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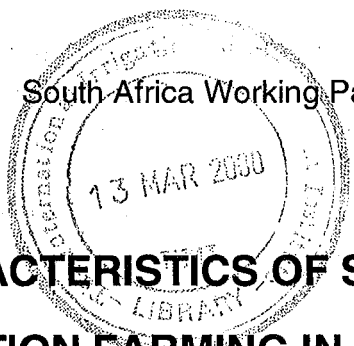
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**CHARACTERISTICS OF SMALLHOLDER  
IRRIGATION FARMING IN SOUTH AFRICA:  
A CASE STUDY OF THE ARABIE-OLIFANTS RIVER  
IRRIGATION SCHEME**

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Commissioned by the  
International Water Management Institute (IWMI)  
Colombo, Sri Lanka



**UNIVERSITY OF THE NORTH**

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## **Abbreviations**

ARDC	Agriculture and Rural Development Corporation
ha	hectare
R	Rand
UNIN	University of the North
PTO	Permission to Occupy

## **Currencies**

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South African Rand 1.00 = US\$ 0.17

US\$1.00 = South African Rand 5.72

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## Executive Summary

The study provides a comparative analysis of three smallholder irrigation projects located in the Arabie-Olifants River Irrigation Scheme. The projects differ in terms of plot size held by each project member. Plot sizes range from 0.12 ha (food plots) to 5 ha through 2.5 ha. The study aims to investigate socioeconomic household characteristics and resource endowment of small-scale farmers, crop choice, productivity and profitability of alternative crop enterprises, and institutional arrangements affecting small-scale irrigation farmers. The overall objective of the study is to provide information for the transformation process which presently affects previously government-managed irrigation schemes. The situation described in this study primarily reflects the status before the government withdrawal.

The analysis shows that small-scale irrigation farmers derive their livelihoods from a number of income sources. Based on crop budget analyzes it was estimated that irrigation farming could contribute to about 37 percent of household income of 2.5 ha farmers, 21 percent of food plot farmers, and 13 percent of 5 ha farmers. Although income derived from irrigation farming is highest for 5 ha farmers, the contribution to household income is lowest, because this group of farmers gains substantial income from alternative sources. The investigation also shows that 2.5 ha farmers are the poorest and almost 60 percent of households in this group are female headed, with relative little formal education.

A large proportion (about 50 percent) of both, food plot and 2.5 ha farmers faces transitory food insecurity for about two months in the year. Households cope with food insecurity by borrowing food and money or by eating cheaper food or by limiting the portion of food consumed (primarily 2.5 ha farmers). Irrigation farming contributes to food security directly through food supply and indirectly through income generation.

Vegetable production, as carried out by food plot farmers, provides higher returns to land and labor than maize and wheat produced by 2.5 ha and 5 ha farmers. For the vegetables investigated, gross margins per ha range from about R 8,000 to R 20,000, whereas maize and wheat provide returns of about R 500 and R 1,450 respectively. But vegetable production seems to be much more risky not only in terms of production but also in terms of marketing. Lack of markets for vegetables was a problem for most vegetable producers. Whether or not contract farming arrangements are a possibility to overcome market constraints needs to be investigated. Vegetable producers are also highly dependant on regular extension advice. Unlike maize and wheat production, vegetables

on food plots are primarily produced using manpower. But ploughing is mechanized. Extension advice is necessary on planting distances, planting time, irrigation intervals, input use, etc.

Apart from marketing and extension two more institutions were investigated, credit and land tenure. While 2.5 ha farmers need credit to finance inputs, this is not the case for 5 ha farmers who have access to off-farm income to a larger extent. In contrast, the majority of food plot farmers are not in need of production credit, possibly because input costs for the smaller plots are relatively low. In future, when farmers in all projects become responsible for pumping equipment repair and maintenance, more medium-term loans will be necessary.

The issue of land tenure remains inconclusive. Farmers in all projects have the "permission to occupy" and seem to feel secure with this tenure status. Whether a more secure status could have a positive impact on productivity as a result of yield improving investments remains unknown. Presently, other constraints (e.g., access to markets and information for food plot farmers and production credit for 2.5 ha farmers) seem to be more dominating.

The study provides insight into the potential and constraints of smallholder irrigation farming in the Arabie-Olifants River Irrigation Scheme. More detailed analyzes on the investigated issues in a situation of government's withdrawal from support services needs to be carried out.



# Chapter 1

## Introduction

### 1.1 Background of the Study

In South Africa, like in many other African countries, small-scale irrigation farming has a long tradition. Farmers primarily used rivers and streams as a source of water to irrigate small plots for the cultivation of grain crops and vegetables for home consumption (Rukuni et al. 1994).

Irrigation farming became more coordinated during the early part of this century, and several large-scale irrigation projects were established, to serve white farmers (Bruwer et al. 1995). In the former "Bantustans" larger irrigation schemes were established by the government since 1940 as a means to provide a source for economic growth and development. Though in most cases, irrigation projects focussed on the production of staple food (e.g., maize and wheat) with the objective to achieve local food self-sufficiency (Kirsten, Van Zyl, and Van Rooyen 1990). Because of a perceived lack of entrepreneurial and managerial abilities amongst black farmers and a philosophy of "optimal resource use," an approach was taken which resulted in the establishment of large-scale, externally managed projects, with little or no community participation. In a later adaptation process, projects were adjusted to settle selected laborers as project farmers under the central management (Van Averbeké et al. 1998).

One of the centrally managed schemes is the Arabie-Olifants River Irrigation Scheme situated northeast of the Arabie Dam in the Northern Province. Like many other similar projects, the scheme faces tremendous problems. Since the government support in terms of credit and service provision, lastly supplied by the Agricultural and Rural Development Corporation (ARDC) has been reduced substantially, most farmers dropped out of production. For most centrally managed and government-supported projects, new management forms, based on community participation, have to be developed and new support services have to be designed and implemented (National Department of Agriculture 1995). As part of the process of restructuring the impact of a possible shift to alternative crop enterprises, offering higher returns to land, labor and water use have to be evaluated.

To support the process of transformation, this study aims to provide insight into the situation of small-scale irrigation farming, based on information from the Arabie-Olifants River Irrigation Scheme.

## **1.2 Objectives of the Study**

More specifically, the study aims to investigate the following aspects of irrigation farming based on a comparative analysis of three projects located within the Arabie-Olifants Irrigation Scheme:

- (1) the socioeconomic household characteristics and resource endowment of small-scale farmers
- (2) the crop choice, productivity, and profitability of alternative crop enterprises and
- (3) the institutional framework affecting small-scale irrigation farmers

The household characteristics and resource endowment determine the importance of irrigation farming to the farmer and his/her ability to invest capital and provide labor. The economic situation of a household influences farmer's crop choice, e.g., cash versus subsistence crops. Productivity and profitability of alternative crops determine farm income, once crops are marketed. Access to and availability of markets are essential to generate income through cash cropping. Other institutional arrangements, land tenure, extension and credit can contribute significantly to the performance of irrigation farming.

The study aims to provide useful information for practitioners and researchers presently involved in transforming small-scale irrigation farming in South Africa.

## **1.3 Research Questions**

To achieve the objectives we are trying to answer the following questions:

What is the welfare status of smallholder irrigation farmers? To what extent does irrigation farming contribute to income generation in smallholder households? Does irrigation farming, as it is carried out presently, have a potential to generate livelihoods? What would be the requirements? What percentage of output is marketed? Does irrigation farming contribute to food security? How much? What institutional requirements are most crucial to improve productivity? How crucial are credit, land ownership, and extension service? Are product markets available? What should be done to increase productivity for the benefits of producers?

## Chapter 2

### Research Methodology

#### 2.1 Selection of Survey Areas

Three irrigation projects were selected as survey sites, Sepitsi food plot project, Veeplaats, a project with 2.5 ha plots per farmer, and Goedverwacht, Center Pivot No 2, a project with twelve 5 ha plots. The selection was done with consultation of staff members of the Agriculture and Rural Development Corporation, who provided a background of all existing projects in the scheme. ARDC, the development organization of the Northern Province Department of Agriculture, Land and Environment supports most of the projects in the scheme through various services. At the time of selecting survey sites, only about 300 ha out of the total of 2,012 ha in the scheme were cultivated. ARDC's inability to provide credit for inputs and maintenance for pumping equipment due to significant budget cuts, was the most frequently mentioned reason for this. This situation limited the choice of projects sites substantially for the study. In general, we were looking for projects with a higher level of ongoing activities. In addition, we tried to capture projects with different average plot size per project member.

#### 2.2 Methods Employed in Data Collection

Information and data were collected between September 1998 and February 1999. Before we interviewed the individual members in each of the selected projects, group discussions were held with project management committees and water management committees to get background information and general information about each project. For member interviews, structured questionnaires were used. Information captured in the questionnaire included information on household characteristics, agricultural production, marketing, consumption and storage, farm and off-farm income, access to credit and extension, land tenure, and problems associated with agricultural practices in general. In each scheme, a simple random sampling method was used to select the respondents. Forty-one out of 81 farmers from Sepitsi's food plot project and 22 out of 102 farmers from Veeplaats were interviewed. Only 3 out of 11 farmers from Goedverwacht, Center Pivot No 2 could be interviewed, because the majority of farmers are wage employed elsewhere. The total sample size for the whole survey is sixty six (66).

### **2.3 Methods Employed in Data Analysis**

Data are analyzed using descriptive statistics on a project basis. Means are used to compare income, farm size, and value of output produced and marketed, and to analyze household characteristics. Other variables like access to credit and extension service, markets, and problems encountered in production and marketing were analyzed using frequency distributions.

Impact analyzes, using regressions, as initially planned to be carried out, could not be computed because of insufficient variability of both independent and dependent variables. For example, the impact of institutional arrangements like extension service, credit or land tenure on the productivity of food plot farmers could not be estimated, because these factors do not vary within a project: farmers received extension jointly, perceptions on land ownership varied very little, etc. Productivity itself does not vary much in the 2.5 ha and 5 ha projects, where most activities are planned and carried out by ARDC staff. These methodological problems should be kept in mind when designing further studies in irrigation projects.

## Chapter 3

### Description of the Study Area

The Arabie-Olifants River Irrigation Scheme is situated on the bank of the Olifants river, extending from Arabia Dam in the south to the confluence of the Lupulin and Olifants river in the north, a distance of approximately 70 km. It is located in the Southern Region of the Northern Province. The area is semiarid with an average annual rainfall of 350 - 500 mm, and poor underground and surface water potential. The scheme was established in 1946/47 with the aim to provide employment and generate income in the area. Initially, flood irrigation was used in the scheme. During 1983/84, the irrigation system was upgraded to overhead (sprinkler) irrigation. The scheme became involved with ARDC in 1993. ARDC acted as a facilitator assisting in the provision of loans (finances), mechanization, training, marketing, technical advice, and extension.

The total area under irrigation is 2,012 ha. Within the scheme there are farmers who hold 10 ha, 5 ha, 2.5 ha, 1.28 ha and 600 square meter plots (so-called food plots). Today, 1,499 ha are under conventional sprinkler irrigation, 150 ha are under center pivot irrigation, and 363 ha are allocated to flood irrigation. Flood irrigation is used by food plot farmers (ARDC 1998). As mentioned earlier, large areas of the overall scheme were not cultivated in 1998.

#### 3.1 Sepitsi Irrigation Scheme

The Sepitsi irrigation scheme is located about 65 km south of Pietersburg. The scheme started in 1996, after a number of farmers from four nearby villages approached ARDC for support and Chief Mphahlele for Permission to Occupy (P.T.O.) a piece of land which was considered to be suitable by ARDC staff. The total number of food plots is 162. Each farmer holds two 600 m<sup>2</sup> plots. The majority of plot holders are women (approximately 70 percent). Members were interested to start the project to generate income and produce food for home consumption. Main crops grown are tomato, onion, cabbage, beetroot, spinach, and butternut squash. The scheme uses flood irrigation. The water is pumped out of the Olifants River, which is located approximately 1 km from the project site. The project has a management which is responsible for coordinating meetings, and a water committee which manages water affairs. Since October 1998, the project faced water problems as a result of continuous breakdowns of the pumps. This affected crop growth significantly.

### **3.2 Veeplaats Irrigation Scheme**

Veeplaats irrigation scheme is situated 70 km south of Pietersburg, about 5 km south of the Olifants River, and only about 5 km from Sepitsi. It was established in 1983, as a scheme using sprinkler irrigation. The scheme consists of 102 plots each 2.5 ha in size. Scheme members are residents of the nearby village Ga-Masemola, under Chief Masemola. Plot holders are mainly women. Farmers grow maize, wheat, cotton, and coriander, primarily to generate income. The scheme is highly mechanized and machinery and credit for inputs is provided by ARDC. Decisions on cultivation practices (planting time, fertilizer applications, etc.) are made by ARDC staff. In the 1998/99 season farmers planted cotton. Because of ARDC's inability to provide inputs on the basis of credit, ARDC negotiated a contract between farmers and LONRHO South Africa for cotton production. Inputs were provided by LONRHO on a credit basis and farmers agreed to market their output to LONRHO.

### **3.3 Goedverwacht Center Pivot No. 2**

There are three center pivot schemes located around Veeplaats. They are numbered and named accordingly. The pivots were established in 1983. We selected Center Pivot No 2 as a study site. It consists of 60 ha. The land is utilized by 11 farmers; 10 farmers hold 5 ha each and one farmer holds 10 ha. Most scheme members are part-time farmers and they are wage or salary employed elsewhere. As a result, center pivot farmers make use of hired labor for weeding and harvesting to a large extent. The scheme is also highly mechanized and the credit for input and machinery is provided by ARDC. Again ARDC staff makes decisions about cultivation practices. It even organizes and prepays hired labor for farmers if necessary. Farmers planted maize and wheat or barley in the past years and cotton in 1998/99, after a contract with LONRHO was negotiated by ARDC staff.

## Chapter 4

### Characteristics of Small-Scale Irrigation Farmers

This chapter aims to provide some insight into the characteristics of households participating in the three selected schemes. The information given below is derived from 66 interviews conducted with scheme members. As mentioned earlier, the number of farmers interviewed from Center Pivot No 2 is very low. Only three out of 11 scheme members could be traced and were available for interviews. However, we think that it is still worthwhile to present the information received from the farmers of the 5 ha project to provide some insight and a basis for comparing the projects.

In this chapter, we will first look at household characteristics in general and secondly provide a more detailed insight into the food security situation of scheme members. We looked at food security in particular because we assume that the food security situation of households has an impact on farmer's production decisions. Thirdly, we are summarizing information on dryland farming activities of irrigation plot holders, because we are assuming that dryland farming activities influence irrigation farming activities, in terms of crop choice, labor availability etc.

#### **4.1 Socioeconomic Household Characteristics**

Table 1 summarizes household characteristics of project members by irrigation project. On average, a household size varies from 6.9 to 7.8 members between the projects. Food plot farmers have the largest number of household members.

In terms of gender of the head of the household, we found that 39 percent of the Sepitsi farmer's households are female-headed. This figure roughly corresponds with other findings for smallholder households in the Northern Province (Hedden-Dunkhorst and Mollel 1998). With almost 60 percent the proportion of female-headed households among 2.5 ha farmers was surprisingly high. The plot allocation took place in 1983, when the project was established. Whether or not plots were deliberately allocated to female-headed household or whether women inherited plots from their husbands, remains unclear.

On average, household heads of 5 ha farmers seem to be slightly younger than household heads of 2.5 or 5 ha farmers. On average, 5 ha farmers have spent ten years in school, followed by food plot farmers with five years and 2.5 ha farmers with two years. The latter result could be related to the larger number of female household heads among 2.5 ha farmers. Usually, among older people less women went to school than men.

Table 1. Household characteristics by farmer group.

	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
Household size	7.83 (2.41)	6.86 (3.42)	7.00 (1.73)
Percentage female-headed household <sup>1</sup>	39	59	0
Average age of head of household	58.17 (12.24)	60.14 (9.31)	53.33 (4.04)
Average number of years in school	5 (4.35)	3 (3.92)	10 (4.04)
Average monthly off-farm income	1122.44 (672.25)	772.27 (915.51)	5233.33 (2482.61)
Major off-farm occupation of head of household <sup>2</sup>			
Wage employed	7.3	9.1	33.3
Self-employed	48.8	31.8	67.7
Pensioner/disabled	31.7	40.9	0
No off-farm employment	12.2	18.1	0
Farm work participation (one or more family members) <sup>1</sup>			
0			
1 day/week	7.3	13.6	33.3
2 days/week	2.4	0	0
3 days/week	4.9	9.1	0
4 days/week	9.8	0	0
5 days/week	4.9	9.1	0
6 days/week	58.5	63.6	0
Total	12.2	4.5	66.7
Total	100	100	100

<sup>1</sup>A female-headed household is defined as a household with no senior, married male adult.

<sup>2</sup>Expressed in percent of households.

Note: Figures in brackets = standard deviations.

Source: UNIN, Irrigation Survey 1998/99.

In terms of occupation of the household head, two out of three 5 ha farmers interviewed are self employed, and 49 percent of the food plot farmers as well as 32 percent of the 2.5 ha farmers are also self employed. One of the three 5 ha farmers is wage employed and so are 9 percent of the 2.5 ha farmers and 7 percent of the food plot farmers. The 2.5 ha farmers have the highest percentage of pensioners (41 percent) and unemployed household heads (18 percent). This situation is also reflected in the household's average monthly off-farm income, which is the lowest among 2.5 ha farmers (R 772) whereby the monthly off-farm income of 5 ha households amounts to R 5,233, and the average off-farm income for food plot farmers amounts to R 1,122.



In terms of farm work participation, about 70 percent of the households from all three projects send at least one household member to the plot for five or more days per week. Where 5 ha farmers are concerned, field work involves mainly weeding, harvesting, and irrigating. Most other activities are mechanized. The 2.5 ha farmers also spend time on shifting irrigation pipes. Food plot farmers, who grow vegetables, spend time on planting, spraying, etc., apart from weeding, harvesting and irrigating using flood irrigation.

#### 4.2 Household Food Security

In order to better understand the circumstances of irrigation farmers, we wanted to find out whether the households are facing problems in terms of food security. We assumed that this could have an impact on their production decisions. We asked the respondents whether they sometimes experience food shortage and if, how often this occurs. The three 5 ha farmers do not have problem of food insecurity. However, 50 percent of the 2.5 ha farmers and 54 percent of the food plots farmers said that they had food insecurity for some time during 1998. The average number of weeks households experienced food shortage in 1998 was 7.1 weeks for 2.5 ha farmers and 7.5 weeks for food plot farmers.

Table 2. Food security status of households in selected irrigation projects.

	Food plot farmers (n= 41)	2.5 ha farmers (n=22)	5 ha farmers (n= 3)
Percentage of households experiencing food shortage	53.7	50	0
Average number of weeks during which households have experienced food shortage in 1998	7.5 (7.9)	7.1 (7.5)	0

Note: Figures in brackets = standard deviations.

Source: UNIN, Irrigation Survey 1998/99.

Respondents were also asked about the strategies they used to cope with food insecurity. Six options, as derived from the literature (Maxwell 1996) and adapted to South African conditions, were offered to the respondents for selection. Borrowing food or money is mostly practiced by both groups of farmers. Forty-one percent of food plot farmers and 36 percent of 2.5 ha farmers used this strategy. The second most practiced way of acquiring food is eating cheaper or less-preferred food. Buying food on credit from local shops is the next most often used coping strategy, again for both groups of farmers. Limiting the portion size is also practiced, but to a much lower extent by

food plot farmers. This could be related to the fact that, food plot farmers' off-farm income is 50 percent higher than the off-farm income of 2.5 ha farmers. Thus their ability to borrow food or money might be higher because of their higher repayment capacity. Visiting neighbors or relatives for days or weeks and skipping meals to cope with food shortage are not practiced among sample farmers.

Table 3. Coping strategies of households experiencing food shortage.

Coping strategy	Food plot farmers (n=22)	2.5 ha farmers (n=11)
Eating cheaper/ less-preferred food	31.8	27.2
Limiting portion size	9.1	18.2
Borrowing food / money	40.9	36.4
Buying food on credit	18.2	18.2
Maternal buffering	0	0
Visit neighbors/ relatives	0	0
Skipping meals for days	0	0

Source: UNIN, Irrigation Survey 1998/99.

The coping strategies used indicate that most households are able to get access to food, and do not need to reduce their food intake. But, the existence of household food insecurity explains why some farmers consider it important to grow staple food (maize) even on irrigation plots.

### 4.3 Dryland Farming Activities

Traditionally, rural households have access to arable land allocated by the chief and communal grazing. Although land resources per household are limited, most rural households in the Northern Province are still engaged in farming activities (Hedden-Dunkhorst and Mollel 1998).

Table 4 provides information about the proportion of farmers holding dry land and owning livestock; and the average size of land held and livestock owned.

It is interesting to note that none of the three 5 ha farmers interviewed holds or cultivates dryland. The finding is probably related to the fact that 5 ha farmers have various other income sources (i.e., irrigation plots, livestock, off-farm income) which provide much higher returns than dryland farming in semiarid areas. However, also the percentage of food plot and 2.5 ha farmers holding and cultivating dryland is relatively small, 34 and 18 percent respectively. Dryland is primarily used to produce subsistence crops, maize in particular. The use of external inputs is usually very limited. The larger number of food plot farmers holding dryland is most probably related to the fact that food plot farmers hold only very small irrigation plots (0.12 ha in total).

Table 4. Dryland size and livestock assets.

	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
Average dry land (ha)	n=15 (37% of total) 1.41 (0.51)	n=4 (18% of total) 1.18(0.90)	n=0 0.0
Average number of cattle	n=7 (17% of total) 12.1 (11.0)	n=2 (9% of total) 5.5 (0.7)	n=2 (67% of total) 70.0 (84.9)
Average number of goats	n= 8 (20% of total) 8.9 (5.7)	n=3 (14% of total) 5.7 (2.1)	n=2 (67% of total) 16.5 (9.2)
Average number of sheep	n=8 (20% of total) 7.8 (5.0)	n=1 (5% of total) 2.3 (0)	n=0 0.0
Average number of donkeys	n=1 (<1% of total) 6.3 (0)	n=0 0.0	n=0 0.0
Average number of poultry	n=1 (<1% of total) 8.2 (0)	n=0 0.0	n=0 0.0

Note: Figures in brackets = standard deviations.

Source: UNIN, Irrigation Survey 1998/99.

Producing maize on small irrigation plots is not economical as returns from vegetable production are much higher as we will see at a later stage. Another reason why more food plot farmers cultivate on dryland might be related to the reason that the Sepitsi project started only in 1996. The scheme is not yet well established in terms of management and coordination. Thus, more farmers might want to stick to dryland cultivation to assure the production of subsistence requirements.

In terms of livestock ownership, the following picture arises. On average, food plot farmers' cattle and sheep herds are substantially larger than the herds of 2.5 ha farmers. Food plot farmers hold, on average, 12 cattle and 8 sheep. Goat herds comprise 6 to 9 animals for 2.5 ha farmers and food plot farmers, respectively. Two out of the three 5 ha farmers interviewed own cattle and goats. In this group of farmers, cattle ownership is extremely skewed, one farmer owns 130 cattle the other farmer owns 10 cattle. Livestock is kept on communal grazing land. Traditionally, cattle ownership is considered an investment for rural households. Cattle are not necessarily kept to generate regular income. They are slaughtered for ceremonial purposes or sold when there is a need for cash. Small stock and poultry are more regularly consumed or sold.

In summary, the above findings related to socioeconomic household characteristics of project members depict the following picture. On average, 5 ha farmers are younger, more educated and have significantly higher off-farm income compared to 2.5 and food plot farmers. Project members from Veeplaats (2.5 ha plots) are mainly older women with little education. Many project members are pensioners (41 percent). Their average off-farm income is lowest among all groups. About every second 2.5 ha and food plot farmer faced food insecurity in his/her household, on average

for about two months in the last year. Similar strategies to cope with food insecurity are used by households from the two groups. On average, food plot farmers are slightly better off in terms of off-farm income than 2.5 ha farmers. They are also slightly younger, but have larger families.

In the next chapter, we will describe irrigation farming practices and estimate productivity and profitability of cropping enterprises. We are also trying to evaluate the importance of irrigation farming for each farmer group by comparing farm and off-farm income.

## Chapter 5

### Irrigation Farming in Selected Projects

In 1996, members of Sepitsi food plot projects started to grow vegetables using flood irrigation. Each of the 81 members cultivates two plots, which together cover an area of 0.12 ha. Major vegetables grown are tomato, onion, butternut squash, beet root, spinach, and cabbage. The members were supported by ARDC with equipment like steel and hose pipes, knapsack sprayers as well as tractor and extension services. Apart from a general management committee and a water committee, members are organized in small, informal groups to purchase inputs. Since October 1998, the project faced major water problems due to pump breakdowns. As a result, the summer crop of 1998/99 suffered significantly, and subsequently most plots were not cultivated. In the past, ARDC usually repaired the pumps and also paid the electricity bills for pump operations. Due to budget cuts, ARDC is no more in the position to repair pumps free of charge and to pay for electricity. Subsequently, since April 1998, farmers were asked to pay for electricity by themselves.

Both Veeplaats and Center Pivots No 2 projects were established in 1983. The allocation of plots prior to the commencement of the projects was left to the tribal authorities. Most cropping activities (ploughing, planting, fertilization, spraying, etc.) are planned for and carried out by ARDC staff using ARDC equipment. Both projects, Veeplaats and Center Pivot No 2, have executive management committees, which are responsible to coordinate activities with ARDC and report back to and negotiate for farmers. Inputs are procured by ARDC. Farmers are charged for these services as well as for the inputs. Service and input costs were deducted from farmer revenues, after the output was marketed. The 5 ha farmers were charged 14 percent interest rate, 2.5 ha farmers did not pay interest. Farmers organize labor for weeding and harvesting (if necessary) using hired laborers or family members or they make use of ARDC's labor services, and pay of it at a later stage. Because of ARDC's financial constraints, the organization could not offer credit for input purchases in the 1998/99 summer season. But ARDC managed to negotiate a contract for 2.5 ha and 5 ha farmers with LONRHO, South Africa for the production of cotton.

#### **5.1 Productivity and Profitability of Crop Enterprises**

To obtain indications of returns to different crops planted, we calculated budgets for major crops in each irrigation project (Annex 1 provides detailed information on individual crop budgets). In

Sepitsi, information on inputs and outputs for tomato, onion and butternut squash was derived from a group interview with a number of project members. Full information on inputs and outputs for other crops were not available, because farmers do not keep records of previously grown crops, and beetroot and cabbage were not harvested yet.

Farmers in Veeplaats and Center Pivot No 2 did not know about input quantities and the prices used on their plots and had only vague ideas about the output quantities. As a result, we had to make use of ARDC's records for the last two seasons to compute crop budgets for maize and wheat for both projects. In terms of average outputs, we partly had to rely on the estimates of extension officers.

Records for cotton, which is planted again in summer 1998/99 since some time ago, are not yet available. The crop is only expected to be harvested in April/May 1999.

Initially, it was planned to compute returns to land, labor and water. Unfortunately, water measurements at Sepitsi could not be carried out, due to the pump problems mentioned early. (The pumps are out of function since November 1998). Besides, it was not possible to record labor inputs from farmers in Veeplaats and Center Pivot No 2, partly because labor was provided to a certain extent by ARDC workers.

Table 5 summarizes crop budgets for selected crops grown in the three projects. In general, vegetables, as grown by Sepitsi food plot farmers, produce significantly higher returns than grain crops, grown by 2.5 ha and 5 ha farmers, on a hectare basis. However, there are large differences between the vegetables. Butternut squash provides highest returns per ha and per labor day. But, markets for butternut seem to be limited and prices vary considerably. Consumers buy butternut squash mainly around Christmas. The returns to labor per labor day from the production of butternut squash (R 26 or R 46 depending on whether hose pipes or steel pipes are used for irrigation) are much higher than the local daily wage rates (R 15). For tomato and onion, returns to labor correspond more to the local wage rate. Markets for tomato and onion are less vulnerable compared to markets for butternut squash. The vegetable outputs harvested by Sepitsi farmers are at the lower range of potential outputs for the respective vegetables produced under irrigation. With improved management, an output of 50–100 percent beyond the level reached could be expected. On the other hand, gross margins calculated here do not include costs for electricity and maintenance of pumps. Farmers did not yet pay these costs.

Table 5. Summary of selected crop budgets.

	Enterprise	Output (kg/ha)	Market value output (R/ha)	Total input cost (R/ha)	Gross margin (R/ha)	Gross margin / labor days (R/ha/labor day)
Food plot farmers	Tomato	16,866	11,450	2,691.22	8,809	10.31 <sup>1</sup> 17.19 <sup>2</sup>
	Onion	10,666	9,696	1,719.54	7,977	10.58 <sup>1</sup> 19.34 <sup>2</sup>
	Butternuts	20,000	22,400	1,925.73	20,474	25.86 <sup>1</sup> 45.50 <sup>2</sup>
2.5 ha farmers	Maize	5,000	2,800	2,202.12	598	-
5 ha farmers	Maize	5,000	2,800	2,368.18	432	-
	Wheat	4,334	3,380	1,914.21	1,466	-

<sup>1</sup>Using hose pipes for irrigation.

<sup>2</sup>Using steel pipes for irrigation.

Source: UNIN, Irrigation Survey 1998/99 and ARDC records.

#### 1997/98 Producer Prices:

Tomatoes ..... R 15.00/ 22 kg crate

Onion..... R 20.00/ 22 kg crate

Butternut squash ..... R 15.00/ 12,5 kg bag

Maize..... R 560.00/tonne

Wheat..... R 780.00/tonne

This applies also for 2.5 ha and 5 ha farmers in the two other sample projects. In the past, maize and wheat were planted in these projects. Table 5 summarizes gross margins for these crops for the last two seasons. Net income from grain crops, and particularly, from maize is significantly lower than returns to vegetable production. In addition, the production of maize and wheat is highly mechanized and does not provide much employment for farmers. Though, in an area with a high unemployment rate, the generation of labor opportunities is extremely important. In addition, using irrigation for the production of grain crops does not seem to be justifiable in South Africa, where maize can be produced cost-efficiently on dryland. But, the technical and organizational design of the 2.5 ha and 5 ha schemes presently do not favor the production of labor-intensive, high-value crops. Here, innovative thinking and planning are required to better use the available resources.

## **5.2 Net Income Projections**

Finally, in the absence of reliable data from farmers, we would like to use the above crop budget data to estimate possible returns from irrigation plots for an average farmer for each of the three sample projects. Two crops per year are planted in each of the projects.

If food plot farmers are growing tomato and butternut under present price and cost structures, they could generate an annual net income of R 3,514 on their given irrigation area of 0.12 ha. This amount corresponds to an annual income of a locally, permanently employed worker, which is about R 3,600. It contributes to about 21 percent of the total household income.

Veeplaats farmers (2.5 ha) growing maize and wheat would generate a net income of about R 5,400 per year (this is using the gross margin for wheat produced on 5 ha plots without hired labor as a reference). This would include their remuneration for labor, which for maize is mainly weeding and harvesting, and for wheat is weeding only. In total, about 45 labor days are required to do two weedings of 2.5 ha of maize and wheat. The income from irrigation farming contributes to the total household income by 37 percent.

Finally, 5 ha farmers generate an annual net income of about R 9,490. Because 5 ha farmers are using hired labor to a large extent, this reflects mainly their remuneration for management activities. This amount contributes about 13 percent of the total household income for 5 ha farmers.

As indicated earlier, these are projections only, but still they provide some indications of what income from irrigation farming amounts to for farmers holding different plot sizes and what income from irrigation farming contributes to the total household income.



## Chapter 6

### Agricultural Institutions Affecting Irrigation Farming

This chapter describes four institutions which are important for agriculture in general and irrigation in particular. These institutions are: marketing, land tenure arrangements, farmer's access to and demand for extension, and credit.

#### 6.1 Input and Output Marketing

The income projections made earlier are based on the assumption of current input and output markets. This section describes the input and output markets faced by project farmers.

##### Input Marketing

Only food plot farmers are involved in the purchasing of inputs. The two other farmer groups were provided with inputs on a credit basis in the past, and in the last season they received inputs from LONRHO, as part of their contract to produce cotton for LONRHO.

The majority of food plot farmers (88 percent of the 41 farmers) buy inputs in groups of 5–10 members to make use of economies of scale in terms of input prices and transport costs. Farmers buy seedlings from nurseries, and fertilizers and chemicals from farm supply shops and cooperatives in Potgietersrus (approximately 80 km), Groblersdal (approximately 88 km), Marblehall (approximately 60), and Pietersburg which is about 65 km away. Twelve percent of food plot farmers find it more convenient to buy inputs individually since inputs last for a longer time as they are not shared between many people. Also, buying individually avoids complications which may arise as a result of buying in groups.

##### Output Marketing

Farmers from Veeplaats (2.5 ha farmers) and 5 ha farmers usually do not market their products themselves. The ARDC staff negotiated with buyers and arranged for transport. Input and service costs were deducted from revenues before farmers received the balance. Maize prices fluctuated to a large extent between the last two seasons, with prices varying between R 35 and R 55 from one season to another. This suggests that storage could provide significant revenue increases. The 2.5 ha farmers usually keep a certain amount of maize for home consumption. They also sell a part of their harvest locally. On average, 2.5 ha farmers marketed 89 percent of the last maize crop and

retained 11 percent for home consumption. Considering an average yield of 5 tons of maize, this would translate into 0.55 tons (about 7 bags) retained for home consumption. The 5 ha farmers interviewed did not retain any maize for home consumption.

Food plot farmers sell their output to hawkers coming to the project, or locally in their villages. The latter involves transporting the vegetables to the villages, some villages are located at a distance of about 1.5 hours walk from the project site. Vegetable prices fluctuate within a season, according to quality. Price fluctuations were the highest for butternut squash (67 percent) and the lowest for tomato and onion (25 percent). Identifying markets was mentioned as a major problem. However, joint marketing activities were not yet considered. Project members indicated that, because the project was still in its initial stage, there was still a lack of trust among members. An informal survey carried out among hawkers in Lebowakgomo, a major center located 25 km from Sepitsi, showed that the Sepitsi project was largely unknown.

Both input and output marketing constraints mentioned by the farmer groups are summarized in table 6. In terms of input purchasing, food plot farmers were primarily faced with a problem of high transport costs due to lack of nearby nurseries. Out of 41 farmers interviewed, 80.5 percent mentioned this problem. Thirty-seven percent of the food plot farmers also mentioned the problem of not being able to generate enough cash to buy inputs. One of the most widespread problems of food plot farmers in terms of output marketing was the absence of buyers or marketing outlets. Eighty percent of food plot farmers mentioned this problem. Veeplaats and 5 ha farmers did not have any problems regarding input marketing. Inputs were supplied by ARDC, or as in the last season by LONRHO. They also did not have a problem of lacking markets, as ARDC is taking care of all their marketing activities. These two groups of farmers, however, had one frequent problem, that is fluctuating or low output prices. One of the three 5 ha farmers and 68 percent of the 22 farmers at the 2.5 ha plots stated this problem.

Table 6. Input and output marketing constraints.

Constraints	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
High transport costs of inputs (no nearby nurseries) (%)	80.5	0	0
Cash constraints for inputs purchase(%)	36.6	0	0
No output markets (no buyers)(%)	80	0	0
Fluctuating/ Low output prices(%)	0	68.1	33.3

Source: UNIN, Irrigation Survey 1998/99.

## 6.2 Land Tenure

The tenure status of land is considered to be an important factor determining the productivity of farmers. The ownership status can determine whether a farmer qualifies for credit or not and it can influence his/her level of investment (Wegrif 1998). We found that all farmers in the three sample projects received permission to occupy from the tribal authority. Despite this fact, we assumed that farmers' perception on their land ownership status would differ. We offered farmers a choice of five defined categories to specify their perceptions about their land ownership status. The results are summarized in table 7.

Most farmers from all sample projects felt secure about their ownership right for both dryland and irrigation plots. Most surprisingly, this also holds for food plot farmers who have been on the plots only since 1996. Eighty-nine percent of food plot farmers, 77 percent of 2.5 ha farmers, and 100 percent of 5 ha farmers feel secure or fully secure. The reason for this result is presumably related to farmer's previous experience with P.T.O.s on land allocated by tribal authorities.

Table 7. Farmer perceptions on land ownership rights.

	Percentage of food plot farmers (n=41)		Percentage of 2.5 ha farmers (n=22)		Percentage of 5 ha farmers (n=3)	
	Dry land (n=14)	Irrigated land	Dry land (n=4)	Irrigated land	Dry land (n=0)	Irrigated land
1. Full ownership	64.30	75.6	100	59.1	0	66.7
2. Secure ownership	14.30	12.2	0	18.2	0	33.3
3. Insecure ownership	7.10	9.8	0	9.1	0	0
4. More insecure	7.10	2.4	0	4.5	0	0
5. No ownership	7.20	0	0	9.1	0	0
Total	100	100	100	100	100	100

Source: UNIN, Irrigation Survey 1998/99.

Notes:

- Full ownership = I can sell or rent out and will get a remuneration for the land and my children can inherit the land.
- Secure ownership = I can give the land to somebody with or without remuneration, but I keep control over it.
- Insecure ownership = I am sure I can use the land for the next 10 years, I do not know what is going to happen after that.
- More insecure ownership = If I do well, I hope I can use the land for the next 5 years.
- No ownership = Although I think I am doing well I am not sure of being allowed to use the land next year.

We also asked farmers about their demand for additional irrigation land. The majority of food plot and 5 ha farmers were interested to cultivate more irrigation land. Food plot farmers mentioned that they were restricted from the ARDC credits because of the small size of their land, thus more land could possibly enable them to access credit. On the other hand, 5 ha farmers indicated the desire to generate more income through an expansion of irrigation farming. Most of the 2.5 ha farmers were not interested to cultivate on a larger area because of low returns from irrigation farming and because they feared more land would only add to their present debt with ARDC.

Table 8. The demand for additional irrigation land.

Demand for irrigation land	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
Percentage in need of more land	68.3	18.2	66.7
Percentage satisfied with current land size	31.7	81.8	33.3

Source: UNIN, Irrigation Survey 1998/99.

### 6.3 Extension Service

Extension advice can have a large impact on productivity. Regarding the three sample projects, extension advice is particularly important for Sepitsi food plot farmers who started their project only in 1996 with most members being inexperienced in commercial vegetable production. Sepitsi food plot farmers received extension service from ARDC twice a week until July 1998. According to ARDC, the service had to be phased out due to budget cuts. As a result, severe problems with the summer 1998/99 crop (cabbage) could be observed in terms of plant spacing and pest control. Sepitsi farmers valued the impact of extension service very high (table 9) and all farmers are interested to receive extension advice at least twice per week (table 10).

Table 9. Perception of impact of extension service on productivity (in percent of total members).

Impact of extension	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
Very much	87.8	81.8	66.7
Much	12.2	9.1	0
Little	0	4.5	0
No impact	0	0	33.5
Do not know	0	4.5	0
Total	100	100	100

Source: UNIN, Irrigation Survey 1998/99.

Table 10. Access to and demand for extension.

	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
Received extension in the last 3 months			
% Yes	100	100	100
% No		0	0
Would like more training			
% Yes	100	68.2	100
% No	0	31.8	0
Frequency of extension service requested			
Everyday	2.4	0	0
3-4/Week	31.7	13.6	0
1-2/Week	65.9	54.6	0
1/Month	0	0	100
Satisfied with current services	0	31.8	0
Total	100	100	100

Source: UNIN, Irrigation Survey 1998/99.

Veeplaats and Center Pivot No 2 farmers are located close to Veeplaats, ARDC's service unit and the base of extension staff. Consequently, the extension service is still regularly provided and accessible. Again, most farmers value the impact of the extension advice very high (table 9). But, the need for frequent advice is less in these two projects (table 10). This is of course related to the nature of farming at Veeplaats and Goedverwacht, where most activities are carried out by ARDC staff.

The examples from the three projects reflect the importance of extension service to farmers, particularly for farmers who are actively involved in the decision-making processes.

#### 6.4 Credit

We also studied credit, particularly by farmer's access to and demand for credit. Until 1998, Veeplaats and 5 ha farmers received credit in the form of inputs and services from ARDC. The amount of credit provided was deducted from the revenues after the harvest. Veeplaats farmers did not pay the interest rate, whereas, 5 ha farmers were charged 14 percent of the interest. Most 2.5 ha and 5 ha farmers were satisfied with ARDC's credit arrangement (table 11).

Table 11. Credit for production inputs.

Parameters	Food plot farmers (n=41)	2.5 ha farmers (n=22)	5 ha farmers (n=3)
Percentage of farmers who received credit	0	100	100
Amount of credit per year (R)	0	10291	21412
Lending institutions	NA	ARDC	ARDC
Interest rate (%)	0	0	14
Percentage in need of credit/more credit	29.3	22.7	33.3
Percentage of farmers not in need of credit/ more credit	70.7	77.3	66.7

Source: UNIN, Irrigation Survey 1998/99.

Food plot farmers did not receive credit from ARDC or any other organization. ARDC argued that the plots were too small. The difficulties to administer small credits might be another problem ARDC would face. On the other hand, most food plot farmers (71 percent) are not interested in credit, because they feared accumulating debt (table 9). Besides, most food plot farmers are probably in the position to generate input cost of R 200 to R 250 per season through off-farm income.

## Chapter 7

### Conclusions and Recommendations

Based on the initial research questions, the following conclusions evolve from the comparison of the three smallholder irrigation projects, located in the Arabie-Olifants River Irrigation Scheme. In terms of the welfare status of the sample farmers, most food plot farmers and 2.5 ha farmers could be classified as poor or vulnerable to poverty. The average household income is slightly below or close to the defined poverty line of R 740 (for a rural household with two adults and three children) (Development Bank of Southern Africa 1998). Households derive their income from a number of sources, including wages, remittances, pensions, etc., and irrigation farming. Given present land resources, cropping practices, input and output prices, and the availability of a market, it was estimated that irrigation farming could contribute about 21 percent, 37 percent, and 13 percent of the household income of food plot farmers, 2.5 ha farmers and 5 ha farmers, respectively. In all three projects, with improved cropping practices, higher returns to irrigation farming can be expected.

Irrigation also contributes to food security. Transitory food insecurity, as a result of poverty, is a problem for about 50 percent of both food plot and 2.5 ha farmers. Maize producing 2.5 ha farmers, on average, retain about 10 percent of the maize production for home consumption. Thus one could say, that irrigation farming contributes directly to food security. But we have to understand that 2.5 ha farmers and 5 ha farmers are growing maize and wheat because these crops are most suitable for the present irrigation design, market arrangements, etc., and not because they are the most profitable crops or meet the objectives of the farmers best. Farmers have experiences with these crops and feel there is no appropriate alternative options. Food plot farmers produce vegetables. They use some of their products for home consumption or, due to lack of buyers, retain some vegetables which are meant to be sold. Thus, because of the perishable nature of vegetables, and the limited need of vegetables in the household, these quantities are relatively small. Though, their impact on household food security in terms of vitamin and micro-nutrient supply might be important.

Irrigation farming, as presently conducted in the Arabie-Olifants River Irrigation Scheme generates livelihoods and there is a potential to achieve higher returns (yields for most crops planted are at a lower level compared to the yield potential for these crops). The study shows that even from the small food plots (0.12 ha) and under present cropping practices and price conditions,

farmers can generate an income similar to an annual local wage rate for an unskilled worker, when producing vegetables. If 2.5 and 5 ha plots would be cultivated with higher value crops like vegetables instead of maize and wheat, substantially higher returns can be expected. But, vegetable production is demanding in terms of management and expertise, and the available family labor would be insufficient to cope with larger plots. Hired labor would be necessary. Hired labor, apart from management skills, requires also the availability of capital to pay workers on a regular basis. In addition, constraints to market larger quantities of vegetables might exist. Food plot farmers mentioned marketing constraints for vegetables, lack of buyers and highly fluctuating prices for some vegetables. To fully explore the possibility to grow and market vegetables on a larger scale in the Arabie-Olifants River Irrigation Scheme, a detailed analysis into local and outside market opportunities is necessary. In this context, possibilities for contract farming should be investigated. Contract farming for tomato, as presently conducted by some smallholder farmers in the Limpopo River Basin, might be an option to overcome both cash constraints for input purchases and marketing constraints.

Another issue which became quite obvious, is the need for extension advice. Farmers mentioned it, but it was also visible that, particularly on the food plots, with good advice, considerably higher yields can be expected. Apart from training on production, training on marketing and group organization (how to benefit from joint action) is required. In this context, with limited government resources available for extension, priorities need to be set. A government extension service should not only focus on productivity and profitability increases, but also has the obligation to contribute to employment generation, and poverty alleviation. Payments for extension advice could be considered where returns to extension justify payments. But, for poor farmers, subsidized services are needed to provide support, particularly at an early stage of operation.

In the study, apart from marketing and extension, two more institutions which could affect farmer performance were investigated—credit and land tenure. In terms of credit, we found that for food plot farmers the need for credit to buy inputs does not seem to be as important as anticipated, most probably because for the small plots, farmer's hold input costs per season are relatively low. For those food plot farmers who face cash constraints for input purchases saving clubs might possibly offer an opportunity to get access to sufficient funds before the planting season. But with the government withdrawal, grants or loans to buy and maintain irrigation equipment will be needed in future. Project members need assistance to learn where and how to acquire loans and how to administer them. For farmers with larger plots credit for inputs is quite important. While Veeplaats and Goedverwacht farmers managed to get credit for inputs from



LONRHO, many other farmers within the scheme did not cultivate at all, because of lack of credit. In the past few years the Land Bank has established a number of programs, including group credit programs, to provide emerging farmers with credit facilities. Whether or not these programs are suitable for irrigation farmers in the Arabie-Olifants River Irrigation Scheme would have to be investigated.

On land tenure we found that most farmers, irrespective of the plot size they hold, feel secure in terms of their ownership rights. With the little variability we found in this respect, it is difficult to approve or disapprove our initial hypothesis that the ownership status would determine productivity via the level of yield improving investments. Yet, we still maintain our hypothesis that in the long run, guaranteed land and water rights are important for intensive irrigation farming, however, in the short run, other obstacles as mentioned earlier seem to be more limiting to improve productivity of smallholder irrigation farmers.

The study shows that small-scale irrigation farmers are a heterogeneous group of farmers, with different objectives and constraints. A blueprint of solutions to improve farmer's performance is not readily available, but support at various levels is necessary. Training and information are some of the most crucial issues.

## ANNEX

### Crop Budgets

Description of enterprise: Tomato (grown on 0.03 ha plots by farmers from Sepitsi).

Output (per hectare).

Product	Quantity	Units	Price (R) / unit	Total revenue (R)	Output buyer	Location/ Distance
Tomato	16,866	kg	15.00 / crate (22kg)	11,500.00	Hawkers	Production area

Variable inputs (per hectare).

Variable input	Quantity	Units	Total price (R)	Seller	Location / Distance
Seedlings	16,666	1 plant	933.33	Maribashoek	80 km
Chicken manure	80	kg	52.00	Local farmer	Masemola village
2:3:2*	132	kg	362.34	NTK, Pietersburg	75 km
Kan	66	kg	138.60	NTK, Pietersburg	75 km
Folithion	1	l	262.00	NTK, Pietersburg	75 km
Virikop	1	kg	60.16	NTK, Pietersburg	75 km
Bravo	3	l	266.49	NTK, Pietersburg	75 km
Malasol	2.5	l	250.30	NTK, Pietersburg	75 km
Tractor			366.00		

\*This defines the ratio of nitrogen, potassium and calcium.

Total input costs: 2,691.22

Labor

Activity	Labor days / 0.03 ha plots	Number of hours / Day / 0.03ha plot	Total hours / 0.03ha plot	Total hours / ha
Land preparation	5	6	30	1,000
Planting	1	4	4	133
Irrigation		3hrs twice / week 30min.twice / week	99 17	3,300 hose pipe 567 steel pipe
Weeding	40	1	40	1,333
Spraying	1	1	1	33
Harvesting	4	2.00	8	267
Sticking	3	5	15	500
Pulling out of plants	2	4	8	267

Total Labor hours / ha: 6,833 (using hose pipe for irrigation)

4,100 (using steel pipe for irrigation)

Equipments used: Hoes, spades, forks, pest sprayer, and pipes.

Gross margin / ha = R 8,808.78

Gross margin / ha / labor days (using hose pipe) = R 10.31

Gross margin / ha / labor days (using steel pipe) = R 17.19

Description of enterprise: Onion (Grown on 0.03 ha by farmers from Sepitsi).

Output (per hectare).

Product	Quantity	Units	Price (R) / unit	Total revenue (R)	Output buyer	Location / Distance
Onion	10,666	kg	20.00 / crate (22 kg)	9,696.00	Hawkers	Production area

Variable inputs (per hectare).

Variable input used	Quantity	Units	Total Price (R)	Seller	Location / Distance
Seedlings	20,000	1 plant	800.00	Maribashoek	80 km
Chicken manure	80	kg	52.00	Local farmer	Masemola village
2:3:2	66	kg	362.34	NTK, Pietersburg	75km
Kan	33	kg	138.60	NTK, Pietersburg	75km
Tractor			366.60		

Total input costs = 1,719.54

Labor

Activity	Number of days / 0.03 ha plot	Number of hours / day/0.03ha plot	Total hours / 0.03ha plot	Total hours / ha
Land preparation	5	6	30	1,000
Planting	1	4	4	133
Irrigation		3hrs twice / week	99	3,300 = hose pipe
		30min.twice / week	17	567 = steel pipe
Weeding	40	1	40	1,333
Harvesting	4	2.00	8	267

Total labor hours / ha: 6,033 (using hose pipes)  
3,300 (using steel pipes)

Equipments used: Hoes, spades, forks, pest sprayer, and pipes.

Gross margin / ha = R 7,976.46

Gross margin / ha / labor days using hose pipe = R 10.58

Gross margin / ha / labor days using steel pipe = R 19.34

Description of enterprise: Butternut squash (Grown on 300m<sup>2</sup> plots by farmers from Sepitsi).

Output (per hectare).

Product	Quantity	Units	Price (R) / unit	Total revenue (R)	Output buyer	Location
Butternut	20,000	kg	14.00 per bag (12.5 kg)	22,400	Hawkers	Production area

Variable inputs (per hectare).

Variable input used	Quantity	Units	Total Price (R)	Seller	Location / Distance
Seeds	2.00	kg	280.00	NTK, Pietersburg	75 km
2:3:2	132.00	kg	362.34	NTK, Pietersburg	75 km
Kan	66.00	kg	138.60	NTK, Pietersburg	75 km
Fololithion	1.00	l	262.00	NTK, Pietersburg	75 km
Bravo	3.00	l	266.49	NTK, Pietersburg	75 km
Malasol	2.50	l	250.30	NTK, Pietersburg	75 km
Tractor			366.00		

Total inputs costs = R 1,925.73

Labor

Activity	Number of days / 0.03 ha plot	Number of hours / Day / 0.03 ha plot	Total hours / 0.03ha plot	Total hours / ha
Land preparation	5	6	30	1,000
Planting	1	4	4	133
Irrigation		30hrs twice per week	99	3,300 (hose pipe)
		30min. twice per week	17	550 (steel pipe)
Weeding	40	1	40	1,333
Spraying	1	1	1	33
Harvesting	4	2.00	8	267
Pulling out of plants	2	4.00	8	267

Total labor hours / ha: 6,333 (using hose pipes for irrigation)  
3,600 (using steel pipes for irrigation)

Equipments used: Hoes, spades, forks, pest sprayer, and pipes.

Gross margin / ha = R 20,474.27

Gross margin / ha / labor days (using hose pipe) = R 25.86

Gross margin / ha / labor days (using steel pipe) = R 45.50

Description of enterprise: Maize 1997 / 98 (Grown on 2.5 ha plots by farmers from Veeplaats).

Output (per hectare).

Product	Yield	Units	Total revenue (R)	Output buyer
Maize	5,000	kg	2,800	Progress mill

Variable inputs (per hectare).

Variable input used	Quantity used	Unit	Total Cost (R)
Rent / levies	-	-	25.00
Plough	-	-	129.24
Disc	-	-	68.84
Futura	-	-	43.56
Boomspray	-	-	562.08
Plant	-	-	56.21
Snk2665	1.20	Bags	196.80
3:2:0 fertilizer	5.60	Bags	442.41
Ammonium sulphate	4.20	Bags	188.07
Fortrol	1.92	l	84.50
Gesaprim	0.48	kg	21.02
Fenom	0.20	l	54.21
Threshing	50.40	Bags	197.07
Seed	-	-	27.55
Aircraft hire	-	-	51.87
Seed / fertilizer transp.	-	-	8.40
Tractor	-	-	45.29

Total input costs: R 2,202.12

Gross margin / ha: R 597.88

Description of Enterprise: Wheat, 1998 (Grown on 5ha plots by farmers from center pivots 2).

Output(per hectare).

Product	Yield	Units	Total revenue (R)	Output buyer
Wheat	4,334	kg	3,381	Progress mill / NTK

Variable inputs (per hectare).

Variable input used	Quantity used	Unit	Total Cost
Rent & levies	-	-	25.00
Repair & maintenance	-	-	15.20
Combine	-	-	269.99
Seed	7.60	Bags	667.58
3:2:0 fertilizer	6	Bags	463.51
Ammonium sulphate	6.00	Bags	324.08
Certificate	-	-	4.83
Storage	-	-	51.85

Hired labor = R 92.17  
 Total input costs: (without hired labor) = R 1,822.04  
 (with hired labor) = R 1,914.21  
 Gross margin / ha (without hired labor) = R 1,558.48  
 Gross margin / ha (with hired labor) = R 1,466.31

Description of enterprise: Maize, 1997. (Grown on 5ha plots by farmers from center pivot 2).

Output(per hectare).

Product	Yield	Units	Total revenue (R)	Output buyer
Maize	5,000	Kg	3,080	Progress mill

Variable inputs (per hectare).

Variable input used	Quantity used	Unit	Total Cost (R)
Plough	-	-	159.02
Disc	-	-	49.19
Levies / rent	-	-	25.00
Bladex	3.33	l	146.69
Boomspray	-	-	26.80
Plant	-	-	40.48
Snk2665	1	Bags	240.14
3:2:0 fertilizer	34	Bags	510.90
Ammonium sulphate	8.00	Bags	432.08
Fenom	0.13	l	36.27
Gesaprim	0.60	kg	26.27
Cypermethin	2.00	l	32.51
Combine	131.00	Bags	256.50
Seed	-	-	33.62
Tractor	-	-	44.85
Aircraft hire	-	-	51.87

Hired labor = R 255.99  
 Total input costs: (without hired labor) = R 2,112.19  
 (with hired labor) = R 2,368.18  
 Gross margin / ha (without hired labor) = R 687.81  
 Gross margin / ha (with hired labor) = R 431.82

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