having nothing at all. It we don’t eat summer crops; we will have to wait for the next summer.

R: During this time you will buy those vegetables, if you need them

P: We don’t have a problem with those vegetables now. I only have to buy tomatoes and onions. When we need vegetables we will harvest the traditional ones.

R: During summer you will grow maize, beans and groundnuts?

P: Yes, in summer I will grow these kinds of crops. I don’t think I will be able to continue with arable farming, therefore this garden will help us because we will be able to produce green maize and other summer crops.

Production period 6

Observation:
The garden is not planted
Interview no. G10.9: 12 July 2000

R: I thought your garden would be planted during this time

P: My problem was lack of water for irrigation. There was no water in the spring. I had planned to plant early but the problem of lack of water let me down. Now the problem has been solved because we have dug the spring. We have fenced it off with thorn bushes to prevent cattle from drinking water.

R: Before you dug the spring, why didn’t you use used water to grow seedlings?

P: I don’t want to use recycled that water any longer. Previously, I used recycled water because there was no other reliable source of water. From now on, I will no longer use it, even when it is mixed. Using that water is like eating dirty food. My children will go to the spring.

R: Are you preparing seedlings?

P: I have already started preparing seedlings. I have planted them in containers so that I can move them to a safe place, in case if there is a bad weather prevails. I have planted beetroot, Swiss chard and chilli. This time I want to sell some of the produce. That is the reason why I have selected these crops. I can make a lot of money from selling.

Exit interviews

Interview No: G10.10

Advantages of having the garden

R: I think this garden helps you very much

P: This garden is very helpful to me. Now life is difficult for me because there are no vegetables in my garden. I am always forced to buy foodstuffs to eat with pap. I am struggling because I only generate money from pension.

Grey water

R: You said the lack of water delayed you to prepare seedlings. Why didn’t you use grey water?

P: Recycled water is not good at all. Even in the beginning I was not willing to use that water. It irritates to eat vegetables that were irrigated using recycled water.

Labour

R: I think the garden does not consume time for you to do other jobs

P: Gardening has a lot of work. I am fortunate because my grandchildren do most of the work. I would not be coping with work because I am old. My grandchildren understand that they should do the work because they see that this garden is helpful to the family. The
pension money that I get is very little; we have to make sure that we do something like gardening to save money.

**Advantages and disadvantages of the irrigation system**

*R*: What do you think about the irrigation system

*P*: This irrigation system is not good because it always blocks. When I am irrigating I have to keep on checking for the blocked drippers. This time I won’t use it because of blockages. I also suspect that the drum is leaking because it rusty.

*R*: You know how to deal with the blockages

*P*: Yes, I know but it is a tiring exercise to unblock those drippers because after unblocking them they block again quickly.

*R*: How are you going to irrigate now

*P*: This time I want to try using a tin, I hope it works well.

*R*: Apart from blocking, do you have other problems with the irrigation system?

*P*: Another problem is the rusting of the drum. If I start using it, it will leak. I really don’t know what I am going to do if it leaks; I have no plan to seal it. Rust and blocking of drippers are the only problems I have with the irrigation.

*R*: Are the only problems, what about producing seedlings?

*P*: I don’t have a problem of producing. I was working in a farm some years ago. I know everything about gardening. I have shown you how good are my seedlings.

**Changes to be made**

*R*: What are the changes that you think should be made to make your gardening easier

*P*: If you can get the pipes to work properly, and help me to solve the problem of rust in the drums. Maybe if it could be painted in the inside it will no longer get rusty.

*R*: Your only problem in gardening is the with the irrigation system?

*P*: If possible, something should be done to solve the problem of lack of water. If we can get water from the pipes on a daily basis, it will be easier to get irrigation water. Everyone can start a garden. At the moment things are very difficult because we go to the springs, what if I was too far from the spring?
## APPENDIX D: QUALITATIVE DATA ANALYSIS

Codes, themes, and categories emerging from the interviews on explanations for divergence from the envisaged adoption scenario

<table>
<thead>
<tr>
<th>Code (Topic)</th>
<th>Theme</th>
<th>Categories of explanations</th>
<th>Interview registration number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The use of grey water</td>
<td>Recycling grey water was rejected</td>
<td>➢ It is unhygienic to use grey water for irrigating vegetables crops.</td>
<td>G1.6, G2.4, G3, 7, G4.1, G5.1, G5.11, G8.1, G2.5, G6.6, G7.6, G9.5, G10.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ The water can make the soils to smell badly.</td>
<td>G4.1</td>
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<tr>
<td></td>
<td></td>
<td>➢ Fear of being laughed at by other community members for using used water for irrigation.</td>
<td>G5.1, G5.11</td>
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<tr>
<td></td>
<td></td>
<td>➢ Grey water made the soil surface to turn white, subsequently making the soil to be hard.</td>
<td>G6.6, G7.6, G9.5</td>
</tr>
<tr>
<td>2. Amounts and frequency of irrigation</td>
<td>Applying less water than recommended (3 x 200 l per week).</td>
<td>➢ Grey water collected was not enough to meet the recommended irrigation; other sources were used to compliment grey water.</td>
<td>G1.1, G2, 1, G3.1, G6.1, G7.1, G10.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Crops were stunted; therefore it would be a waste to apply the recommended irrigation.</td>
<td>G6.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ The garden was not entirely planted because of damage to seedlings during transportation, and damage to crops by livestock. The remaining crops</td>
<td>G3.6, G5.7</td>
</tr>
<tr>
<td>3. Use of the Drum &amp; Drip system to irrigate crops</td>
<td>Participants stopped using the irrigation system</td>
<td>When the entire garden is not planted use of the system would be a waste because it also water the unplanted area.</td>
<td>G3.6, G6.10, G8.9, G9.10</td>
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<td>-------------------------------------------------</td>
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<tr>
<td></td>
<td></td>
<td>The drippers were continuously clogging.</td>
<td>G7.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The drum was leaking.</td>
<td>G1.10, G4.8, G5.10</td>
</tr>
<tr>
<td>4. Harvesting and the use vegetables</td>
<td>Daily harvesting and consumption of vegetables was not followed</td>
<td>People including children preferred other foodstuffs to the vegetables that were planted.</td>
<td>G1.7, G4.2, G5.2, G7.3, G2.2, G3.2, G8.2</td>
</tr>
</tbody>
</table>

- When a bucket is used, it is possible to irrigate all the crops with half a drum of water. G7.8
- Summer crops were grown and they require less water than vegetable crops. G2.4, G3.4, G4.5, G5.5, G6.4, G7.5, G8.5, G9.4, G10.5
- The soil dries up quickly. Applying more water will ensure that the soils remain wet. G1.5
- The soil dries up quickly. Daily irrigation will ensure that the soils are always wet. G1.5, G6.5, G8.6
- When seedlings have just been transplanted they need to be watered daily so that they can adapt to the local conditions. G4.6
- When the entire garden is not planted use of the system would be a waste because it also water the unplanted area. G3.6, G6.10, G8.9, G9.10
- The drippers were continuously clogging. G7.8
- The drum was leaking. G1.10, G4.8, G5.10
- People including children preferred other foodstuffs to the vegetables that were planted. G1.7, G4.2, G5.2, G7.3, G2.2, G3.2, G8.2
<table>
<thead>
<tr>
<th>5. Growing of the recommended vegetables throughout the year</th>
<th>- The garden looks beautiful when the vegetables are big and green.</th>
<th>G7.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables were given away or sold before the household requirements were met</td>
<td>- The family is big. It has to wait for the vegetables to grow large so that they can harvest enough for the entire family.</td>
<td>G10.3</td>
</tr>
<tr>
<td>- Vegetables were given away to strengthen the social network, which can be relied upon in times of need.</td>
<td></td>
<td>G1.2, G2.2, G3.2, G4.3, G5.3, G5.8, G6.2, G7.2, G8.3, G9.2, G10.2</td>
</tr>
<tr>
<td>- Vegetables are sold to generate money to purchase other foodstuffs or other necessities.</td>
<td></td>
<td>G1.7, G9.6</td>
</tr>
<tr>
<td>- Vegetables were sold to people who came to ask for vegetables, but who do not form part of the friends of the participant.</td>
<td></td>
<td>G7.7, G8.9</td>
</tr>
<tr>
<td>- During summer the people grow summer crops.</td>
<td></td>
<td>G2.3, G3.3, G4.4, G5.4, G6.3, G8.4, G9.3, G10.4</td>
</tr>
<tr>
<td>- Vegetable crops cannot survive in summer because it is too hot.</td>
<td></td>
<td>G3.3, G9.3, G10.4</td>
</tr>
<tr>
<td>Event</td>
<td>Description</td>
<td>Code Numbers</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Participants did not know how to grow seedlings.</td>
<td>G2.3, G4.4, G6.3, G7.3, G8.4</td>
<td></td>
</tr>
<tr>
<td>Gardens were planted to show loyalty to the researchers who introduced the technology.</td>
<td>G3.3, G4.4, G6.3, 7.4, G8.6</td>
<td></td>
</tr>
<tr>
<td>Stopped growing in next summer</td>
<td>Traditional vegetables were available during summer.</td>
<td>G1.9, G2.8, G3.8, G4.8, G5.9, G6.8, G7.9, G8.8, G9.7</td>
</tr>
<tr>
<td></td>
<td>Vegetable crops cannot survive in summer because it is too hot.</td>
<td>G1.9, G3.8, G4.7, G5.9, G6.8, G8.8</td>
</tr>
<tr>
<td></td>
<td>Vegetable crops will need more water because it is too hot.</td>
<td>G7.9</td>
</tr>
<tr>
<td>Delayed planting and not planting the entire gardens in winter</td>
<td>Failed to produce vegetable transplants.</td>
<td>G2.9, G3.10, G5.19, G6.10, G8.8</td>
</tr>
<tr>
<td></td>
<td>Lack of irrigation water.</td>
<td>G10.9</td>
</tr>
<tr>
<td>A garden was abandoned</td>
<td>Responsibility was shifted to a young person.</td>
<td>G2.9</td>
</tr>
</tbody>
</table>
Codes, themes, and categories emerging from the exit interviews

<table>
<thead>
<tr>
<th>Code (Topic)</th>
<th>Theme</th>
<th>Categories</th>
<th>Interview registration number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assessment of the D &amp; D irrigation technology</td>
<td>Participants are not satisfied by the way the D &amp; D irrigation technology works</td>
<td>➢ The drum has a short life span (leaking after 2 years).</td>
<td>G1.11, G3.11, G4.9, G5.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ The drippers continuously clogged.</td>
<td>G1.11, G2.10, G3.11, G4.9, G5.11, G6.10, G7.10, G8.9, G9.9, G10.10</td>
</tr>
<tr>
<td>2. The use of grey water</td>
<td>Participant are not keen on grey water</td>
<td>➢ It is unhygienic to collect grey water and to use it for irrigating vegetables.</td>
<td>G1.11, G2.10, G3.11, G4.9, G5.11, G6.10, G7.10, G8.9, G9.9, G10.10</td>
</tr>
<tr>
<td>3. Main problems regarding crop production</td>
<td>Production of seedlings is seen as the main problem</td>
<td>➢ Participants want to purchase seedlings because they cannot produce their own because it is a difficult process.</td>
<td>G2.10, G3.11, G4.9, G5.11, G6.10, G8.9, G9.9</td>
</tr>
<tr>
<td>4. The importance of vegetable gardening</td>
<td>Vegetable gardening was seen to be important</td>
<td>➢ It supplies households with fresh vegetables. This made them to save money on vegetables or alternative foodstuffs</td>
<td>G1.11, G2.10, G3.11, G4.9, G5.11, G6.10, G7.10, G8.9, G9.9, G10.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Selling vegetables increased income of some households</td>
<td>G1.11, G9.9</td>
</tr>
</tbody>
</table>