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FACTORS WHICH INFLUENCE THE ACCEPTABILITY OF IRRIGATION SCHEDULING WITH SPECIFIC REFERENCE TO SCHEDULING MODELS

by

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Report to the

WATER RESEARCH COMMISSION

by the

DEPARTMENT OF AGRICULTURAL ECONOMICS, EXTENSION AND RURAL DEVELOPMENT

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EXECUTIVE SUMMARY

The main goal of this pilot research project was to investigate the factors which influence the acceptance of irrigation scheduling with specific reference to scheduling models. Within this framework the objectives of this research were to:

- measure the perception of the practice of irrigation scheduling in general
- identify the human and environmental factors which influence the acceptability of irrigation scheduling models in general
- identify the specific human and environmental factors which influence the use of the models
- give guidelines concerning the changes needed to be made to irrigation scheduling models to improve the acceptability of the models
- make initial technical changes to the models.

To effect these objectives, three sites were chosen, viz.:

- The Rust de Winter Irrigation Scheme, which is representative of a typical land redistribution situation.
- The Riet River Irrigation Scheme, which represents a site where an irrigation scheduling model was introduced a number of years ago.
- The Loskop Irrigation Scheme, which represents an irrigation scheme where SWB, representing a new computer-based irrigation scheduling model, is being released.

The research focus at each of the three sites was slightly different. At Rust de Winter, the focus was on the main goal, viz. factors which influence the acceptance of irrigation scheduling with specific reference to scheduling models. At Riet River and the Loskop Irrigation Scheme, the focus was on the objectives as shown above.

Since Rust de Winter differs from the other sites in terms of its socio-economic circumstances, different research methodologies were employed at the sites. Rust de Winter required a range of typical Participatory Rural Appraisal (PRA) techniques, while at Riet River and Loskop questionnaire based semi-formal interviews were used. At Rust de Winter the combinations of PRA techniques that were used were; transect walks, semi-structured interviews with key informants, historical timelines, Venn diagram, seasonal calendar, constraint identification and ranking and scoring and prioritisation. Based on a problem conceptualisation the traditional questionnaire was constructed. The latter was focused specifically on achieving the goal of the research.

The results of the **Rust de Winter** investigation are shown in Chapter 2. They can be summarised as follows:

- The history of irrigation at Rust de Winter tells a tale of intentional but sadly unsuccessful political involvement and intervention that started almost 20 years ago.
- Since the political involvement, the administration of the Scheme was not up to standard and the land administration processes proved to cause prolonged inconveniences for and uncertainty with irrigation farmers. The area falls in two provinces, which administratively worsens the situation.
- The socio-political issues at Rust de Winter effectively smother one initiative after the other, leading to irrigation scheduling being so low on the priority list of irrigation farmers that it hardly features. The historical time line shows how the current irrigation farmers moved in and actually squatted on their land and started farming. After years of waiting for bureaucracy to take decisions and give meaningful direction, they could not wait longer. The current plans to subdivide a piece of land into circa 350 smaller plots seem to create a lot of uncertainty and unrest among the local irrigation farmers. It will substantially decrease irrigation water availability.
- Effectively there are five communities, four ethnic groups and two farmers' organisations that find it difficult to co-operate and therefore find great difficulty to agree on many issues of mutual concern.
- The irrigation farmers are (generally speaking) poor and cannot afford to buy the land or agricultural inputs. Few tractors and agricultural implements are available.
- Infrastructure has deteriorated at a steady pace since the middle 1980s when the previous white landowners started leaving the area. The canals are in disrepair and there

seem to be attempts by the Department of Water Affairs and Forestry to restore them. Citrus orchards are also run down and no longer economically viable. When the previous farmers left, there were about 21 pivot systems that remained on the land. Only one or two are in use today.

- Two agricultural co-operatives have been formed, but neither has managed to start functioning.
- The climate is conducive to agricultural production, but water availability is problematic. The area is unsuitable for rain-fed crop production. Groundnuts do not do well because of the high clay content of the soil. Vegetable production has excellent potential.
- The situation at Rust de Winter is complex and difficult to analyse. It seems to have a high degree of socio-political fluidity, which makes investigations and general extension work very difficult.
- Land tenure arrangements and the concomitant insecurity are creating big problems for irrigation farmers. Farmers complain that many decisions are still taken in a top-down fashion in Pretoria and Johannesburg.

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- Access to agricultural credit and agricultural inputs barely exist. Farmers borrow irrigation equipment from the Department of Agriculture. Those are not used appropriately looked after and farmers complain of a general lack of labour to shift irrigation pipes. Flood irrigation is not a suitable practice at Rust de Winter, but some farmers use it. Lack of proper irrigation equipment leads to considerable inefficiencies. "Fixed programmes" of moving irrigation pipes are very commonly found.
- It was found that the general agricultural knowledge of irrigation farmers was poor and they conceded to this by complaining (priority number 1) that they do not have access to effective extension advice nor servicing. Their working knowledge of specific crops was acceptable to farm with those crops. Irrigation scheduling did not feature in the needs analysis.
- Irrigation farmers' main restrictions are lack of access to credit, high inputs costs, water availability and price. Game also damage crops. Farmers regard the cost of water and

- its availability as very important, and as restricting crop production for long periods during the cropping season.
- Only one farmer has a computer, which he uses for record keeping for a beef herd of cattle. Another is available at the local extension office.

The results of the **Riet River Settlement** investigation are shown in Chapter 3. They can be summarised as follows:

- The area has two soil types, viz. heavier greyish alluvial soil and red sandy soil. Both are generally deficient in nitrogen and phosphorous.
- The PUTU and BEWAB irrigation scheduling models were introduced to Riet River during 1989. The launching took place at a farmers' day.
- Most farmers (69.9%) are younger than 60 years. There are no significant age differences between those who schedule and non-schedulers.
- Significantly more farmers with larger irrigation plots were scheduling than those with smaller plots.
- Level of education did not show significant difference between schedulers and nonschedulers, nor did farming experience.
- Riet River has a water-table problem.
- The availability of computers is a problem at Riet River. Only eight farmers use computers for farming activities, one of which for irrigation.
- Almost 35% respondents are computer illiterate and did not own one, while 30.2% said they were not interested in computers.
- Only two respondents said they had not heard of irrigation scheduling before.
- The local co-operative seems to play an important role in scheduling servicing and scheduling information supply, since 51.2% respondents had heard of scheduling from its staff.
- The majority (60.5%) respondents said the main purpose of scheduling is the optimum application of water.
- There is some scheduling discontinuance at Riet River. The reasons given, however, are inconsequential.

- An agricultural extension agent spoilt the farmers by doing too much for them and taking too much responsibility. Therefore the current scheduling activities seem more agent driven than driven by irrigation farmers.
- Respondents are very positive about irrigation scheduling. They mentioned variety in soil types, water-table problems and lack of infrastructure as hindering scheduling. Yet, they did not respond very positively to the attributes of computer-based irrigation scheduling models. It seemed that many (42.9%) are quite satisfied with the current (low) levels of sophistication of irrigation scheduling they were having.
- Respondents seem to be divided regarding irrigation scheduling with a computer, with 28.1% perceiving it as very difficult. More than 70% agreed that scheduling can save water and money.
- Only ten respondents had not heard of BEWAB, but all had a very limited and vague knowledge of how it worked and what it entailed. Only one farmer is still using BEWAB, and this application is an adapted version thereof. Most (72.1%) seemed to have a clear understanding of the fundamental principles of scheduling.
- Quality of irrigation water needs to get more attention in future. It is beginning to show problems with overhead irrigation systems, since the levels of weed, algae, sludge and mud are sometimes too high for these systems.
- Respondents are very sure of their current and future lawful water rights.
- There were no problems concerning the amounts of water asked and received, and only 32.6% did not trust the sluice system of water delivery.
- Farmers pay for their full quota of water, whether they use it or not. This has negative effects on sustainable water use. Most (67.4%) farmers would prefer volumetric payment for water, and only for what they use.
- Erratic electricity supply seems to impact on general farming and scheduling activities.
- Farmers say that irrigation water is too expensive at Riet River. They also complained about the cleaning of the canal system, saying it is ineffective and overly expensive.
- Only five respondents want subsidies on water in future. The price of water at Riet River is a topic of much discussion.

- Farm layout limited irrigation scheduling at 14 respondents' properties, but 60.4% said that the settlement is well designed and can accommodate scheduling activities.
- Farmers were divided regarding whether the Irrigation Board was a successful endeavour. Consultants indicated that farmers are unhappy with the influence of their representatives to the Irrigation Board. They had a variety of ideas on how to manage the Scheme more effectively, but there was no consensus about the matter.
- According to irrigation farmers there is a need for qualified irrigation scheduling advisors. They had mixed feelings about the state extension services. Most (76.7%) said that extension could play a role to alleviate the non-scheduling problem at Riet River.
- Thirty-three respondents had a reasonable idea of the plant requirement and root depth at different growth stages, while only 12 had a reasonable idea of the field capacity of their soil types. Other aspects of knowledge of their soils were also low. They did not have an acceptable level of sophisticated knowledge required to understand the details of scheduling.

The results of the Loskop Irrigation Scheme are shown in Chapter 4. They can be summarised as follows:

- Only one respondent is older than 60 years, and the average age was 44 years.
- All the respondents had a matric level of education, while 42% had obtained post-school qualifications.
- A total number of 20 respondents (64.5%) have a total number of 21 years or more experience, while 45% have more than 20 years' farming experience.
- There are 18% respondents with plots larger than 120 hectares, while 23% have plots smaller than 40 hectares.
- No significant differences were found between age, land size, experience or education between irrigation schedulers and non-schedulers. Respondents believe they do scheduling when they use time-based water application.
- Tobacco seems to be the most popular crop in terms of income and cotton the second most popular. Permanent crops seem to gaining popularity.

- The pivot system is seen as "the ultimate" and most wanted in irrigation technology, while conventional manual sprinkler irrigation is the most widely used. Pivots and conventional manual sprinkler irrigation function in tandem.
- Of the 71% respondents who have computers, 96% use them in their farming. Forty-five percent of the total number of respondents uses computers in irrigation scheduling activities. Twenty-nine percent respondents do not have computers nor access to it.
- Only three respondents said they have never heard of irrigation scheduling before. Extension agents seemed to have played the major role in propagating irrigation scheduling at Loskop.
- Sixty-two percent respondents had an idea of what scheduling is, while 19% knew what it is.
- Seventy-three percent of the respondents claim that they apply irrigation scheduling. There is a relationship between the practice of scheduling and knowledge thereof. Six respondents have an intimate knowledge of scheduling, yet only four of them apply it. The reasons are unknown.
- Respondents perceive scheduling as important, and link scheduling with sustainable water use, saving money and securing crop yields.
- Only 22.6% respondents claim scheduling to be "not easy" to apply. There is a relationship between respondents' perception of the importance of scheduling and applying it.
- Respondents (77.7%) who said scheduling "is easy" to apply are applying it.
- Respondents are well aware of the need to save water in future and indicated that scheduling can play a big role in this regard.
- Farmers pay for their full quota of water, whether they use it or not. This propagates against sustainable water use.
- Loskop farmers are politically aware, but not up to date with the current debates on water rights and security. Many (70%) seemed apathetic and cynical about the changes that are coming.
- Sixty-five percent respondents are very sure that they get the water they pay and ask for, while 29% said there are chances of water being stolen. They did not say that theft

- actually occurs. There is a general trust in the Irrigation Board and fellow farmers concerning this matter.
- Respondents (58%) say that irrigation water is expensive and there is no consensus as to how to pay for water.
- The issue of water subsidies is not controversial and respondents seem to anticipate government not to subsidise them any longer.
- The overall management of Loskop is well accepted and appreciated by respondents.
- Most (94%) respondents say that extension can play a meaningful role to address the situation of non-scheduling at Loskop, but could not come up with any significant plans to effect this. However, they have to be consulted on this issue in future.
- There are no significant complaints that the outlay of Loskop, nor its administration, hinders irrigation scheduling.
- Specialists and extension practitioners were asked which knowledge farmers need to apply scheduling in a proper manner. Generally, respondents did not have this required level of knowledge concerning plants, the soil or the climate. Several (19.4%) respondents make use of irrigation consultants, only 9.6% respondents had a good knowledge of plants and the soil, and 51.6% did not have any knowledge or were very unsure.
- Not many (35.5%) respondents integrated rain-meters well with their scheduling activities, while 25% integrated mini-maxi temperature well with scheduling.
- Respondents perceived the attributes of SWB very well, and it is estimated that 13% respondents will adopt it very easily.
- Only one respondent was unwilling to pay for scheduling advice. There is no consensus on how to pay for such a service, but respondents are inclined to link payment with increases in crop yields and/or income.
- The reasons why Loskop irrigation farmers do not use scheduling revolve around time, costs, ease-of-use, irrigation system design, field layout and availability of computers. Assistance and/or advice must be timeous, regular and continuous.
- Several technical changes were requested and are being made to the SWB model. They all have to do with the practical implementation and application of the model.

During this project technology transfer was effected in several ways. At Rust de Winter the farmers were engaged in dialogue and extensive discussions about irrigation. They were made aware of the need for appropriate scheduling and the principles of the application were explained to and discussed with them on an individual basis. At Riet River farmers were engaged in discussions about scheduling and the need thereof. The need for them to take more responsibility for data and scheduling was discussed with some of the farmers and they were made aware of the need to upgrade their scheduling skills and applications.

At Loskop the following steps were taken:

- extension workers and irrigation consultants were trained to install and run SWB, to install soil moisture pipes, to use a Neutron probe and to link with the SWB programmers
- a Neutron probe of the University of Pretoria was made available to Loskop project coworkers
- a farmers were then introduced to SWB
- a farmers are still being provided with advice and assistance concerning the use of SWB
- Hoedspruit farmers were also linked with SWB application
- farmers were made aware of the proper application of scheduling.

The implications of these findings are that:

- irrigation scheduling technology is available,
- irrigation farmers' knowledge seems to be deficient and
- extension can play a role to alleviate this problem.

It must be stated that irrigation scheduling cannot be practised effectively in the absence of appropriate and sustainable crop farming practices e.g. soil preparation. Irrigation scheduling is not a panacea to irrigation problems and its effectiveness depends on its interrelatedness with appropriate and sustainable farming practices.

This research has focused on selected irrigation scheduling models. It is recommended that further research should be done to include the whole country and other irrigation scheduling models.

As discussed above, it is clear that sufficient progress has been made towards achieving the main goal and each of the objectives. Therefore it can be concluded that the goal of this research has been achieved.

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CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

"South Africa is one of the water-scarce countries of the world. It has an annual rainfall of 480mm average compared to a world average of 860 mm. Rainfall is furthermore highly variable in different years, unevenly distributed during the year and also over the various surfaces of the country" Du Plessis (1998). Water resource management in South Africa is shifting increasingly from supply management to demand management. One of the demand management tools is to increase the price of water to a level where it leads to a reduction in demand (Du Plessis, 1998). Irrigation will have to compete increasingly on an equal basis with other sectors for the available water supplies. Increasing water prices on irrigation schemes will help to ensure more efficient water use and it will become increasingly difficult to continue with the economic production of low value crops (Du Plessis, 1998).

The technology (computerised irrigation scheduling models) to implement demand management is available, but not widely used. Other methods e.g. tensiometers and evaporation pans are also available, but this research focuses only on the different perceptions regarding computerised models.

Project motivation

The costs of irrigation will probably rise, because there is a general growing awareness among the public and the authorities that water is a scarce commodity. South African farmers are already under severe pressure due to cost escalations over the last decade or more. Farmers therefore have to keep expenditure as low as possible and a way to assist them in doing so is for irrigation farmers to optimise production by minimising all irrigation related costs. An appropriate way for irrigation farmers to do this is to make use of suitable irrigation scheduling models. The SWB model is new on the market and probably one of the most advanced and accurate irrigation scheduling models available.

However, if SWB is not accepted by farmers they will not use it and huge quantities of irrigation water would go to waste. It is therefore important to establish the acceptability of SWB, and to make required changes to the model to increase its acceptability with farmers.

An analysis to identify the factors which influence SWB's acceptability, could lead to meaningful changes to SWB. This could then increase the acceptability of SWB with irrigation farmers. The probability is low to replicate in other communities the list of factors which influence the acceptability in a specific irrigation farming community. Yet, extension staff and researchers can take cognition of those factors in their extension and research programmes. Since the mediating factors in a person's psychological field are inter-related and mutually influence each other, the acceptability of the model could be enhanced in target communities. In this way water can be conserved and the cost of irrigation could be harnessed to the advantage of farmers and the whole community.

The SWB model, however, has not been tested with farmers and adjustments may be required for different crops and to the consumer-friendliness of the programme. This research contributed towards these ends.

The goals of this research

The goals of this research were to:

- measure the perception of the practice of irrigation scheduling in general
- identify the human and environmental factors which influence the acceptability of irrigation scheduling models in general
- identify the specific human and environmental factors which influence the use of the models
- give guidelines concerning the changes needed to be made to irrigation scheduling models to improve the acceptability of the models
- make initial technical changes to the models.

Irrigation management models

Irrigation management models are based on the following:

Soils have a capacity to store water, a portion of which is available to plants. The quantity of plant available water is determine by soil depth (potential rooting volume), soil texture, soil structure and the chemistry of the soil. Characteristics of the plant itself, such as growth stage, root development and the physiology of the plant determine the extraction of plant available water by plants. Plant development and physiology, as well as evaporation, is influenced by climatic conditions.

Water is added to the soil water store through rainfall and irrigation. This store is depleted through evapotranspiration, a combination of transpiration and evaporation. Water loss is found when runoff takes place where water application or rainfall exceeds the infiltration rate of soils, and through drainage to below active root zone when the storage capacity of soil is exceeded by excessive rainfall or irrigation.

The main objective of irrigation management models is to balance the plant available water in soil in such a way that optimum plant production is achieved with a minimum water loss.

1.2 IRRIGATION SCHEDULING MODELS

The Soil Water Balance (SWB) model was released recently, while PUTU and BEWAB were released at Riet River Irrigation Scheme during 1989.

The Soil Water Balance (SWB) model

Soil Water Balance (SWB) is a mechanistic, real-time, generic crop, soil water and salt balance, irrigation scheduling model. It is based on the improved generic crop version of the NEW Soil Water Balance (NEWSWB) model published by Campbell & Diaz (1988). SWB gives a detailed description of the soil-plant-atmosphere continuum, making use of

weather, soil, crop and management databases. Simulations with SWB can be run using two types of model: i) The crop growth, mechanistic model calculates crop growth and soil water balance parameters; and ii) The FAO-type crop factor model calculates the soil water balance without simulating dry matter production mechanistically. SWB performs the calculation of the water balance and crop growth using three units, namely weather, soil and crop.

The weather unit of SWB calculates the Penman-Monteith grass reference daily evapotranspiration (ETo) according to the recommendations of the Food and Agriculture Organization (FAO) of the United Nations (Allen et al., 1998).

In the soil unit of SWB, water movement in the soil profile is simulated with a multi-layer cascading model, after canopy interception and surface runoff have been accounted for. Salt redistribution assumes complete mixing of irrigation and rainfall with the soil solution of the top soil layer, and similarly for the soil solution percolating to the next lower soil layer and so on.

In the crop unit, SWB calculates crop dry matter accumulation in direct proportion to transpiration corrected for vapour pressure deficit (Tanner & Sinclair, 1983). It also calculates radiation-limited growth (Monteith, 1977) and takes the lower of the two. This dry matter is partitioned to roots, stems, leaves and grain or fruits. Partitioning depends on phenology calculated with thermal time and modified by water stress.

An FAO-based crop factor procedure was developed and combined with the mechanistic SWB model, thereby still allowing evaporation and transpiration to be modelled separately as supply- and demand-limited processes. A more technical description is given by Allen et al., 1998.

¹ For technical detail, see Allen et.al., 1998; Robbins, 1991; Campbell & Diaz, 1988; Campbell & Norman, 1998.

Management, weather and soil data are required as input in order to run both the crop growth and the FAO model of SWB. These are planting date, latitude, altitude, rainfall and irrigation water amounts and quality, as well as maximum and minimum daily temperatures. In the absence of measured data, SWB estimates solar radiation, vapour pressure and wind speed according to the FAO recommendations (Allen et al., 1998). In addition, volumetric field capacity, permanent wilting point, initial volumetric soil water content and the content of ionic species are required for each soil layer. Specific crop growth parameters and FAO crop factors are also required to run SWB. An extensive database of specific crop growth parameters and FAO crop factors is included in SWB.

BEWAB irrigation model

Bennie, Coetzee, Van Antwerpen, Van Rensburg & Burger (1988) describe the development of this model. Further refinement of the model was based on research done by Bennie, Van Rensburg, Strydom, & Du Preez (1997), whilst a culmination of 22 years of research is described in Bennie, Strydom, & Vrey (1998). Linked to this last report is a computer based water management model called SWAMP, which was developed out of BEWAB.

The following synopsis of BEWAB is based on Bennie (1991).

BEWAB was developed as an irrigation water management computer model that gives the researcher, irrigation management advisor and farmer an easy-to-use tool for on-farm irrigation management. It calculates a water balance equation on a daily basis to give cumulative values on which decisions regarding irrigation application and frequency are based.

Inputs required are the type of crop, length of the growing season, target yield, and depth of soil. silt plus clay content for 200 mm depth intervals and a selected rain storage capacity to be provided for.

Evapotranspiration plays an important role in this model, and can be determined by:

- direct measurement of water content or depletion of the rooted profile with e.g., a
 neutron probe
- estimation from the potential evapotranspiration or the Class A pan evaporation using the relevant conversion factor for a crop
- estimation from seasonal water production functions and curves of day-to-day variation in crop water demand.

Direct measurement is the most accurate, but also the most expensive, therefore the remaining two methods are generally applied for irrigation management. It has however been found that Class A figures result in an over-estimation of plant water requirement, and therefore can lead to considerable over-irrigation. BEWAB calculates consumptive water use over the season from the upper boundary water production functions based on historic water-use relationships.

Rainfall storage and deep drainage are managed to minimise losses. BEWAB allows the user to manage irrigation in such a way that a portion of the soil profile is made available for storage of rainfall.

The programme makes provision for four possible water management regimes, the detail of which is described by Bennie (1991). The programme output is a printout of recommended water application schedules for the four different moisture regimes.

PUTU irrigation model (PUTIRRI)

De Jager, Van Zyl, Kelbe & Singels (1987) describe the initial development of this model. The following synopsis of PUTU is based on De Jager, (1989) and Mottram & De Jager (1991). The model was first developed as PUTU9-86, and further developed to PUTIRRI as a generalised application model.

The development of this model shifted the accent from a hydro-pedological approach of previous models, to an agrometeorological approach, integrated by checking of soil and plant water status. This represented a new philosophy for irrigation scheduling, particularly where irrigating numerous different plots, on a large number of farms, is concerned. Under these circumstances this model offers a convenient and accurate scheduling method.

PUTU was developed as a simulation model to solve two problems in irrigation scheduling:

- that of keeping a record of daily plant and soil water status required for real time scheduling of a large number of different plots which is time consuming and difficult;
- that of using some sort of sensor to monitor soil water content or plant water status which is practically just not possible on a large scale.

These problems where overcome by computerisation and the estimation and predicting of plant water status in various crops, in different growth stages and spread over a large area. Automatic weather station and a crop growth model provided the answer.

Values of microclimatic variables can be representative of an area included in a 50 km radius. Atmospheric evaporative demand computed from such weather data was therefore applicable to all crops anywhere inside this area. This model is a real time irrigation scheduling model which uses hourly values of incoming solar radiation, temperature, relative humidity, wind speed and direction, and rainfall collected by the weather station and downloaded onto a computer at daily, or some other convenient, intervals. This data is then used to calculate the reference crop evaporation by applying the Penman-Monteith equation. The model then computes the atmospheric evaporative demand (AED) by multiplying the reference crop evaporation by a crop coefficient, which varies throughout

the crop's growth. This crop coefficient is derived from two other coefficients, which in turn reflect soil surface drying and account for the degree of vegetative cover and ratio of maximum plant evaporation from the crop to reference evaporation.

Further inputs into the programme are specific soil and plant characteristics. The crop model then calculates plant and soil evaporation and plant water status for each plot.

Output is a table that gives the following for each farmer, his land and crop on a daily basis: water stress factor; leaf area index; irrigation amount; rain; drainage out of root zone; profile plant available water; atmospheric evaporative demand; water deficit below upper drained limit which equals the maximum amount of water required. From these figures, and including the expected evaporative demand, it is then possible to predict when the next irrigation would become necessary.

1.3 REFERENCES

ALLEN, R.G., PEREIRA, L.S., RAES, D. & SMITH, M., 1998. Crop evapotranspiration. Guidelines for computing crop water requirements. Irrigation and Drainage Paper No. 56. FAO, Rome, Italy.

ANNANDALE, J.G., BENADÉ, N., JOVANOVIC, N.Z., STEYN, J.M. & DU SAUTOY, N., 1999. Facilitating irrigation scheduling by means of the Soil Water Balance model. Water Research Commission Rep. No. K5/753, Pretoria, South Africa. In press.

BENNIE, A.T.P., 1991. Sound water management concepts and their application at farm level. Proceedings of the Southern African Irrigation Symposium. WRC Report No TT 71/95. Water Research Commission. Pretoria.

BENNIE, A.T.P., COETZEE, M.J., VAN ANTWERPEN, R., VAN RENSBURG, L.D., & BURGER, R. DU T. 1988. 'n Waterbalansmodel vir besproeiing gebaseer op die

profielwatervoorsieningstempo en gewaswaterbehoefte. WNK-verslag Nr 144/88/1, Waternavorsingskommissie, Pretoria.

BENNIE, A.T.P., STRYDOM, M.G.H. & VREY, H.S., 1998. Gebruik van rekenaarmodelle vir landboukundige waterbestuur op ekotoopvlak. Waternavorsingskommissie. Pretoria.

BENNIE, A.T.P., VAN RENSBURG, L.D., STRYDOM, M.G. & DU PREEZ, C.C., 1997. Reaksie van gewasse op voorafgeprogrammeerde tekortbesproeiing. WNK-verslag 423/1/97, Pretoria.

CAMPBELL, G.S., & DIAZ, R., 1988. Simplified soil-water balance models to predict crop transpiration. In: Bidinger FR and Johansen C (Eds) *Drought research priorities for the dryland tropics*, ICRISAT, India, pp. 15-26.

CAMPBELL, G.S. & NORMAN, J.M., 1998. An introduction to environmental biophysics. 2nd ed. Springer, New York.

DE JAGER, J.M., 1989. Computer modelling for real time irrigation scheduling at remote sites. Proceedings of the South African Institute of Agricultural Engineers. Pretoria.

DE JAGER, J.M., VAN ZYL, W.H., KELBE, B. & SINGELS, A., 1987. Research for a weather service for scheduling the irrigation of winter wheat in the Orange Free State Region. WRC Report No 117/1/87. Water Research Commission. Pretoria.

DU PLESSIS, H.M., 1998. South Africa a water-scare country. Paper read at the Fertigation symposium of the Fertiliser Society of South Africa, Pretoria, 1998.

MOTTRAM, R. & DE JAGER, J.M., 1991. Irrigation Scheduling for crops using real time weather data. Proceedings of the Southern African Irrigation Symposium. WRC Report No TT 71/95. Water Research Commission. Pretoria.

MONTEITH, J.L., 1977. Climate and efficiency of crop production in Britain. Philos. Trans. R. Soc. London B 281 277-294.

ROBBINS, C.H., 1991. Solute transport and reactions in salt-affected soils. In: Hanks, R.J. & Ritchie, J.T. (Eds.) Modeling plant and soil systems. Agronomy Monograph No. 31, ASA-CSSA-SSSA, Madison, Wisconsin, USA, pp. 365-395.

TANNER, C.B. & SINCLAIR, T.R., 1983. Efficient water use in crop production: research or re-search? In: Taylor, H.M., Jordan, W.R. and Sinclair, T.R. (Eds.) Limitations to efficient water use in crop production. ASA-CSSA-SSSA, Madison, Wisconsin, USA, pp. 1-27.

CHAPTER 2

IRRIGATION AT THE RUST DE WINTER IRRIGATION SCHEME

2.1 INTRODUCTION

There are many factors that influence normal development and functioning of an irrigation scheme like Rust de Winter, for instance issues like historical, socio-economic, financing and environmental aspects. These physical and human realities facing the irrigation farmer should be taken into account when reasons for adoption or non-adoption of scheduling models as part of the irrigation farmers' management are investigated.

Historical overview of the scheme

The valleys of the Elands, Enkeldoorn and Mokkarivers, as well as the adjacent areas, were occupied by cattle-owning Sotho-speaking people for hundred of years. Before that, middle and late Stone Age Khoi people occupied the area for an even longer period. The Voortrekkers were the first Europeans to settle in the area towards the middle of the last century when the area was totally depopulated due to raids by Mzilikatzi. These pioneering farmers used the area for winter grazing and hunting, before being forced back to their highveld farms for the summer by malaria and cattle diseases (SADT, 1992).

During 1906 an irrigation scheme with a dam was proposed at the current Rust de Winter, but nothing came of this proposal until the early 1930's when construction started. Both the dam and canals were completed in 1935. The Rust de Winter dam has a storage capacity of 28.09 million cubic metres. The catchment area is 1147 km² in size (see Figure 2.1).

During 1987 to 1991 approximately 36303 hectares was bought by the now defunct South African Development Trust Corporation (SADT) from 68 individual owners for an amount of approximately R97 million. This included 1875 ha under the proclaimed Rust de Winter Irrigation Scheme and was earmarked for the incorporation into the KwaNdebele homeland. This land was purchased as compensatory land for the loss of the Nebo farms and as an area for resettlement of Ndebele occupants of the farms Geweerfontein 156JR, Bloedfontein 153 JR and Kalkfontein 143 JR. The incorporation never took place. After the land was acquired, the South African Development Trust Corporation (Pty) Ltd (SADT) was appointed to manage, plan and develop the area for individual farmer settlement and to render a supporting service to the farmers settled on the land. The aim was to settle 34 farmers from KwaNdebele and to establish a nature reserve.

A total of 4 169 hectares of irrigation land were bought by the State, of which only 1875 hectares were registered irrigation land under the Rust de Winter State irrigation scheme. At the time of purchase it was alleged that 2294 hectares were irrigated from other sources than the Rust de Winter dam. A total of 7000 cubic metres of water per hectare per annum was initially allocated out of the Rust de Winter dam to the 1875 hectares registered for irrigation. Of the 1875 hectares registered for irrigation, 827 ha were allocated to farms with irrigation areas of 6 ha to 137 ha per registered farm unit. The rest was allocated in 12 ha units (SADTC, 1992). The left bank of the Pienaarsriver comprised of 24 farms and 22 irrigation plots and the right bank of 65 irrigation plots.

Rust de Winter irrigation scheme profile

In the beginning phases of planning done by Demacon (1996), the assumption basis was that 7,5 million cubic metres of water per annum would be available for the scheme. This approach negates the water supply to 1100 ha per annum. However, the Minister of Water Affairs has decided during 1998 to allocate only 1,5 million cubic metres of water per annum (or circa 214 ha per annum) at a 98% assured supply. This means 2.64 million cubic metres of water per annum on a 70% assured supply after a careful updated hydrological analysis of the Rust de Winter dam and catchment. This is quite a difference in comparison with the original water right at an allocated consumption of 7000m³/ha/annum, thus 13,1 million cubic metres per annum in total for irrigation during

1994/5. The 70% assured level allowed for the irrigation of the originally scheduled scheme area commanded by the dam of 1875 ha (a maximum quota of 7000 m³/ha/annum). This reduction in allocation will reduce the irigable area from 11 000 ha to 214 ha.

An irrigation scheme like this demands a well designed distribution system capable of delivering water without problems. The canal system exists of two main canals known as the northern and southern bank canals. The canals served the smaller canals, which is distributed in the irrigation area. The northern system consists of about 24 km canals and provide the irrigation area of the northern bank of the Elandsriver as well as the northern portions of the farms Rooykop 181 JR and Leeuwkraal 184 JR. This canal ends on the border between Leeuwkraal 184 JR and Bezuidenhoutskraal 166 JR. The southern system consists of about 29 km canals. The main canal served only the smaller canals in the irrigation area on the southern banks of the Elandsriver. This system is also provided with about 13 km drainage canals to dump excess water back into the river. The condition of parts and sections of the canal system (northern and southern) is in different states of disrepair and Department of Water Affairs is currently in the process of restoring the canal system in anticipation of the allocation of irrigable land to beneficiaries.

Management of the distribution system is absolutely important in preventing conveyance losses that will influence the availability of water. The Department of Water Affairs and Forestry currently administer the dam and irrigation canals. The availability of water is currently no problem but during 1989/90 only 61% of the quota and during 1990/91 only 3,7% of the quota was awarded because of drought. Poor management of the system could be of more importance than assurance levels. The scheme was planned for a level of assured supply or risk of failure somewhere between 70% (high risk of failure) and 85% (low risk of failure) with the proviso of good management and distribution systems.

The Department of Land Affairs declared their intention to cut up land to smaller entities rather than to have big pieces of land with communal ownership as shown in the planning of Demacon. Based on the supposition that 7,5 million cubic metres of water per annum

will be available for this project, 12 extensive farming units, 91 mixed units (irrigation and extensive farming), 400 food plots, 600 food gardens and 1300 residential sites were planned by the planning agency Demacon and approved by the Steering Committee in 1977.

Since then the Department of Water Affairs and Forestry (DWAF) revised the decision that water be used primarily for agriculture. Should the proposed residential settlement of circa 350 erwen within Rust de Winter be accepted, the 1,5 million cubic metres allocation per annum would be divided in half. The fact that this area does not have abundant water resources and local resources are very limited, priority is given to the use for domestic purposes and therefore the reallocation of water. During 1994 the then KwaNdebele Regional Water Supply Scheme also requested the release of 8 million cubic metres water from the Rust de Winter dam to supplement the shortfall. In a meeting with the Minister during 1998, it was stated that between 150-200 ha of land would enjoy the right to irrigation. But it was also mentioned that the distribution of thirteen irrigation farmers along the canal system causes severe water conveyance losses. The suggestion was urged that cooperation amongst farmers and officials are needed to curb these losses.

During the planning exercise of SADTC (1992), 184 boreholes were present in this area. Most of those are unsuitable for either human or animal consumption due to chemical composition. No borehole was tested for maximum delivery potential. Many of the boreholes identified during this exercise are no longer in use, because many since 1992 dried up, or the boreholes had been deliberately damaged or even destroyed.

The water from the dam is managed by Department of Water Affairs. The Rust de Winter Irrigation Advisory Committee consists of representatives of each community group, the Departments of Water Affairs and Agriculture Gauteng, and deals with problems concerning water distribution as requested by irrigation farmers, maintenance of canals, non payment of water bill, etc. The cost for the maintenance of canals is recovered from the State. The water tariffs has escalated from R265/ha during 1997/98 to R300/ha during

1998/99 (6,62c/m³). The farmers have asked for the subsidising of water tariffs with the following proposal to the Department:

25% of full irrigation water tariff in first year 50% in second year 75% in third year 100% in fourth year

The relevant Department has not as yet accepted nor rejected the above proposal. The Rust de Winter Irrigation Advisory Committee took notice of the fact that the present system of payment before water would be released was impractical and unfair. The Department has since been advised to alter the condition in the authorisations pertaining to the levying of tariffs to that being followed on other irrigation schemes. That is: payment for a year's water would be made in two instalments, the first at the end of the winter harvest and the second at the end of summer harvest. This system was implemented during May 1998.

The Advisory Committee accepted the Scheme Regulations that are applied within Rust De Winter. They stipulate that the start of water release in the canal will only be considered when the total request (left and rightbank canals) for release exceeds 200 m³/h. Telephonic ordering of water release is also not allowed. Water must be ordered a week in advance (on Fridays). The water release in the canal will be closed if the request water is beneath 100 m³/h. Many of the very small-irrigation farmers have serious problems with this regulation. In many cases they may need only 50m³/s, and then approximately 216m³/s water must be released to cover the conveyance losses. Due to the relatively low flow rate at which water is released down the canals, irrigation farmers are experiencing problems to abstract their water through the existing gauging flumes to their balancing dams. It was decided that where required, the Department will install larger gauging flumes at the canal off-takes to increase the abstraction rate to irrigation farmers' balancing dams.

Administration and management of the scheme

With the proclamation of the Abolition of Racially Based Land Measure Act., 1991 the South African Development Trust Corporation (SADT) was phased out in 1993. The shares, assets, powers and duties of SADT were transferred by means of Proclamation No R111 of 1993 to KwaNdebele Agricultural Company (KAC). KAC as the responsible empowered institution, in conjunction with the Department of Land Administration and the then KwaNdebele Department of Agriculture, continued the "care-taking" function of the state land and assets and the further planning. The objective leading to KAC's involvement was to settle "emergent" farmers on commercially viable farming units in an organised manner through a democratic selection process. Technical and economic planning matters were undertaken by a broadly represented Planning Task team. They were appointed by the Rust de Winter Management Committee and chaired by the Department of Agriculture.

The Rust de Winter Development Company (a full subsidiary of KAC) was empowered to give effect to the implementation of the proposed farmer settlement programme. The company acted as an agent of the Department of Agriculture for the management and further development of agricultural projects on land in the Rust de Winter area. The company was appointed by virtue of its expertise in the agricultural management and development sphere with the objective of settling farmers and the rendering of comprehensive farmer support services to the emergent farming community. In addition the company undertook to establish certain community development projects with the aim to equip individuals and community groups within the area with a variety of skills required to enable them to competently establish, manage and operate sustainable ventures and activities designed to improve their quality of life (Rust de Winter Development Company (Pty) Ltd., 1995).

An "accommodating" approach to land distribution was followed, recognising the anticipated land needs of the Litho/Ndunza and Manala Tribal Authorities, former SADT worker groups, and certain legal land lessees (farmers) already established on land. The

area was planned to accommodate 77 individual farmers and the farmers were selected by a selection committee comprising of members of the Agricultural Credit Board (ACB) and local interest groups. The land was advertised and the settlement of the successful applicants was planned for June 1994. However, during August 1994 the Litho/Ndzundza Tribal Authority served notice that they intended to institute legal proceedings against the ministers of RSA and KwaNdebele for setting aside of any decisions which prejudiced the rights of Litho to the Rust de Winter land. This political intervention eventually halted the implementation processes. Since then no further settlement action took place. The Litho/Ndzundza Tribal Authority was of the opinion that they, as the major interest group, were not sufficiently consulted regarding the future utilisation of the area. At this time various groups and individuals moved into the area and began to lobby for formal land allocations.

As a result of invasion of land in July 1994 by members of the Litho/Ndzundza tribe, the Rust de Winter Land Forum was established by the Minister of Land Affairs to resolve the matter. The forum was later substituted by a technical committee of Rust de Winter. The task was to identify the people presently occupying the land and to determine finer details like leasing tariffs. At this point the majority of the land lay idle although some was utilised by neighbouring KwaNdebele cattle farmers and previous commercial farm labourers. Little irrigation took place and most of the land was used for extensive grazing. That was also when infrastructural upgrading efforts came to a halt. Many of the fences have long been removed or those that remain are badly rusted and in need of major repairs. The Department of Land Administration also has representation on the forum. KAC, RDW Development Company (Pty) Ltd and ACB have been excluded from this planning forum as not to jeopardise their positions.

During this time Gauteng Province identified various Land Reform Projects. Rust de Winter was one. Since 1994, 40% (comprising most of the irrigable land) of RDW falls in the Northern Province and approximately 60% of the area (comprising mainly of grazing) falls within Gauteng province. On 20 March 1995, the Minister of Land Affairs declared

that the Provincial Pilot Land Reform Steering Committee should take over the responsibility of Rust de Winter. The objectives of resettlement had changed to accommodate disadvantaged groups and individuals in terms of RDP and Land Reform Pilot Programme Principles. Consequently, resettlement planning of the pilot project area was postponed and would since be undertaken as part of the National Land Reform Pilot Programme.

In December 1994 the Rust de Winter Land Reform Project Forum was established. KLM (later known as Mpumalanga Development Company or MDC) reviewed its position during February 1995 with regards to all contacts pertaining Rust de Winter Development Company, the Community Development Centre and other contractual commitments to government.

Since 14 February 1995 the Rust de Winter Farmer Settlement Programme became the responsibility of the Department of Land Affairs. This Farmer Settlement Programme then became a Presidential Project (Pilot Land Reform Programme), and the purpose of the Rust de Winter Project Forum (RDWPF) was to assist the pilot project in the delivery of land and other development projects to the communities of RDW as per government policy. The Land Reform Programme's main priority has been the redistribution and restitution of land. The Rust de Winter Project Forum was established in August 1994 to deal with the allocation of land in the Pilot District. However, it has also become a forum for resolving disputes and disseminating information. Members of the RDWPF consist of representatives for the five community groups, viz.: Kwa Litho (Litho Ndundza Tribe), Manala Tribe, KwaNdebele A, KwaNdebele B and Vuka Zenzele. The Land Forum decided that those groups should be accommodated on the Rust de Winter farms. Each community has been allocated a demarcated area.

As stakeholders, the Manalas (lead by King Mahbena) are apparently a small group and represent a tribe of about 29 villages in Vaalbank and Kwalanga (approximately 40000 residents). The Vuka Zenzele is an organisation of approximately 300 farm workers joined

by well-off farmers outside Rust de Winter. The KwaNdebele Cattle farmers A and B are tribal Ndebele members but not related to the Lithos. Each group consists of about 50 members, but they act mainly as individuals and the differences are mainly related to language. Other members include one representative from Nature Conservation, Department of Agriculture: Gauteng, Department of Agriculture: Northern Province, Job Creation and an independent farmer. The RDWPF meetings are held at least twice a month to discuss issues related to Land Reform, the relationship between various stakeholders and general agricultural and development issues. Women's groups and the youth have to date, been poorly represented on the Forum. This is believed to be due to the prevailing tribal influence in the area, particularly amongst the Ndebele people, whereby middle-aged and elderly men dominate decision-making.

On many occasions the implementation of settlement of farmers has been indefinitely postponed until a mutual political agreement with interest groups was reached. In some instances the dispute arose out of long standing family and tribal feuds, while in other instances the involvement of ex-homeland officials was the cause. Invariably, antagonists towards the land reform process believe that they will not qualify as beneficiaries and that nepotism and favouritism will dominate the selection process. Since then the land issues are hotly debated and farmers are engaged in and still awaiting further discussions with government and the Land Bank. Some have very clear opinions about what land arrangements should be and how they should be handled.

Socio-political characteristics of the area

The following discussion gives an overview of some of the relevant socio-political characteristics of Rust de Winter

Age

Table 2. 1: Age distribution of Rust de Winter respondents (N = 17)

Age distribution (years)	Number of respondents		
20-30	0		
31-40	3		
41-50	5		
51-60	7		
61-70	1		
> 70	1		
Total	17		
Average	52		

Table 2.1 shows that the majority of farmers (70.5%) are between 41 and 60 years old. The oldest respondent was 72 years of age and the youngest 36 years old. This corresponds with the Ndebele tribal characteristics whereby middle-aged and elderly men tend to dominate decision making and forums of this kind.

Education

The formal education of Rust de Winter irrigation farmers are shown in Table 2.2.

Table 2. 2: The education levels of Rust de Winter irrigation farmers (N = 17)

Level of education	Number of farmers		
No school training	1		
Primary school			
Grade 1-5	5		
Grade 6-7	4		
High School			
Grade 8-9	2		
Grade 12	3		
Post school	2		
Total	17		

The majority of farmers (52.9%) interviewed completed some grade at primary school level 3, while 29.4% passed grade 12. Two respondents obtained official post-school qualifications, but neither are agricultural related and therefore not considered applicable for agricultural purposes.

Experience

Table 2. 3: Farming experience of respondents at Rust de Winter (N = 17)

Number of years farming experience	Number of respondents
0-5	4
6-10	6
11-15	4
16-20	1
> 21	2
Total	17

From the findings in Table 2.3 it is evident that some of the respondents have many years of experience. Most of the respondents were born on a farm and/or grew up as farm labourers. Four of the respondents have less than five years of farming experience. Many of the farmers interviewed (52.9%) are both farming and either involved in some sort of business venture, or practising another occupation. This is important to take notice of since it influences these farmers' technology requirements.

Rust de Winter farmers are generally poor and most of them cannot afford to buy land. Most of the residents and farmers in Rust de Winter are previous farmers' resident labourers and former SADT employees. Only a small number of farmers could be classified as commercial farmers on a basis of having the minimum capital base, while many are "trainee" farmers who lack the finances but have the potential to develop over time to fully fledged commercial farmers. Since the purchase of land by the State, several lease arrangements have been entered into with local black farmers. During 1999 there were 105 signed short term lease agreements awarded to farmers at an annual levy of R8/ha. Despite this highly concessionary rate (a residual feature of KaNgwane policy), very

few farmers fully pay their leases and a culture of non-payment exists. Problems cited as reasons for non-payment are the following: lack of infrastructure, duration of leases (one year) is too short a period to attract credit funds, unemployment and lessees' inability to occupy farms due to illegal squatting. In some instances the low rental has resulted in subletting.

Some lessees hope that they will be awarded the opportunity to buy all or part of the leased land as part of the Land Reform Programme. However, the relative low lease costs mean that many of the current farms are quite large (\pm 2000 ha) and many farmers could have difficulty in raising the necessary capital for the purchase price.

Subsequent to the departure of the previous farmers, many commercial outlets at Rust de Winter closed down. The nearest commercial centre where domestic and agriculture supplies can be purchased is now at Settlers. The area has some of the basic infrastructure which is required for agricultural production. There is good access by road from Pienaarsriver and Moloto. A tar road from Bronkhorstspruit passes through the western portion of the scheme, while the road to Settlers is only tarred for a few kilometres. The tar road is in a good condition while the gravel and dirt roads that pass through the area are in different states of disrepair. The service roads to the livestock units are mostly tracks and are in a reasonable to bad condition.

A large number of rural settlements are found along the northern edge of the irrigation scheme. Within the irrigation scheme there is one established settlement, and the beginnings of another, smaller settlement. Many of the original farm homesteads are abandoned and dilapidated. Rust de Winter's estimated 1998 population is approximately 1165 households or 5000 residents. Almost 35 percent of the economically active population is unemployed, and the average household has an monthly income of R436 (Demacar, 1996). Approximately 58% of the households surveyed by the Demacon consortium during 1998 indicated that they would like to own farming land exclusively,

while 32 % would like to own land jointly in small groups. According to Demacar (1996), the main sectors of employment are agriculture (48%) and services (27%).

There are telephone lines and electricity, but only a small number of households have access to these amenities because of the high unemployment rate. A network of powerlines is distributed effectively through the irrigation area to serve pumping stations. The power distribution to the livestock units is poor. In close proximity to Rust de Winter are the towns of Hammanskraal, Pienaarsriver and Warmbaths, which supply social services such as hospitals, businesses, shops, post offices, etc. In the town or the remainder thereof, a post office, police station, general dealers as well as community hall and a primary school are present. A clinic service is also rendered on a regular basis. The maintenance of the clinic services is essential and an average of 300 patients is treated there per month.

The Community Development and Training Programme came to a halt during March 1999 with the phasing out of Mpumalanga Development Company. A Community Development centre was situated on the farm Rooykop. This centre provided training opportunities for the adult family members of the community, thus potentially enhancing their quality of life together with their marketable skills. These community development actions comprise of training in sewing, knitting, cooking, baking, training in the building of home made stoves, handcraft, home economics and vegetable gardens and day-care centres. It offered a number of positive spin-offs to the local population at large, including creation of job- and entrepreneurial opportunities, creation of economic activities, profitably selling products produced at the Community Development centre.

Synthesis

Land reform is the emphasis at Rust de Winter. The tenure status of land is seen by
many inhabitants of Rust de Winter as an urgent need which should have been
accommodated some time ago. Weak tenure contracts are restricting people's
investment in the property they occupy and limiting the level of utilisation of the land.
This also inhibits the normal development and functioning of the irrigation scheme.

- The general education and training level of farmers and beneficiaries of this land reform programme is low and therefore skills development is seen as essential.
- Entrepreneurial support to help farmers in decision making is generally lacking.
- Irrigation scheduling as part of water management enjoys a very low priority among farmers.

Geo-physical characteristics of the area

Locality

The Rust de Winter irrigation scheme lies 110 kilometres north east of Pretoria metropolis, and 40 kilometres north east of Hammanskraal on the road from Pienaarsriver to Siyabuswa (see Figure 2.1). The area is located between 25°9' and 25°14' latitude and 28°31' and 28°43' longitude. The total area is 36000 ha of which 1875 ha is listed with irrigation rights from the Rust de Winter dam.

Climate

The climate at Rust de Winter is typically one of summer rainfall accompanied by high temperatures, and followed by cool winters. Data used to describe the climate was obtained from the Weather Bureau of South Africa (1995) and data collected at the Rust de Winter weather station. The Elandsriver flows in a west-eastern direction through the middle of the area and has an effect on the climate. At the lower areas near the river frost is more frequent and intense than higher up and farther from the river.

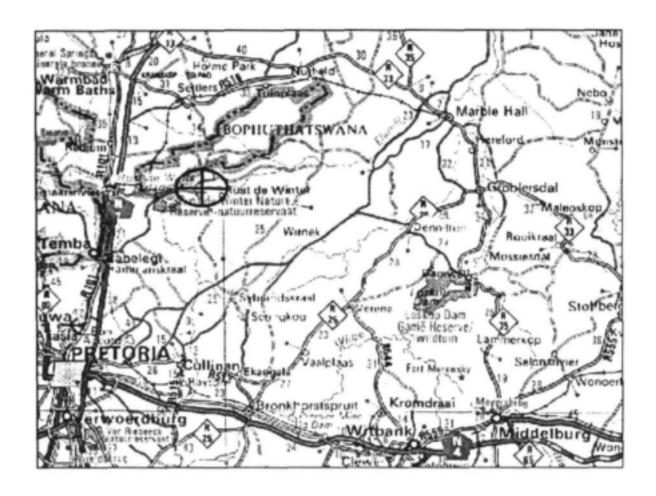


Figure 2. 1: Location Map of Rust de Winter

Rainfall and evaporation

Meteorological stations are found in and around the planning area like for instance Settlers and Towoomba. The average rainfall over a 36-year period has been 600 mm per annum (Erasmus, 1981). The area has pre-dominantly summer rainfall, with precipitations that vary from thunderstorms with high intensity and run-off to gentle rain of a few millimetres. Rain usually occurs during the summer months (43% of the total rainfall) of October, November, December, January, February and March. During these months an average precipitation of 60 mm per month or more is normally recorded. An average of 49 raindays occurs during the year. Of these, 23 days occur during October, November and December (Weather Bureau, 1995). Rain also occurs during the other months of the year. The average is less than 10 mm per month, which hardly benefits plant production. Rainfall distribution and evaporation rates are such that rain-fed crop production is considered nonviable, because of the low rainfall.

The average evaporation per day is relatively high. The mean Class A-pan evaporation data in mm per day are given in Table 2.4.

Table 2. 4: Mean monthly Class A-pan evaporation (mm/day)

Month	A-Pan (mm/day)	Mean mm/month		
January	6,6	204,6		
February	5,9	165,2		
March	5,0	155,0		
April	4,0	120,0		
May	3,0	93,0		
June	3,0	90,0		
July	3,0	93,0		
August	4,3	133,0		
September 6,1		183,0		
October	7,0	217,0		
November 5,9		177,0		
December	7.4	229,0		
Total	5.1	1860,1		

Temperature

The Weather Bureau (1995) supplied the data from the weather station at Rust de Winter. These figures indicate that the summer months can be considered hot and the winters mild to cold. In Table 2.5 the average monthly temperatures and extreme temperatures are given in degrees Celsius.

High temperatures may occur during the summer months and the highest recorded was 40,7°C. The winters characteristically have relatively hot days with cold nights. Temperatures below 0°C frequently occur during winter.

Table 2. 5: Mean monthly maximum and minimum temperatures in °C for Rust de Winter

Month	TM	TX	TN	TX H	TX L
Jan	23,6	29,9	17,2	35,4	12,7
Feb	22,8	29,3	16,3	33,7	12,3
March	21,6	28,3	14,8	33,1	9,9
April	18,8	26,3	11,3	31,4	4,2
May	14,7	23,3	6,0	29,7	-0,4
June	11,4	21,1	1,8	24,6	-2,8
July	11,2	20,6	1,8	25,9	-3,1
August	13,9	23,4	4,4	28,7	-1,0
Sept	17,9	27.1	8,9	33,1	2,0
Oct	21,7	30,1	13,4	35,7	7,0
Nov	22,6	29,7	15,4	35,8	10,2
Dec	22,9	29,7	16,2	35,6	11,2

Legend:

TX = Mean daily maximum temperature in °C

TN= Mean daily minimum temperature in °C

TM = Mean monthly temperature in °C

TX H = Mean monthly maximum temperature in °C

TX L= Mean monthly minimum temperature in °C

Frost

Frost, with varying degrees of severity does occur in the area. Data from nearby weather stations (Kalkfontein 550/487) indicate that very light frost (6°C Stevenson screen temperature) can be expected from 24 April until 20 September, a period of 64 days, while very heavy frost (-2 °C) can be expected during the 27 days between 13 June and 9 July.

Hail

No hail data for Rust der Winter are available, but it is expected that the situation is very similar to that at Towoomba Research Station where an average of 1,6 hail days can be expected annually with the best chance during October, November, December and February.

Soils

The altitude of the area at the Elandsriver is 965 metres above sea level, which gradually increases to 1050 metres where the hills occur. Although water was allocated for 1875 ha, a detailed soil survey of the irrigation area between the north and south canals on 6055 hectares was conducted by SADT (1992). For the rest of the irrigation scheme a semi-detailed soil survey was done. Soil forms such as Hutton, Oakleaf, Clovelly, Avalon, Longlands, Wasbank, Westley, Estcourt, Valsriver, and Arcadia occur in the study area. The restrictive characteristics of each soil resulted in the soils being classified into five irrigation "suitability" (capability) classes, relevant to irrigation.

Table 2. 6: Areas of soil capability classes for irrigation in the irrigation survey area (STK, 1992)

Soil capability class	Area (ha)	Dominant soil types
I	1391,9	Oakleaf, Hutton
II	1554,6	Clovelly, Oakleaf, Hutton
Ш	1384,2	Hutton, Oakleaf, Bainsvlei, Arcadia
IV	801,1	Valsriver, Arcadia, Escourt
V	923,8	Katspruit, Valsriver, Westleigh, Oakleaf, Avalon,
TOTAL	6055,6	

It is clear that a diversity of soil types exists and that not all the soil between the existing canals is of a good irrigable quality. Since only a portion of the potential 1875 hectares has water allocation, only class I and II is recommended for irrigation. Soil capability classification is a product of land and soil characteristics – the largest restrictive influence, determining the irrigation suitability classes.

Some of the factors that are taken into consideration with the classification of soil for irrigation purposes are: colour of the soil, soil depth, soil texture and porosity, slope, erosion hazard, wetness, salinity and sodic conditions. The following capability classes as indicated in Table 2.7 are used to estimate the suitability of various soil types for irrigation.

Table 2. 7: Capability classes of soil (Scotney, 1987)

Capability class	Description					
I	Highly irrigable, without any restriction					
II	Highly irrigable, with moderate restrictions					
III	Minor restrictions, mechanical and/or chemical problems limit cultivation					
IV	Limited soil depth and mechanical as well as chemical problems restricting cultivation					
V	Not recommended for irrigation					

Grazing capacity

If one takes into consideration that small-scale irrigation currently forms only about 4% of total irrigation in South Africa on 1.3 million hectares, irrigation in these areas is seen as important in integrated rural development, land reform programmes and poverty eradication. Streamlined procedures and support like irrigation scheduling is necessary to enable small-scale farmers develop new opportunities. Other forms of augmenting incoming are also important and many small scale irrigation farmers are also involved in animal production.

Decades of regression, particular of the sweeter veld types, bush encroachment, erosion, and invasion by poison leaf have reduced the grazing capacity to below the 1 LSU on 6 ha ratio given by the Department of Agriculture. It varies between 7 ha/LSU for the mixed bushveld up to 14-15 ha/LSU for the sandveld and rough hills found in the area. A diagonal strip running from south west to north east is potentially the best grazing land, but it has been over utilised in the past, and will require good management if the area is to be rehabilitated in the future.

Cattle ranching is seen as the only farming system adapted to the extensive grazing area. Even this, as previous owners have found, is difficult in the rocky areas and poison-leaf infested sandveld on the southern part of Rust der Winter.

The south-western part of Rust der Winter is because of its ruggedness, much more suited to nature conservation and ecotourism than to agricultural use. A nature reserve was therefore also declared in 1998 on the farm Leeuwfontein, and Nature Conservation together with the community is currently managing this reserve in a joint manner. Apart from the nature reserve mentioned, Nature Conservation is also managing the Enkeldoornspruit Nature Reserve that extends over 16585 ha and also forms part of the Rust de Winter area. This area is a mountain catchment area, which provide most of the water in the Rhenosterkopdam. This area has a very low carrying capacity due to its sour

nature. Therefore game farming appears to be a competitive alternative for land use in some parts of Rust de Winter, however it will require high levels of expertise and capital in order to be sustainable.

2.2 RESEARCH METHODOLOGY REGARDING WATER MANAGEMENT

Introduction

The objective with this research project was to assess existing irrigation practices and equipment used by irrigation farmers in the practice of irrigation scheduling in general. This assessment aimed to establish an insight and overview into the realities of small-scale irrigation farming (human and environmental factors).

Selection of research area

Taking into consideration the natural resources of this area and the existing infrastructure, it is an area with considerable potential for irrigation as well as mixed farming (crop and livestock). In the past, previous farmers harvested reasonable yields (see Table 2.13) from crops like maize, sunflower, cotton, green mealies, groundnuts during the summer period and wheat during the winter months. Currently there are about 13-15 small-scale irrigation farmers in the Rust de Winter area who desperately try to make ends meet - some of them on a part time basis. Generally speaking, the state of irrigation farming in Rust de Winter is in many cases below standard. It must be noted that water availability is a limiting factor to the success of agriculture in the area.

With this in mind, the area was ideal to assess whether small-scale crop farmers practise irrigation scheduling and identify some of the constraints that hamper the introduction of irrigation scheduling models.

Orientation and planning

An initial visit was made to the area in the company of the local extensionists. A general impression of the standard of irrigation farming and a first hand picture of prevailing circumstances and resources were obtained through transect walks on the farms. Through this a very good idea of the changing circumstances within the area was obtained. During the informal interviews with some of the irrigation farmers it was clear that some farmers have sufficient knowledge to implement an irrigation model while other farmers will heavily rely on a "recipe", and assistance by other people or individuals.

The Participatory Rural Appraisal (PRA) approach was used to assess irrigation farmers of Rust de Winter and enable them to share, enhance and analyse their knowledge on crop practices and local conditions (Botha, 1997). Through the PRA approach a process of constructive community dialogue was designed and supported. This method was decided upon to avoid a top-down paternalism and to access informal knowledge.

The PRA approach used in this assessment is also known as Participatory Situational Analysis (PSA). Semi-structured interviews were decided to be appropriate for this appraisal, after consultation between the researcher and the extensionist. The process entailed:

- individual interviews with individual farmers during pre-visits and transect walks on three farms.
- interviews with key-informants to gather special information on the background of Rust de Winter and attempt to draw a historical timeline.
- this was followed by group interviewing of farmers to access information from this broad body of knowledge. During this exercise several diagrams were drawn, viz. mapping of the important natural resources and a social map of the different areas allocated by the five community groups.

- A Venn diagram was drawn to indicate the key organisations and groupings within Rust de Winter.
- The group of farmers thereafter drafted a seasonal calendar in an attempt to get an understanding of the seasonal activities as the community perceived them. Then the group of farmers was asked to identify the major constraints that prevent them from optimal crop production.
- These constraints were then scored and ranked by the group to indicate the prioritisation of these elements.

Choice of data gathering methodologies and data gathering

The complexity of the socio-economics and ecologically adapted crop farming demanded an action-oriented participatory research approach. Researchers are often accused of giving limited recognition of the extent and value of land users' knowledge (De Walt, 1994). PRA, according to Robert Chambers, is "to enable people to share, enhance and analyse their knowledge of life and conditions, to plan and act". The key principle with PRA is the empowerment of the local community by raising people's awareness and capacity by equipping them with new skills for analysis and problem solving.

It involves the extensive use of diagrams, permitting the visualisation of information at all times (Hilton & Young, 1998:6). Therefore, PRA is a process of transferring skills and is all about listening, observing and thinking. PRA builds on existing indigenous knowledge and the finding of an entry point for communication that fits with the specific community. In other words, communicating at their level and learning from these people about local practices and conditions.

Through the participatory approach all the persons with substantial stakes in irrigation were identified and involved. The goal of this appraisal was to identify irrigation farmers' problems in a participatory manner and also the possible collaborative solving of problems

through the generation and use of knowledge. The involvement of communities in their own problem identifying and solving also builds capacity.

The technique of semi-structured interviews (SSI) was followed. The researcher and one of the extensionists acted as facilitators and guided possible answers or solutions to questions. This facilitation role is a very important aspect, because participants were actually guided to discover answers. The methodologies and their aims were as follows:

- Individual interviews during the pre-visit and transects walked on the different farms were used as a method of gaining information of a more personal nature.
- This was followed by key-interviews with five key-informants to gather special information beforehand e.g. historical timeline, background to the Scheme and some of the changes that took place over time.
- The next step was to interview (semi-structured interviews) a group of farmers (± 15) to gather information on irrigation practices on a community level. The group interviews presented valuable diagrams through which essential information in a condensed and understandable form were gathered e.g. mapping, Venn diagram, transects, seasonal diagram or calendar and matrices where elements were ranked and scored and then prioritised. Each of the different diagrams will be discussed in detail later. The drawing of diagrams helped participants to analyse schematically and almost immediately the questions asked by the facilitator. The diagrams stimulated immense conversation amongst the participants.

This exercise, apart from giving access to a broad source of knowledge, also provided immediate means of cross-checking and evaluating the information on crop and irrigation practices, as members in the group corrected each other where necessary. The group interview also served as cross-validation of the information that was received at an earlier stage from the key-informants.

Information sources

The information sources comprised of local black crop farmers (12 farmers) farming in Rust de Winter on mixed farms comprising approximately 5 ha -137 ha irrigable land each. Crops such cotton, maize, vegetables and wheat are grown at the Rust de Winter irrigation scheme by these farmers. They are all members of the Rust de Winter Farmers Union. These farmers are mainly from the Vuka Zenzele and Manala community groups. Some of these farmers are well experienced in crop farming while others are very "new" to this type of farming. Apart from the 12 farmers, individual farmers from the Litho community group were invited, of which three attended. These three farmers are farming with crops like maize, dryland cotton and the old (existing) citrus orchards.

The five key informants who gave a background of Rust de Winter and who drew the historical timeline, are farmers (three of them) and two officials (extensionist and extension technician) responsible for the area.

The three farmers were:

Mr LC Mthimunye, member of the executive of the Rust de Winter Agricultural Cooperative (RDWAC), member of the executive of Rust de Winter Agricultural Union (RDWAU) and as private stakeholder and therefore member of the RDW Project Forum (RDWPF)

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- Mr J Mziza, executive member of the RDWAC, executive member of RDWAF.
- Mr MM Bopape, chairman of RDWPF, executive member of RDWAF, executive member of RDWAC.

Orientation of officials and committees

Extension support in Rust de Winter is assigned to the state and a private company by the name of Lohnro. A state extension technician is assigned to help Rust de Winter farmers.

Another well-seasoned and experienced state extensionist, stationed in Germiston, backs up the local technician. This extensionist visits the area twice or more as needed per week.

Lohnro focuses mainly on cotton production and apart from providing the necessary finances for cotton production, it also facilitates the provision of inputs like fertilisers, pesticides, seed, etc. Lohnro also monitors on a regular basis the expenditures as well as crop growth progress, through an extensionist based at Settlers. Scouting of cotton is also done on a bi-weekly basis and advice is given to farmers from the Vuka and Manala communities where needed. However, because of the big extension area Lohnro had to service, the state extension technician rendered help. The latter is well experienced in the production of cotton.

Another private company, Clark Cotton, was also engaged in the supporting and financing of approximately 160 ha to the Litho farmers. That was later reduced to 25 ha. Clark Cotton's intensity of servicing is not the same as Lohnro's. About all the farmers involved in this project made losses during 1997/98 season.

During 1997/98, the Pietersburg based Agricultural Rural Development Corporation (ARDC) provided wheat farmers with the necessary capital. Eight farmers participated in this project. Approximately 120 ha was planted and an average of 3,08 t/ha was harvested, with the maximum yield of 3,7 t/ha and the minimum of 2,1 t/ha. The ARDC served farmers together with the extensionist from Germiston on a very intensive basis (twice a week). Since then the position within ARDC changed and during the coming winter season (1998/99) farmers were urgently seeking for the necessary credit to finance wheat production.

The Rust de Winter Farmers Union (RDWFU) was established by the farmers in 1996, with Mr David Tauyatswala as first chairperson. The goals of this farmers' union is in the first place to unite the five community groups. The group has agreed that each group will nominate two representatives to form the executive of this Union. Meetings take place

every fortnight and the membership, which comprise of stock and crop farmers count approximately eighty-six. The main purpose of this establishment was to unite farmers in the agricultural development action and to solve farming problems. This organisation acts as the mouthpiece of the farmers when issues like for instance water aspects and allocation were discussed with the Minister of Water Affairs during 1998. This is a well-organised and properly constituted farmers' organisation which serves as an important body to make farmers' needs known to authorities and other institutional organisations. Most of the executive of this farmers' union also form the executive of the Rust de Winter Cooperative.

The Rust de Winter Irrigation Advisory Committee was formed during May 1998 with the prime goal to steer water allocation within Rust de Winter. It came about especially as an outflow of a meeting between the farmers and the Minister of Water Affairs (1998). They discussed the downscaling of the irrigation quota from 7.5 million cubic metres per annum to 1.5 million cubic metres per annum, implicating that the downsizing will be from 17875 ha to 241 ha. The Minister requested more formal and appropriate co-operation and communication channels between irrigation farmers and the Department of Water Affairs. This Advisory Committee consists of representatives of the five community groups, Mr Mthimunye (private stakeholder) and officials from Department of Water Affairs and Forestry as well as the extensionist of Gauteng Agriculture. Scheme regulations were specifically compiled for Rust de Winter and adopted by irrigation farmers. This advisory committee meets once every month.

The Rust de Winter Project Forum (RDWPF) was established during 1995 to assist the Pilot Land Reform Project in delivery of land and other development projects to communities of Rust de Winter like for example the establishment of an article 21 company, namely the Rooykop Broiler Breeder Project. The RDWPF meet every fortnight to discuss progress with land allocation, planning, etc.

A co-operative trading as Rust de Winter Agricultural Co-operative has been registered and launched during October 1998. The other registered co-operative is the Litho Co-operative Ltd. However, there is a need to facilitate the merging of these two co-operatives, since they are in the same area and working together in the RDWPF and RDWAU. Although both co-operatives are registered not one of them yet opened their doors for trading because of the lack of start-up funds.

Pilot interviews

Pilot interviews were executed to get an idea of the Rust de Winter farmers' irrigation activities. Open-ended questions concerning the irrigation activities and decision making regarding irrigation were asked and answers were written down briefly. Transect walks were made on three farms whereby an idea of the different circumstances within the area were obtained. This gave a good overview of what is happening in the field of irrigation at Rust de Winter and the possibilities when irrigation scheduling is implemented. The natural resources as well as the human potential were observed and helped to better understand the causes linked to the conditions.

Key-interviews

This pilot interviews were followed with semi-structured interviews with five key informants for the gathering of specific information about the political background, development constraints experienced and to present a historical timeline of Rust de Winter since the first invasion by black farmers during 1985. The key- informants used in this exercise consisted of three farmers and the two extensionists responsible for servicing Rust de Winter. The farmers who participated were identified and selected by both the extensionists as well as the farming community as opinion leaders within the area. They were the chairman of the Rust de Winter Project Forum, an executive member of the Rust de Winter Agricultural Union and an executive member of the Rust de Winter Cooperative. They were interviewed to submit information over a wider spectrum and also

present a historical time line through which the history, events, development and constraints were raised. A summary of the key historical events in the community and their importance regarding the current situation and circumstances were highlighted.

The discussions with the key- informants were followed with a tour accompanied by some of the farmers to three of the irrigation plots. On each of the irrigation plots a transect was walked whereby a thorough idea of the area potential (natural resources) and problems regarding crop production and especially irrigation were observed. This gave an idea of what is currently happening regarding land reform and allocation and what may happen if certain development planning and changes are executed.

Group interviews

These were followed by semi-structured group interviews with almost all the irrigation farmers (15 farmers) the following day to gather information on a community level. This gave access to a broad source of knowledge. The group interviews was first of all used to present a schematic illustration of the natural resources, residential areas, land allocation by the five groups and the drawing of a seasonal diagram. Through the drawing of diagrams the complexity of information was simplified. Participants were through this technique permitted to analyse schematically and the diagrams stimulated conversation amongst farmers. The farmers were inspired through this technique to give their opinion about certain problems experience and to categorise this opinion.

While mapping and transects are used in spatial analysis of a wide range seasonal diagrams and time lines looked at time. The Venn diagrams served an important function in analysing decision-making relationships (Botha, 1997).

Data analysis

Pilot interviews

In Table 2.8 information collected from respondents and as observed by the author are shown. The condition of the crops is reflective of the combined estimations of the crop condition, by the extensionist, the Lohnro agent and the author.

Table 2. 8: Information about the Rust de Winter farmers (March 1998)

Respondent	Tenure	Crops	Ha	Condition of crops	Age	Financial status	Level of training
1	one year contract	cotton mealies groundnuts	35 5 20	2 4 4@	52	strong	literate, well experienced
2	lease from contract holder	cotton	10	3	50	poor	illiterate, little experience
3	one year contract	cotton	10	4	47	inter- mediate	literate, well experience

(@ = needs immediate attention or serious losses will result)

Legend to condition of crops:

- 1 Very poor, massive weed infestation, very poor plant population, general condition of plants are very poor and 0-10% of the production potential will be achieved.
- 2 Not good, serious weed infestation, poor plant population, general condition of plants are poor, and about 11-30% of production potential will be achieved.
- 3 Moderate, weed infestation, plant population on standard, general condition of plants are not well, and about 31-50% of production potential could be reached.
- 4 Good, some weed infestation, plant population almost optimal, general condition of plants are on standard, and about 51-70 % of production potential could be achieved.
- 5 Very good, very little weed infestation, plant population optimal, general condition of plants are good, and about 71-100% of production potential could be achieved.

The situation at Rust de Winter is very complex with the socio-political circumstances surrounding land re-distribution. The farmers currently have lease contracts of one year only, which are too short to enable them to apply for affordable credit and therefore require revision. The farmers lack access to credit and most farming inputs, which hamper agricultural productivity in general. With this 'orientation visit' it became clear that farmers are aware of irrigation scheduling, but the majority makes use of a 'fixed irrigation' programme.

Morris & Tom (1990) described typical problems of small-scale irrigation farmers. The following problems, which are very similar to those, were mentioned during interviews with the different respondents:

- Except for one respondent with experience of cotton production, it was said openly by farmers that cotton cultivation and production is unknown. They therefore lack the required knowledge to manage this crop effectively.
- The availability of labour also seemed to be a problem. The supply is irregular and it is said to be very difficult to get workers over the festive season as well as weekends. Labour was said by all to be expensive.
- The farmers do not have sufficient access to production credit. The farmers also do have very limited cash on hand to pay labourers and serve production inputs.
- Farmers complain about the high cost of irrigation water and electricity. Respondent one indicated that his electricity bill amounts to R5000-R6000 per month. The other farmers' electricity bill was said to be about R300 each per month.
- Respondent number one did experience problems to irrigate on time because of the limited irrigation systems available; therefore the groundnuts visited were under severe stress because of drought. None of the respondents keep sufficient records of the costs of their activities, or is able to use such information for management purposes.
- Agricultural productivity at Rust de Winter generally is hampered by the lack of easy access to required inputs e.g. fertilisers, seeds, pesticides, etc. The respondents also have to hire tractors and other implements from private contractors or one of the more

privileged farmers. There was an unfortunate incident where respondents had to replant totally, because of either: the poor condition of agricultural equipment they have had to rent or due to poor utilisation of this equipment. The exact causes are unknown, but it indicates the seriousness of these constraints on productivity. Generally the agricultural productivity is said by the extensionist to be low, because of a variety of interlocking determinants.

All three respondents indicated that they irrigate on a "fixed rotational basis". They are aware of the necessity of measuring how much water they put on the crops through irrigation, but do not make use of any method in this regard. From visual evidence it was clear that some areas in some of the respondents' lands were totally below the crop requirements, while other spots showed signs of over irrigation.

Historical timeline:

The following historical timeline (Figure 2.2) were presented by the key-informants and was part of the key-interviews. Mr Mthimunye acted as spokesman on behalf of the key-informants and presented the major political background and development associated with the different historical events. This historical timeline clearly illustrated changes that involved the use of land over time since 1983, when the farms were initially purchased by the South African government off 68 white commercial farmers, with the aim of including them into the former homeland of KwaNdebele. This however never took place. According to the informants, the area was once a thriving commercial agricultural region, until the droughts of the early 1980's took their toll.

1002 1000	White former amount				
1983 – 1988	White farmers removed				
	KwaNdebele - high potential				
	Fallow irrigation scheme and infrastructure				
1989 - 1993	Still planning -forced black farmers in squatting				
	STK was farming on Rust de Winter				
	STK phased out				
	The Department of Development Aid plan for black farmers				
1994-1997	Some agreement - farmers agreed to pay. However cannot afford - yearly lease tariff				
	Presidential Land Reform Pilot Project (Gauteng)				
	Three provinces involved: Gauteng, Mpumalanga and Northern				
	Province				
	To be run by people of Rust de Winter				
	Grazing allowed on yearly basis				
	R3,5 million planning done by consultants/planning agency (Demacon) - but they ignored lessees				
	Many workshops been held with community, where proposals of the planing by Demacon were discussed				
1997	Planning presented to lessees - top-down approach				
	Problem: Year lease & finance problems for farmers				
	MEC (Gauteng) do not budget for Rust de Winter (implementation of planning)				
	Await answers from Mr Derrick Hanekom after consultation				
	between delegates from Rust de Winter Farmers Union and Director				
	General: Land Affairs (May 98)				

Figure 2. 2: Historical timeline and transect of Rust de Winter

This time line provides a better understanding of the current situation and gives important information regarding the perceptions of the key informants concerning development activities. It also provides a summary of the key historical events in Rust de Winter and their relevance to and importance for the current situation.

The key-informants also indicated that while STK was still busy planning farms during 1989-1993, various groups and individuals (like Mr Mthimunye himself) moved into the area. They actually squatted and began to lobby for formal land allocations. During 1994

the South African Development Trust Corporation was phased out, and the land was put under the administration of the Department of Agriculture. The Department of Development Aid was responsible for the utilisation of the land until the emerging farmers could be settled on the land. The planning and farming by SADT and the Department of Development Aid were clearly indicated by the key informants as a top down approach by government. It was very obvious from these interviews that farmers didn't like the approach by SADT and KAC, since planning and implementation of farming practices were carried out by the relevant institution, with farmers as passive onlookers being responsible only for payment of accounts.

During the latter part of 1994 and early part of 1995 numerous meetings took place between officials of the Department of Land Affairs and other departmental agencies in an attempt to reach a workable interim solution to the area. By then the situation became highly politicised and volatile. At this point the majority of the land were not used. A very small percentage, however, was utilised by neighbouring KwaNdebele cattle farmers and previous commercial farm labours. Little irrigation took place during that period and most of the land was used for extensive grazing.

With the establishment of the Rust de Winter Land Forum during 1995, a stage was reached when interest groups were reasonably satisfied with the proposed interim. Farmers agreed to pay lease tariffs, although they could ill afford that. During this time the Gauteng Province identified various Land Reform Projects. Rust de Winter was one. During 1995 the Minister of Land Affairs declared that the Provincial Pilot Steering Committee should take over the responsibility of the Department of Agriculture of Rust de Winter. The objectives of resettlement had now changed to accommodate disadvantaged groups and individuals in terms of RDP and Land Reform Pilot Programme Principles. The planning agency, Demacon was contracted by Land Affairs during 1996 for R 3,5 million to submit a workable development plan.

The problem with this development plan (according to the informants) was the fact that the instruction from the Department of Land Affairs to Demacon was to plan Rust de Winter without taking into consideration the present lessees. The key-informants clearly showed their antagonism against such planning done by Demacon. Several workshops were held between Demacon and the community to obtain information on the needs and requirements of the broader community. However, they still see this as a top down approach by government, especially Department of Land Affairs. They however did not see this problem as a mistake by politicians, but rather of officials from the relevant Department. The year-to-year leases were also seen as not sufficient for a farmer to farm properly and to be in a position to plan ahead.

Mapping

Mapping was used to help obtain clarity and understanding on the visions and ideas of the community, and it also contributed in the conceptualisation of problems. This exercise was done jointly by the farmers and the extensionist on a well-prepared area map of Rust de Winter. This map was drawn by Demacon, the agency that was responsible for the overall planning of Rust de Winter. With this exercise the proposed residential settlement, food plots, town and infrastructure were mapped and received a lot of attention. The respondents mapped also the current residential areas at Witlaagte (mainly Litho community), Vaalbank and the remainder of Rust de Winter town. The natural resources e.g. the soil, water, grazing, and so on were identified and illustrated. They also illustrated the allocation of land with regard to the five communities. Most of the farmers grew up in Rust de Winter and therefore are well aware of the resource potential of the area. The proposed residential settlement of circa 350 erwn led to a very active and emotional discussion and debate. The farmers are of the opinion that the proposed settlement of residents would be to the disadvantaged of farming at large in Rust de Winter.

Venn diagram

Members of all five groups in Rust de Winter were present during the drawing of the Venn diagram. The groups were asked to draw a Venn diagram to indicate the key organisations or issues within the community and their relation and significance to each other when it comes to decision-making. The person nominated by the group of farmers to represent them in this exercise was a Litho. During the discussions, therefor, a lot of emphasis was placed on the importance of the Lithos. He was nominated because he is one of few farmers with a post-school education and therefore regarded as the most appropriate person to draw this diagram. However, because he is also quite an extrovert, a lot of emphasis was placed by him on the importance of the Lithos and their right to land allocation. The Lithos are the bigger group relative to the other four communities. The spokesman was also of the opinion that the Lithos must lead when it comes to decision making with regard to Rust de Winter development. The Venn diagram was presented by means of circles, each representing one of the five communities, key-organisations or issues within the communities and their relation and significance to one another in decision making within Rust de Winter (Figure 2.3).

It was clear from the sizes of the circles that the Litho spokesperson was of the opinion that the Litho community is the most important group when decisions and planning of the area are discussed in Rust de Winter. The problems between the different communities as far as honouring of the boundaries of land allocated for leasing and future settlement were stressed through this exercise. The Venn diagram also emphasised the establishment and registering of the two co-operatives namely Rust de Winter Co-operative and the Litho Mkgundlulo Co-operative as a result of problems between the Lithos and the rest of the communities.

Legend:

- Litho's
- Manala
- KwaNdebele A
- KwaNdebele B
- Vuka

Figure 2. 3: Venn diagram as drawn by Rust de Winter irrigation farmers

This schematic illustration (Figure 2.3) also illustrated the lack of co-operation between the Lithos and the rest of the community groups in Rust de Winter. These conflicts and disputes between the different groups arose primarily over the issue of perceived power and influence. The Lithos felt that they were not adequately represented on the Rust de Winter Forum. The dispute in some instances also arose out of family and tribal feuds.

Seasonal diagram for crop production and irrigation

This technique was used to indicate the different seasonal patterns. Everything is linked to rainfall, which was indicated in the second column (see illustration in Table 2.9). The diagram also indicated patterns on a bi-weekly basis. The seasonal diagram brought about an understanding of the seasons and the general cultivation practices as the community perceived them. The local extensionist acted as facilitator in the drawing of this seasonal diagram. The most important practices concerning the production of crops within Rust de Winter as per month were indicated in column three (see Table 2.9).

Table 2. 9: Seasonal diagram on crop production and irrigation practices

Month	Occurrence of rain	Propagation practices	Relevant constraint for each month
January	X	Plant up to 15/1; Weed control; Irrigation; Topdressing; Aphids; American Bollworm	2 3 4 5 6 7 8
February	Х	Sunflowers plant; Irrigation; Soil preparation for vegetables; Weed control; Fertilising 2 weeks before plant; Butterfly on cotton (American bollworm)	2 3 4 5 7 8
March	x .	Vegetables plant; Cutworm control (cabbage; carrots, spinach, pumpkin); Topdressing 2 weeks after plant; American bollworm control; Maize: stalkborer ('chilo') control	3 4 5 7 8
April	x	Irrigation; Weed control; Cotton: harvest	3 4 5 7
May	X	Vegetables: harvest Cotton: Harvest Maize: Harvest	1 5
June		Maize: Harvest	1 5
July		Irrigation equipment ready; Credit; Soil analysis	1 5
August		Irrigation equipment ready; Credit; Soil analysis	1 5

Month	Occurrence of rain	Propagation practices	Rele		ac					t f	o
September		Seedbed preparation (plough, disc, rip); Lime; Phosphate; Wait for rain; Weed control	2		3	4	ļ	5		7	
October	x	15/10 planting date: Maize and cotton; Fertilising; weed control; Irrigation; Cutworm control	2	3	4	ı	5	(5	7	8
November	Х	Plant; Fertilising; Weeds; Irrigation; Pest control (Stalk borer ('chilo') American bollworm; Aphid, red spider mite control on cotton; Second topdressing	2	3	4	5	6	6	7	8	3
December	х	Plant; Fertilising; Weeds; Irrigation; Pest control: aphids, red spider mite American bollworm; aphids; Top dressing		2	3	4 5	5 6	5 7	8		

Legend of constraints:

1. Lack of credit

2. High input costs

3. Water not sufficient

Water expensive

Extension and advice needed

Hail and environmental factors

Labour expensive

Game

They are well aware of:

- u the importance of the correct planting time for the relevant crops
- u the possible losses when planting time is incorrect, and
- the need for a well-prepared seedbed, weed control, pest control (especially on cotton and maize), irrigation and fertilisation.

Some of the relatively "new" farmers within the group were clearly lacking the appropriate knowledge they need to manage crops effectively.

The following eight constraints in crop production were identified by the group of farmers (Table 2.10).

Table 2. 10: Elements that hamper optimal crop production in Rust de Winter

Elements	
Lack of credit.	
2. High input costs.	
Water not sufficient.	
Water expensive.	
Extension or advice needed.	
Hail and environmental factors.	
7. Labour expensive.	
8. Game	

The question was then asked by the extensionist to indicate the relevance of the identified elements of constraints in the production of crops (1-8) attached to each month of the year as illustrated through the seasonal diagram. This is indicated in column four of Table 2.9 (seasonal diagram), and does not necessarily present the sequence or importance. This is seen as a very important tool in assessment, but also in the planning, implementation and monitoring phases that may follow.

Ranking, scoring and matrices

With the seasonal diagram completed and the eight most important obstacles to optimal crop production identified, the group of farmers were asked to prioritised these elements.

A matrice was used to do scoring and ranking to uncover the individual irrigation farmer's or the group's relative prioritisation of elements that were seen as important for crop production. This technique was used to identify the key constraints or opportunities as well as understanding preferences. It not only provokes the discussion of criteria for selection, but also attempts to develop an understanding of the basis for making choices and decisions. This stimulated very fruitful discussions and was used for basic analyses.

The eight constraints (Table 2.10) were used to do pairwise ranking and scoring. With this method the prioritisation of importance of elements were measured. The results are shown in Table 2.11.

Table 2. 11: Pair-wise ranking and scoring of constraints that hamper optimal crop production in Rust de Winter

Crops	1	2	3	4	5	6	7	8	Score
1	x	x	X	X	x	x	х	x	5
2	1	X	X	X	x	x	x	X	1
3	1	3	X	X	x	X	X	x	4
4	1	4	4	X	x	X	x	x	5
5	5	5	5	5	x	x	X	x	7
6	1	6	3	4	5	x	X	x	1
7	1	2	3	4	5	7	X	x	2
8	8	8	3	4	5	8	7	x	3

The discussion surrounding these choices was interesting. Pairwise ranking was used as precursor to more detailed matrix ranking, and to obtain more detail about specific themes arising out of the group discussions. The discussion that followed was very lively.

The elements were not only ranked but also scored by the farmers, and in this way not only preferences were found, but the relative weight given to each preference was indicated through a number of counters depending on the preference. The scoring system was made clear to participants. The constraints were ranked by "rank" or " importance" from 1 to 5, with one the highest ranking and 5 the lowest. The closed scoring method was used where each element as important for crop production could be scored between one and five. This was also done for the whole matrix. Therefore the farmers expressed elements and constraints that they regarded as of particular or less importance.

The scoring by farmers and the final ranking by the farmers are indicated in Table 2.12. Farmers scored the maximum for appropriate support and extension services on a regular basis when needed. They also voiced the need that an expert is needed on a daily basis, especially to help them with the practical implementation of certain crop practices. From

the final ranking, elements like the high cost of water and the lack of credit were placed second. Table 2.12 shows that, although labour is mentioned by almost every farmer as a problem, it only ranks fourth, and high input costs of crop production ranks fifth. It also came as a surprise that the problem with game was reckoned as a bigger constraint in the production of crops than labour (ranked in the third place). The issue of water availability came third. This final ranking exercise was an eye opener for many of the participants.

Table 2. 12: Final ranking of identified constraints that prevent optimal crop production in Rust de Winter

Constraints	Farmers' score	Rank 2	
Lack of credit	5		
2. High input costs	1	5	
Water not sufficient	4	3	
Water expensive	5	2	
Extension or advice needed	7	1	
6. Hail and environmental factors	1	5	
7. Labour expensive	2	4	
8. Wild animals (game)	3	3	

The practice of ranking and scoring were generally easily understood and acted as a strong stimulant for discussion. Through the ranking exercise, discussions were opened and intense discussions followed as a result.

Crops under irrigation

Successful crop production depends on the crops' adaptability to climatic conditions and the soil quality of the area. The five most likely crops grown are: wheat during the winter months, and cotton, groundnuts, sunflower and maize during the summer months. These crops are irrigated, as the area is not really suitable for rain-fed crop production. During the 70's and 80's dryland crop production took place on a fairly large scale. However, climatic data reported indicate that this is a risky option. The following production yields were obtained during 1990/91 (SADT, 1991).

Table 2. 13: Production yields of various crops in Rust de Winter (SADT, 1991)

Crop	Yield (ton/ha)
Wheat	3,8 -4,3
Maize	5-6
Seed Maize	3,5
Green mealies	6
Sunflower	1,5
Cotton	2,5
Seed Cotton	1,5
Groundnuts	1-1,5

Groundnuts (± 30 ha) were cultivated in the Rust de Winter area and the average production yields varied during 1997/98 between 0,6-0,8 t/ha. This area is not considered as an important production area for groundnuts because of the relative high percentage clay present in the soil. Apart from the relative low production yields, farmers experienced problems with low quality products because of production practices like water scheduling. The major component of the groundnut production is traded locally. This is a traditional food item that is consumed generally by local people as a protein supplement between meals.

The Rust de Winter area has a vast potential for vegetable production because of the suitability of soils, relative mild winter, autumn and spring periods. Crops are sold mainly to hawkers from Pretoria, Johannesburg and Hammanskraal. Important vegetable crops planted are: onions, all the pumpkin crops, sweet potatoes on relevant weakly developed structure cabbage (winter and summer), carrots, spinach, beetroot, green peppers and also (on limited scale) tomatoes under drip irrigation. Average yields for most of the vegetable crops are beneath the expected potential, and mainly relate to poor production practices and general management. The absence of a clear marketing strategy hampered many of the farmers, and it was only when harvesting started that many thought about an appropriate marketing channel. At the moment two farmers are involved in such a production, with many others who are interested.

South Africa is a net importer of cotton. From this viewpoint, expansion possibilities exist in the industry. The production of cotton in South Africa will, according to expectations, within the following two to three years increase to normal production levels of 50000 tons of cotton lint. It is also expected that consumption of cotton fibre will increase due to its price advantage on non-cotton fibre. From a production point of view, cotton reveals certain qualities that make it extremely suitable for the settlement of new crop farmers. Features like drought resistance, rendering of cash income and relative favourable marketing conditions, make it suitable to fit in a farmer settlement programme. The Cotton Board initiated the Small Farmer Working Group. They took a decision that the potential of small-scale cotton farmers must increase to approximately 30% of the national cotton crop over the next ten years. This led to enormous interest by private companies like Lohnro Cotton and Clarke Cotton (Lithos) in helping the farmers with access to affordable credit.

The following tabulated information on cotton production for 1998/99 gives an indication of what the area's potential looks like. This information was part of a monthly report submitted by the extensionist during April 1999. During that period of reporting some farmers at Rust de Winter started picking, and about 30 tons of cotton had been sold to Lohnro at that stage. Some farmers experienced some hail during May 1999 which influenced the production severely.

Table 2. 14: Cotton production at Rust de Winter (1998/99)

Farmer	Planted ha	Expected yield/ha	Yield to date	Income	Loan amount	Paid to date	Remark	cs
1	15	2500	6800	18020	45000	14416		
2	5	2500	0	0	7500	0		
3	5	2500	2160	5724	15000	4579.2		
4	12	2500	0	0	36000	0		
5	5	2500	0	0	15000	0	Failed weeds	by
6	5	2500	2600	6890	7500	5512		
7	7	2500	1800	4770	21000	3816		
8	5	2500	0	0	7500	0		
9	15	2500	0	0	45000	0	Hit hail	by
10	10	2500	5140	13621	30000	10896.8		
11	5	2500	0	0	7500	0		
12	50	2500	12400	32860	150000	26288		
Total hectares	139			81885	387000	65508		
RDW Total yield expected		347500					100	

According to soil surveys, the soils available in the area have a high irrigation potential without any restriction. The soil was therefore assumed to be suitable for the establishment of orchards. Existing citrus orchards occur on some plots and these orchards were leased to local (Litho) farmers. Most of these orchards are not economically viable anymore because of neglect. The irrigation systems were neglected and are mostly in a poor condition. Irrigation takes place every third week if no rain occur during this period, and irrigation is done mainly through flood and conventional pipe system. A lack of production practices such as weed control on some plots contributed to the deterioration of trees. Tree removals and deaths in the past resulted in poor stands in some orchards. This hampers efficient management and results in uneconomic units. Pest and disease control of red scale (Anonidiella aurantii) and bud mite is done where needed.

According to SADT (1992) records there was a total of 30 ha of citrus, consisting of 5463 Valencias, 1134 Navel and 329 Naartjie trees (total 6926 trees), in 1990. All citrus trees are presumably on rough lemon rootstock and are between 10 and 36 years old. Some of the orchards are garden plots rather than commercial units. The areas around Moloto and Groblersdal are well known for the production of peaches and citrus respectively. The availability and quality of irrigation water may hamper the long term practice of this enterprise. Research has proven that a significant interaction exists in the case of citrus between tree age and size, irrigation management and yield curves. There is a direct correlation between water usage of a mature citrus tree and fruit growth. Correct irrigation practices are therefore of the utmost importance to ensure a constant fruit growth pattern, production of large fruit and optimal utilisation of irrigation water. Water supply is important during the early spring period when fruit set occurs, soils are still cold and low humidity conditions prevail.

Methods and types of irrigation

Short-furrow flood irrigation

Some of the Litho farmers are making use of short-furrow flood irrigation systems, where water flows by gravity from balancing dams. The biggest practical problem experienced by these farmers are that serious leakages occur in most of the dams and that the slope of the field does not suit the layout of such a system. The main drawback with local flood irrigation is that air is expelled from the soil when water fills the pores and it takes several days before plant growth resumes because of waterlogged conditions. The most serious danger of this practice is the formation of saline conditions, and taken into account the relative low quality of irrigation water in Rust de Winter, this practice is not recommended. Some of the farmers see this as viable and it seems to be popular because of its manageability and maintainability without sophisticated equipment.

Conventional manual sprinkler systems

Conventional manual sprinkler systems consisting of lateral pipes and sprinklers are borrowed from the Department of Agriculture by all the irrigation farmers. Apart from problems experienced by farmers to make use of an appropriate pump (usually too big or else too small for the required area to be irrigated), about 90% of the farmers are equipped with systems consisting of a mixture of low, medium and high pressure sprinklers. Therefore the discharge rate, uniformity of water application of particular sprinklers, water drop size and spray distribution differs between different sprinklers due to nozzle diameter and pressure. Very commonly found are sprinkler lines which extend beyond their designed lengths and sprinkler nozzles that are not replaced when required. Irrigation farmers in general do not like the use of portable systems, because of chronic labour shortages. Apart from the above, labour is relative expensive. This type of irrigation system demands good management to ensure even and sufficient water application over the entire field.

Centre pivot systems

During 1994 KAC reported that the total area identified for irrigation was 1338 ha, consisting of 747 ha moveable centre pivots and 591 ha conventional sprinkler irrigation. Those were divided between 39 farming units. About 21 centre pivots were purchased by SADT from previous owners after their departure. Only one or two are in use today, and the remainder is in a state of disrepair. The one centre pivot system (60 ha) currently in operation covers an area of \pm 110 ha because it can also be moved to an alternative position. Most of the remaining centre pivots are in a very bad condition and need considerable repair to make them operational again. Some of the centre pivots installed in the past by commercial farmers cover different soil types, with the result that optimal production practices like fertilisation, irrigation and soil preparation practices are not possible. The number of centre pivots on Rust de Winter as counted in 1994 is shown in Table 2.15.

Table 2. 15: Number of centre pivots installed and in operation at Rust de Winter during 1994 (SADT)

Area covered per centre pivot (ha)	Centre Pivots purchased by SADT from previous owners (1991)	Total Area (ha)
13-20	5	89
21-30	4	106
31-40	4	146
41-50	0	0
51-60	3	162
61-70	0	0
71-80	1	72
81-90	3	256
91-108	1	108
Total	21	939
Average per pivot (ha)		45

Computers and irrigation scheduling at Rust de Winter

Farmers have very limited cash on hand and therefore only one farmer uses a computer on his farm for the record keeping of a stud beef herd and general management of the farm. He also makes use of "fixed programs" submitted by experts to irrigate his cotton and other crops like maize, vegetables and groundnuts underneath a centre pivot and with conventional manual sprinkler systems. Apart from this one private computer, the extension technician based at Rust de Winter has a computer, which is used to serve farmers, especially with budgeting of crop production.

The rest of the crop farmers irrigate on a "fixed programme" submitted by an expert on a specific crop, like for instance Lohnro or the extensionist from the government.

2.4 RESULTS OF THE NEEDS ANALYSIS OF RUST DE WINTER IRRIGATION FARMERS

The following needs were identified from the interviews held with key-informants and a group of irrigation farmers from Rust de Winter.

Needs emanating from the historical transects

The year-to-year leases are not sufficient for a farmer to farm properly and to plan ahead. They want to know from the Minister of Land Affairs when they can buy land and at what price. Authorities complain that farmers do not pay their leases, but they never hear what the price of land is. The farmers want longer leases (\pm 5 years) so that they can farm properly and get the necessary finance.

The one key-informant pointed out that the Department of Land Affairs should ensure that "the right jockey is on the right horse," namely that the right person is buying the land. Five-year leases could be awarded, and used as a test period. The current lease amount of R8/ha, which is accepted to be below market, cannot be afforded by most of the lessees. This is because of the fact that many farmers (± 101 lessees) are currently leasing land, but are not actually farming because of major constraints such as the affordability of finances.

The key-informants indicated that there are problems surrounding this project straddling two provinces. According to the farmers there does seem to be significant difference between the contribution made by the Gauteng provincial government and that of the Northern Province. This has not affected the pace of planning work to date in Rust de Winter, but is likely to become a problem when the provision of extension and support services to beneficiaries is arranged. Of particular concern to the farmers are the current provincial rules, which prevent the spending of money across province borders.

The Pilot District office responsible for the allocation of land is situated in Pretoria, which seem to hamper clear communication. Many of the problems expressed by farmers in Rust de Winter is because of decisions taken in Johannesburg and Pretoria, without appropriate consultation of farmers in Rust de Winter. This oversight will become even more important as implementation phases draw near.

"Top-down" externally managed systems (like those of SADT, KAC and now the Demacon projects) are unacceptable to farmers. Farmers have made this very clear. High political and social costs are involved when farmers play only a passive role on irrigation projects (Bembridge & Sebotja, 1992). Farmers want some decision-making power and freedom of choice regarding the overall planning of Rust de Winter.

Farming practices with specific reference to irrigation

A wide spectrum of crops are indicated in this document to be adapted to Rust de Winter and pending on the entrepreneurial skills, appropriate marketing channels and strategy applied, farmers are in the position to make good profits from farming in this area. The fact that water availability is limited makes this an important factor to the success of agriculture in the area.

Some of the Litho farmers make use of flood irrigation systems. The biggest problems are serious leakages in the balancing dams and the fact that the slope field conditions in most instances do not suit the layout of such a system. With the relatively high running costs of water, this system is not recommended. It is, however, manageable and relatively cheap since it requires little permanent infrastructure. The soil characteristics of Rust de Winter may lead to serious saline conditions when flood irrigation is practised.

Many of the farmers make use of manual conventional manual sprinkler systems that are borrowed from the Department of Agriculture. Unfortunately the majority of farmers are equipped with systems consisting of a mixture of low, medium and even high-pressure sprinklers. These systems are not owned by the farmers, so maintenance is very poor. Therefore, apart from over- and under irrigation and resultant yield losses, increased power consumption (electricity) was mentioned as a problem by many farmers. The nozzles in many cases are worn to such an extent that double the designed application rate is applied. In cases where farmers do replace nozzles, they do it with any size nozzles which they can find. In many cases farmers have sprinkler lines of up to 150-200 m. This exceeds the designed length parameters. Farmers accepted the fact that a certain stand time according to the delivery requirements of a particular system is needed, yet then often change to longer night and shorter day cycles. This is mainly the result of the limited number of laterals available per farmer. Therefore laterals need to be repositioned from one area to the next. The laterals need to be disconnected from the mainline and drained before they can be repositioned. During the night time this does not happen, which makes irrigation cycle duration longer. A common fault often found amongst the farmers is that, because of limited equipment, spacing between the layouts is erroneous.

One farmer who is currently using a centre pivot, is making use of a moveable system (60 ha). This farmer rarely entertains the idea of reverting to other types of irrigation systems because of the big advantages included as far as labour is concerned. Although he is aware of the mechanical deterioration because of this practice, he does not have another option. All the farmers are making use of a "fixed program" according to the crops they cultivate, and little or no measurement take place. With this practice it is also common to find certain spots that are over or under irrigated. Many farmers, especially in the beginning phases of farming, seem to apply much less water than what is recommend for optimal application. This may be the correct recommendation when lower planting densities were planted, and may be an option to consider in future.

Agriculture productivity in Rust de Winter is hampered by the fact that only a few farmers own tractors or implements. Farmers make use of contractors or more privileged farmers to prepare their seedbeds. But, because of the time constraints in the beginning of a season, usually problems with either seedbed preparation or the planting of a crop are experienced.

During 1998/99 two farmers had to replant because of incorrect planting (too deep) of cotton by the contractor. This is not only to the financial disadvantage of the farmer but also demoralising. The general seedbed preparations consist of ploughing, disc and then planting of the specific crop phases.

Some farmers converted their conventional sprinkler system to fertigate their crops, because of the relative shortage of labour and also the high cost of the latter. This system is commonly used for topdressing of wheat, maize and cotton.

The crop seasonal calendar and irrigation

From the information obtained through the seasonal diagram, it was clear that the farmers regarded extension support as the most important element needed to succeed in crop production and to ensure sustainability. For a very long period the extension service was very weak in Rust de Winter and dealt primarily with the administration of leases. Extension services must be made answerable to the community they are assigned to serve.

Important for this study is the fact that farmers regarded both the cost of water and availability of water as very important and indicated 67% applicability of these elements during the season. This means that for 67% of a year both are relevant to decision-making processes of crop farmers. The farmers are well aware of the fact that water availability is a major problem in Rust de Winter, especially so after discussions with the Minister of Water Affairs. Although the water tariff applied in Rust de Winter is at a high concessionary rate of 6,6c/m³ compared to 65.6c/m³ at Riet River, the cost of water is still regarded by crop farmers to be relatively high in comparison to the rest of the inputs regarding crop production. Together with the water tariffs and water availability, the group indicated that labour at Rust de Winter is relative expensive. Apart from labour cost, the availability of local people to work on the farms was raised as a major problem.

Other elements, like the problem with game especially damage during the winter season by kudus and warthogs was awarded a relevance of 58%. High input costs were identified to be relevant for 50% of the year, especially during the months when crops were planted and seedbed preparation, etc. needs attention. Lack of credit and environmental factors (like the occurrence of hail) were indicated to be relevant for 33 % percent of the time. This exercise helped farmers to realise that although lack of credit and high input costs are very relevant factors to be kept in mind by every farmer involved with crop farming, elements like the correct water usage and importance of the necessary support services is of absolute crucial importance.

The seasonal calendar indicated that farmers do have some level of knowledge to farm. However, despite their knowledge, they do not apply it. The overriding reason is the fact that most of the farmers do not have money on hand and they have to make do with what they can afford to purchase.

Perceived constraints

Farmers ranked the eight perceived constraints that hamper optimal crop production in the following order of priority (Table 2.16):

Table 2. 16: Final ranking of the eight perceived constraints that prevent optimal crop production

Constraints	Ranking
Extension or advice needed	1
2. Water expensive	2
3. Lack of credit	2
4. Water not sufficient	3
5. Game	3
6. Labour expensive	4
7. Hail and environmental factors	5
8. High input costs	5

The availability of the necessary support and extension services, which include wise use of water, is seen by all the farmers as essential to ensure sustainable development and maintenance of Rust de Winter. The farmers expressed their need for irrigation specialists (e.g. irrigation engineers) who can give them technical advice.

Although farmers are aware of the availability and cost of water (Table 2.12), they can not afford high tech irrigation scheduling models. Most of them are aware of the necessity to measure how much water they irrigate, but do not make use of any method to effect it. None of them were able to tell the water needs of different crops, nor how much water they apply in a month or season. They expressed their needs as follows: "... we are able to observe the critical stages when plants need water with an experienced eye and then irrigate according to the available soil water capacity and needs of the crops".

Access of affordable credit is a major factor to ensure that a project like Rust de Winter will continue. Farmers indicated that the steps currently being taken by the Minister of Land Affairs and Agriculture (to establish a state supported credit facility) are not in operation yet. Furthermore, the interest rate of 19-23% mentioned by the Land Bank was perceived as much too high for farmers to purchase land, or for production capital. A preferential interest rate, said farmers should be negotiated as an interim arrangement with commercial financial institutions. Thereby a portion of the risk associated with lending to land reform beneficiaries (like the farmers at Rust de Winter) could be underwritten by the state for a period of time.

Labour was said on many occasions during this assessment to be very expensive. The daily rate for labourers is R15/worker/day and R35/day/tractor driver, inclusive of food. Labourers usually come from adjacent areas and not from Rust de Winter itself. The reasons are unknown, but one respondent said: "the local people are too lazy to work the lands. We have to get workers from elsewhere." The availability of labour also seemed to be a problem. The supply is irregular and it is said to be very difficult to get workers over the festive season as well as weekends. Apart from those problems, the government is

involved with a project where waterway invader plants (rivers and adjacent areas) of Rust de Winter are eradicated. The current salary paid to these labourers are R30/day (twice the rate for farm workers) and R50/day for field managers. As could have been expected, many of the farm workers had left to join the State project, which left farmers with serious problems.

2.5 CONCLUDING COMMENTS AND RECOMMENDATIONS

The most important skills that are required in supporting small scale farmers are "people skills". It is important for field staff to be able to understand the management of natural resources, yet they should also have good people skills. Ground level support for the implementation of sustainable irrigation practices and the sustainable use of water is very important. Consultants are very expensive and can be only assist for a limited period of time. Properly structured and accountable extension services and support are needed. It became evident from this survey that the farm workers who were left behind after the commercial farmers had left, have poor farming skills and require basic training. Farming skills, adult education, and financial and marketing skills are important and need to be addressed at Rust de Winter.

The provincial government has proposed a demonstration farm. Thereby efficient and profitable farming systems could be demonstrated in close proximity to the farmers. Here, the suitability of applicable irrigation systems could be demonstrated. This could also help with the identification, adaptation or development of appropriate farming technologies for Rust de Winter. There is a dire need for hands-on, on-farm practical training of irrigation farmers at Rust de Winter. This could be done through the involvement of farmers and their organisations in the planning as well as the development of training strategies.

No recommendations regarding an irrigation model and the use thereof is possible without determining the growers' management potential. This includes the following:

- Irrigation management: use and maintenance of equipment, design and installation of equipment, understanding of irrigation, attitude towards water management, applicability of irrigation methods, scheduling practices.
- Crop profit potential: soil suitability, climate suitability, crop yield, production costs, gross margin potential, market and rate risks, production risks
- General management of a farm
- Labour management: labour situation, attitude towards development actions, training inputs, labour efficiency

Farmers indicated their intention to try out irrigation scheduling on Rust de Winter. However, taken into account all the other constraints (socio-political constraints and in particular land allocation) mentioned in this report, scheduling of water is not high on farmers' priority lists. It also became very clear from this assessment that intensive support regarding irrigation through technical staff who are familiar with the conditions of Rust de Winter will be needed. During the initial stages a well-trained consultant or extensionist should render this service. It is important that the identification, adaptation or development of appropriate technologies for a specific area must be undertaken together with the relevant beneficiaries.

From this survey with the farmers of Rust de Winter, primary factors affecting the sustainability of similar irrigation schemes and land reform projects were identified:

- broad community support for the whole process
- a viable and practical implementation plan
- a careful balance between the availability of, and demand for water
- correct prices attached to land (both purchase and lease) and water resources
- skills development of all participants (farmers and non-farmers) to enable them to take advantage of opportunities presented by economic growth
- access to affordable credit
- long term, close proximity, extension and support services

Some of the above factors are interrelated and in isolation they would make little sense. For example, available credit without skills development may result in financial liquidation. Similarly, having skills developed and being trained in new innovations like for instance irrigation scheduling, without the necessary financial resources could lead to frustration and disillusionment.

2.6 REFERENCES

BEMBRIDGE, T.J. & SEBOTJA, I., 1992. A comparative evaluation of aspects of the human impact of three irrigation schemes in Lebowa. S.Afr. J. Agric. Ext. 21: 30-41

BOTHA, C.A.J., 1997. Communication for development focused on agriculture. Workshop Material and Guidelines, University of Pretoria.

DEMACON, 1996. Land reform pilot programme. Preservation to Provincial Steering Committee.

DE WALT, B.R., 1994. Using indigenous knowledge to improve agriculture and natural resource management. *Hum. Organiz*, 53: 23-31.

ERASMUS, J.F., 1981. Rainfall deciles for Transvaal Region SIRI Report No GB/A187/18. Soil and Irrigation Research Institute.

HILTON , R. & YOUNG, D., 1998. Agriculture and natural resources series: Working Papers in Development. London.

MORRIS, J.R. & THOM, D.J., 1990. Irrigation development in Africa. Westview Press, Boulder, San Francisco.

RUST DE WINTER DEVELOPMENT COMPANY (PTY) LTD., 1995. Minutes of the Board Meeting held on the 1995 at Rust de Winter.

SADT, 1992. Economical and Physical Planning of the Rust der Winter farms. A preliminary report

SCOTNEY, D.M. (Convenor), 1987. A system of soil and land capability classification for agriculture in SATBVC states. Unpublished report, Dept of Agriculture and Water Supply, Pretoria.

CHAPTER 3

IRRIGATION SCHEDULING AT THE RIET RIVER IRRIGATION SCHEME: THE PERCEPTIONS AND ATTITUDES OF RIETRIVER IRRIGATION FARMERS

3.1 INTRODUCTION

The great depression experienced during the 1930's, together with the coinciding drought gave a sudden impetus to the development of several labour intensive state irrigation schemes that were substantially subsidised by the Department of Labour. Schemes such as Boegoeberg, Pongola, Vaalharts, Riet River and Boskop were used to provide employment for destitute whites. Farmers with known farming experience, often from drought stricken areas, ex-servicemen and elderly people were allocated plots or smallholdings on those schemes.

In January 1946 the Government settled the first 26 ex-servicemen from various branches from the army on a trial basis at the Riet River Irrigation Scheme. The first person to be settled on the scheme was a captain Van Rooyen, while the first superintendent was a Mr Wasserman. In May 1946 14 additional people were settled on a trial basis.

Some of the ex-servicemen were married to British women from the heart of London. They could not speak Afrikaans and had no knowledge or experience of farming. One could assume that they would not be able to adapt to the new way of life but apparently they were all settled personally after the first probation year was completed.

After the 1948 Government elections more farmers were settled on the scheme. At that stage the settlers encountered numerous problems and realised that the infrastructure and facilities on the scheme were mostly inadequate. Because of these circumstances a local

Farmers' Association was formed to address the local problems and inadequacies which they experienced at that stage.

The following were some of the major issues of concern:

- The lack of a good road system was a serious problem for the settlers. There was a need for a road from Bloemfontein to Petrusburg and from Koffiefontein and Jacobsdal to Kimberly. In order to accomplish this it was necessary to build a bridge over the railway line to Kimberly. The present Nico Smit Bridge had to be raised slightly.
- There were no marketing facilities and there was an urgent need for a co-operative to provide a marketing function for agricultural produce.
- Telephone services did not exist and they also required electricity on the scheme.
- In addition public transport proved to be a serious problem as there was only a railway bus service once a week.
- It also became evident that provision would have traditional water supplies for agricultural development on the scheme.

From the above it is clear that many problems were encountered which inhibited the normal development and functioning of the irrigation scheme.

The members of the Farmers' Association found themselves more involved in trying to solve administrative problems than with their own agricultural production activities.

It would appear that from the outset of the irrigation scheme, the local community generally experienced great financial difficulties. For the benefit of the most needy people in the community a few ex-servicemen initiated some fund-raising schemes which included concerts and also horse racing. The proceeds derived from these functions were made available to the poor people on the scheme (Nel, 1999).

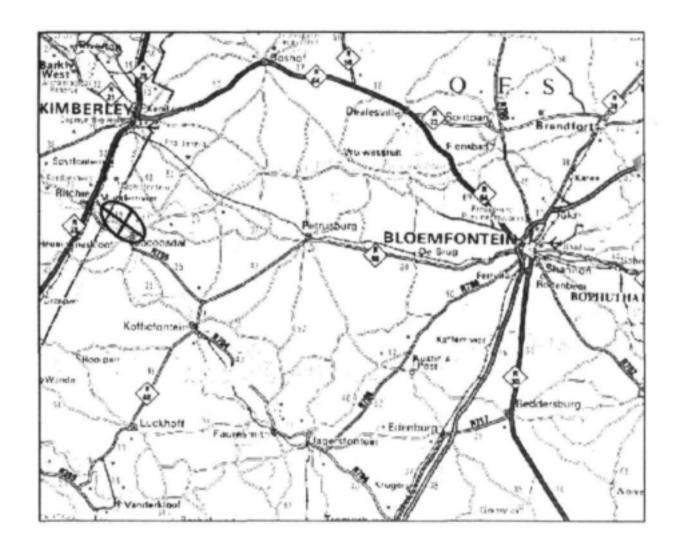


Figure 3. 1: Location map of Riet River Irrigation Scheme

In the late 1970's and early 1980's vast areas of the country were subjected to severe drought conditions. The Government initiated several drought relief schemes for the survival of the farming population. The Deputy Minister of Agriculture (Sarel Hayward) at that time was most concerned about the conditions at the Riet River irrigation scheme. Officials from the Department of Water Affairs also informed him that the Kalkfontein Dam could no longer provide sufficient water to satisfy the requirements of the Riet River scheme. It was also brought to his attention that in the initial planning of the Orange River Project, provision was made for the construction of a canal from the PK le Roux dam to the Riet River. Due to a shortage of funds this was however, not a priority. The Department had also received numerous requests for assistance from the Riet River Farmers' Association and Regional Development Society (Nel, 1999).

After Sarel Hayward became Minister of Water Affairs in August 1982 he left no stone unturned in his efforts to assist the Riet River Irrigation Scheme farmers. Through his efforts Cabinet approval for the construction of the canal from Van der Kloof Dam to Riet River Irrigation Scheme was obtained in March 1983. Construction commenced immediately thereafter and was completed on 15 March 1987. It was generally accepted that, because of the major role that Sarel Hayward played in the development of the canal, it would initially be called the "Sarel Hayward Kanaal". The name of the canal has subsequently been changed to the "Oranje Riet Kanaal".

Soil types of Riet River Irrigation Scheme

Two soil types are found on the settlement. The road between Jacobsdal and the Modderfontein Railway station forms the boundary between these soil types. The area between the river and the road composes heavier alluvial soil with a grey colour and there are sporadic signs of salinity. On the other side of the road the soils are mainly of a red sandy nature on a lime layer. These sandy soils vary in depth and are also very subject to severe wind erosion, which causes a major problem in crop production on the irrigation scheme.

From trials conducted at the Riet River Agricultural Research station it was established that soils were generally deficient in nitrogen and phosphorus.

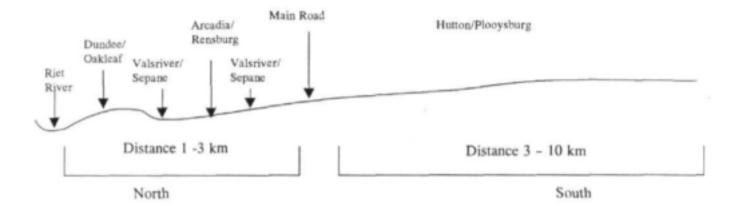


Figure 3. 2: A schematic presentation of toposequence of soils of Riet River Irrigation
Scheme

Figure 3.2 gives a schematic distribution of the various soil types which are found at the Riet River Irrigation Scheme.

Climate of Riet River Irrigation Scheme

Rainfall

The Riet River Irrigation Scheme falls within an area with a very low rainfall and the average precipitation is approximately 300 mm p.a. The area has pre-dominantly summer rainfall, with precipitations that vary from thunderstorms with high intensity and run-off to gentle rain of a few millimetres. Rain usually occurs during the months of October to March. During these months an average precipitation of 48 mm per month or more is normally recorded (Table 3.1). Rain also occurs during the other months of the year. The average rainfall for these months is approximately 10 mm p.m., which hardly benefits plant production. Rainfall distribution and evaporation rates are such that rain-fed crop production is considered non-viable, because of the low precipitation.

Table 3. 1: Average rainfall for Riet River Irrigation Scheme

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainfall/mm	40.9	62.7	58.2	25.4	5.4	5.3	6.4	6.5	16.4	42.7	39.1	45.7

Temperature

According to the data reflected in Table 3.2 the summer months can be considered hot and the winter months cold. The average, minimum and maximum temperatures are given in degrees Celsius in Table 3.2.

Table 3. 2: The average, minimum and maximum temperature for the Riet River Irrigation Scheme

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Maximum temperature	34.2	32.1	30.2	26.3	23	18.9	19	22	26.4	28	30.5	32.8
Minimum temperature	17.8	16.9	14.4	10.1	6	0.8	0.1	2.7	7.6	11.1	13.9	15.8
Average temperature	26	24.5	22.3	18.2	14	8.8	8.5	12.3	17	19.5	22.2	24.3

High temperatures may occur during the summer months and the highest temperature recorded was 41.5°C. The winters are relatively cold especially the nights and the lowest minimum temperature recorded is -80°C. Frost is a general occurrence. The earliest date of frost is 25 April and the latest date of frost is 13 September. The mean numbers of days with frost is 216 day.

During the summer hailstorms do occur and serious crop losses have been encountered in this regard.

Transport

The Modderfontein Railway station on the mainline between De Aar & Kimberly was well situated to be of great benefit to the settlers. Unfortunately it was an old station and did not keep up with modern developments and was therefore unable to provide satisfactory services to the local people. In March 1953 the Modderfontein Railway station handled the following products.

Lucerne	8977 ton
Potatoes (seed)	1652 ton
Potatoes (market)	659 ton
Vegetables	381 ton
Wheat	354 ton
Fruit	80 ton
Groundnuts	32 ton
Peas (seed)	12 ton

SAR also provided a road-motor service between Koffiefontein through Jacobsdal to Modderfontein station and back to Koffiefontein twice a week. This service also provided an efficient service to the local farmers.

At this stage many of the farmers (settlers) had their own form of transport i.e. lorries, tractors & trailers to handle their own produce.

Crop production

According to the findings of Gertenbach (1953) by the end of March 1953 approximately 780 ha were utilised for crop production. The following crops were produced and the areas under cultivation are also indicated.

Wheat

324 ha

Lucerne

270 ha

Potatoes 157 ha

Groundnuts 12 ha

Peas 10 ha

Maize 8 ha

At that stage potatoes proved to be the major crop as far as income was concerned. It comprised approximately 60 % of the total income of crops sold on the settlement. This area was initially earmarked for the production of seed potatoes for the needs of the rest of RSA. The Riet River Research station was incorporated for this function. The quality was excellent and competed favourably with the best in the world at the International Show held in the Argentine 1952. Seed potatoes were also exported to countries like Uruguay and Madagascar.

The total water requirement and the frequency of application are closely associated with rainfall, type of soil and temperature. Trials in this regard were conducted at the Riet River Research station. It was found that there was an increase in lucerne production when two applications were made instead of one using the same amount of water. When one application was made the application of more than 120 mm was not effective. This means that excessive application of water on this scheme was not beneficial (Gertenbach 1953).

At that stage there was a tendency of heavy application of water and waterlogging was a frequent occurrence especially in the low-lying areas. The water-table rose and officials from the department felt that this was an issue of great concern for the future of the settlement (Gertenbach 1953).

Lucerne was grown on the heavy soils situated close to the river and yields of up to 2 tons per cutting were achieved and six cuttings per season were made.

Wheat was the main winter crop and was used in rotation with potatoes and lucerne.

In the early 1950's ealworm infestation was identified as one of the most serious problems facing the future of this scheme as a potato producing area. Potato production was then confined only to new land or when land had been rested for a period of 5 years and longer.

3.2 RESEARCH METHODOLOGY REGARDING WATER MANAGEMENT

Introduction

This chapter outlines the methodology adopted to investigate the various interacting groups of factors which determine the success of irrigation systems, including the physical, human and institutional aspects. The selection of study area, orientation and planning of the survey, sources of information, questionnaire design, sampling and interviewing procedure and analysis of data are discussed.

Selection of research area

The PUTU and BEWAB irrigation scheduling models were designed and tested by J. de Jager and A. Benny respectively. These models were initially introduced in 1989 on a large scale to the Riet River Irrigation Scheme (Van Rooyen, 1989). A conceptually complete evaluation of the impact of these models requires that information be collected in order to assess the current situation. Furthermore, it was anticipated that the Riet River Irrigation Scheme was easily accessible to researchers and that they would have free entry to, and the co-operation of the irrigation farmers in collecting the data.

Orientation and planning

The planning of the study commenced in February 1999 and took approximately two months to complete. A personal visit was made to the research area.

The purpose of this preparatory stage was to obtain a clear picture of the farming situation in the area selected. During this period discussions were held with various government officials, irrigation farmers and members of the Southwest Co-operative connected with the development and management of the settlement. At the same time a complete list was compiled from the local records of all the landowners, which was used for the selection of a random sample.

Sources of information

Following the orientation phase it was decided to use two basic sources of information, via library research, which included a range of research, reports articles in journals and local sources. Demographic information on individual farmers, such as age, education, size of farm, communication and participation were not available and had to be obtained from the irrigation farmers themselves. Little was known about the personal and socio-psychological factors, which form an important aspect of this investigation.

Orientation of officials and committees

Before the investigation commenced the research procedures and questionnaire used in the study were discussed with government officials at all levels, members of the local farmers' association and members of the Southwest Co-operative. The person in charge of the Riet River Research Station (Mr Wimpie Mareè) is very familiar with the activities and management of the settlement, agreed to assist with the survey.

He initially accompanied the chief researcher when the survey commenced during the first week of March 1999. During this period he was able to familiarise himself with the content of the questionnaire as well as the correct procedures involved with interviewing.

Questionnaire objectives and design

Objectives

A questionnaire method for the collection of data formed the basis of the study. Separate questionnaires were used for the irrigation farmers and other officials involved with the irrigation scheme. The main objectives of the questionnaire for irrigation farmers were:

- To assess the perception of the settlers regarding the practice of irrigation scheduling in general.
- To determine the human and environmental factors which influence the acceptability of the irrigation scheduling models.
- To determine the specific human and environmental factors which influence the implementation of the irrigation scheduling models.

Design

The questionnaire for farmers provided the main body of information concerning the impact of irrigation scheduling at the Riet River Irrigation Scheme. Information was collected on the following aspects:

- demographics of respondents
- irrigation at Riet River an overview
- perceptions of respondents towards irrigation scheduling
- perceptions of institutional factors and their influences
- knowledge of respondents required for irrigation scheduling

Most questions were open-ended which allowed the respondents to motivate their replies.

The questionnaire for officials working on the settlement was concise. The purpose of this questionnaire was to obtain their views on the irrigation scheme concerning the socio-economic conditions, agricultural practices and current extension methods used.

An individual's age is one of the most important factors pertaining to his personality makeup, since his needs and the way in which he thinks and behaves are all closely related to the number of years he has lived (Smith & Zopf, 1970, Lombard, 1994 and Kinsey & Binswanger, 1993).

Increased production in agriculture and an improved standard of living from the farming population is achieved by the introduction of improved crops, inputs and methods of cultivation within an appropriate institutional environment (Lundahl, 1979:457). Lundahl (1979) continues by stating that these changes do not take place automatically, but that they are controlled by human action. Human behaviour therefore needs to be altered too, and this is where education plays a vital role.²

The survey

The field research was planned over a period of one month, which commenced on March 1999 and was completed at the end of that month.

During each interview the researcher explained to each respondent what the purpose and objective of the investigation was. Good human relationships evolved throughout this investigation.

Reliable data was obtained by observation and where possible, fields were visited to assess the condition of the crops and crop management in general.

Botha & Lombard (1991), Kinsey & Binswanger (1993) and Sartorius von Bach et al., (1993).

Sampling procedure

A complete list of landholders on the irrigation scheme was compiled from available information derived from local government officials. It was also possible to obtain a list of landholders who were practising irrigation scheduling under the guidance of an irrigation consultant.

There were 49 landholders on the irrigation scheme of which 16 practised irrigation scheduling under the control of the irrigation consultant from Northwest Co-operative. It was decided to include all those practising irrigation scheduling in this sample, while 28 were selected randomly from the other non-scheduling group. In deciding on the sample size, the cost, as well as time and staff available were of necessity more overriding factors.

Interviewing procedure

The purpose of the investigation and the questionnaire in particular was fully explained to the respondents. Generally, the questions were easily understood and readily answered.

However, due to the intensive nature of the farming system that is normally practised on irrigation schemes, it was a rather time consuming exercise to work out a programme for the interviews. In many instances it required several visits to respondents to find them at home and available for interviewing. Ultimately, 15 of the 16 respondents who were practising irrigation scheduling, and 28 of the 35 non-irrigation scheduling respondents were successfully interviewed.

The questionnaire for the officials were handed out to them, after which these were completed at their own time and returned to the researcher.

Data analysis

Questionnaires were checked and coded for analysis. Frequency distribution tables were compiled for the important variables. To test perceptions on certain issues a scale was used from 1 to 10 where one was a negative value and 10 a positive value. Sophisticated statistical analysis was not considered necessary for this type of investigation.

3.3 DEMOGRAPHIC PROFILE OF RESPONDENTS AND IRRIGATION SCHEDULING

Age and irrigation scheduling

The age distribution and irrigation scheduling of the respondents is shown in Table 3.3.

It was found that the respondents were very evenly distributed within the different age groups. The majority of respondents (69.9%) were in the age group of 21-50 years and only one respondent (2.3%) was older than 60 years.

From the findings of this study it is clear that age does not appear to be an inhibiting factor for the adoption of modern agricultural technology such as irrigation scheduling. There are adequate theoretical grounds for expecting the younger members of the social system to be more innovative (Crouch & Chamala, 1981).

Table 3. 3: Age distribution of respondents and irrigation scheduling at Riet River Irrigation Scheme (1999) (N = 43)

	Scheduling (N	= 15)	Non-scheduling $(N = 28)$		
Age groups	Number of respondents	%	Number of respondents	%	
< 30	4	26.6	5	17.9	
31-35	0		2	7.1	
36-40	3	20.0	5	17.9	
41-45	0		5	17.9	
46-50	3	20.0	2	7.1	
51-55	2	13.3	6	21.4	
56-60	3	20.0	3	10.7	
61	0		0	0	
Total	15	100	28	100	

From Table 3.3 it is evident that there were no apparent differences in the age distribution of those respondents who were doing irrigation scheduling and those who were not.

Educational level of respondents and scheduling

The educational qualifications of the respondents and irrigation scheduling are presented in Table 3.4.

Table 3. 4: Educational level of respondents and irrigation scheduling at Riet River Irrigation Scheme (1999) (N = 43)

	Educational level	Scheduling (N	15)	Non-scheduling (N = 28)		
		Number of respondents	%	Number of respondents	%	
1.	Senior Certificate	3	20	5	17.9	
2.	Post Matric (Agric)	6	40	12	42.8	
3.	Post Matric (Commerce & Industry)	2	13.3	1	3.6	
4.	Technical training	4	26.7	10	35.7	
	Total	15	100	28	100	

It was found that 41.9% of the respondents had obtained a Post matric qualification in the agricultural field. A further 39.5% had obtained Post Matric qualifications in Commerce & Industry as well as Technical training. This means that 81.4% of the respondents have obtained a qualification higher than Senior Certificate. One must keep in mind that the relationship between education and farming progressiveness has been studied by numerous researchers and that in general, the beneficial effect of higher education on farming progressiveness and efficiency has been established. Table 3.4, however, shows no significant differences in education levels between the respondents who schedule and those who do not.

Vocational training

Only eight respondents (18.6%) had no vocational training other than a Senior Certificate. According to Lipton (1977) research has shown that farmers with some form of vocational training are likely to be more progressive farmers than those with no vocational training.

Farming experience and irrigation scheduling

Table 3. 5: Farming experience and irrigation scheduling of respondents at Riet River Irrigation Scheme (1999) (N = 43)

Number of years farming	Scheduling (N = 15	Non-scheduling (N = 28)		
experience	Number of respondents	%	Number of respondents	%	
1-5	4	26.7	5	17.9	
6-10	5	33.3	6	21.4	
11-15	0	0	3	10.7	
16-20	0	0	3	10.7	
>21	6	40.0	11	39.3	
Total	15	100	28	100	

From the findings in Table 3.5 it was evident that the respondents were not lacking in farming experience. Approximately 40% of the respondents had more than 20 years of

farming experience. Only 9 respondents had less than 5 years of farming experience. It was further established that 39.4% had only farming experience while the rest had a wide range of experience, which included commerce, industry and the technical field. Table 3.5 also shows no sign of any obvious differences between those who schedule and those who don't.

Farm size and irrigation scheduling

The size of the holdings is reflected in Table 3.6.

Table 3. 6: Size of holdings of respondents and irrigation scheduling at Riet River Irrigation Scheme (1999) (N = 43)

	Scheduling ((N = 15)	Non-scheduling (N = 28		
Farm size in ha.	Number of respondents	%	Number of respondents	%	
46-85	6	40	18	64.3	
86-105	0	0	2	7.1	
106-125	4	26.6	2	7.1	
126-145	1	6.7	1	3.6	
146-165	1	6.7	1	3.6	
166-185	0	0	1	3.6	
> 186	3	20	3	10.7	
Total	15	100	28	100	

Thirty two respondents (74.4%) had holdings, which ranged from 46ha to 125ha under irrigation. Six respondents had more than 186 ha of land under irrigation. The general impression gained from the survey was that the respondents were satisfied with the size of their lands under irrigation. Table 3.6 shows that there were significant differences in the distribution of size of land between those respondents who were doing scheduling and those

who were not. Sixty percent of the respondents who were scheduling had a land size of 106 hectares and more, while only 28.6% of the respondents who were not scheduling had similar land sizes.

3.4 THE IRRIGATION SYSTEM AT RIET RIVER IRRIGATION SCHEME - AN OVERVIEW

In 1989 irrigation scheduling was introduced at the Riet River Irrigation Scheme by a group of farmers under the leadership of the Free State Region. This means that water is only applied to the soil when the soil moisture content becomes low. The main advantage of this system is that plants are not subjected to moisture stress, while yields are increased, costs are reduced and water is saved.

This was the first time that irrigation scheduling had been undertaken on a large irrigation scheme basis. Previously it was conducted on an individual farmer basis. It was initially carried out on wheat, but crops such as maize, cotton, groundnuts were to be included in future scheduling (Van Rooyen, 1989).

The results of water scheduling trials conducted at the Riet River Irrigation Scheme were discussed at a local farmers' day and were made available to local farmers. At that stage several farmers had already started applying the principles of scheduling.

The scheduling service, which has been introduced for the Riet River Irrigation scheme, is based on a computer model developed by De Jager J from the University of the Orange Free State. The model is known as the PUTU-model. This model incorporates the climatic parameters and physiological characteristics of the particular plant to determine its water requirements. It is possible to determine the water requirements on a regular basis through this model. Particulars provided by the automatic weather station situation at the Riet River Agricultural Research Station is used for these calculations. The weather station is linked telephonically to the computer. The climatic data is obtainable on a weekly basis from the

weather station. By using the PUTU-model it is possible to determine the weekly water consumption figures of plants. This information is passed on to the University of the Orange Free State by computer. Staff of the Free State Region analyse the data to determine the water consumption figures (Van Rooyen, 1989).

These water consumption figures are subsequently made available to the farmers on the Riet River Irrigation Scheme, on notice boards placed at strategic places throughout the scheme. It is also possible to obtain the data telephonically from the agricultural extension office at Koffiefontein or from the office of the Department of Water Affairs at Jacobsdal. The service is provided free of charge to the farmers, and is based on the PUTU-model. There are no agents supporting any other models. This explains why PUTU is still functional at the Riet River Irrigation Scheme.

The main bottleneck of scheduling in the past was to determine the quantity of water actually used by the plants. According to an official of the Southern Free State sub-region of the Agricultural Development this has been greatly simplified by incorporating the PUTU-model. All that is now required of the farmer is to keep a detailed record of the moisture status of his soil. This involves that the water-holding ability of the soil profile must be known, and by means of a balance sheet it would therefor be possible to establish when the next application should be made. The farmer controls these activities by using an auger or examining a soil profile.

If a water-table is present in the soil this will complicate the situation since the additional supply of water made available to the plants is not taken into account by the PUTU-model.

Because a water-table is a common occurrence on this scheme a Neutron-watermeter is used to determine the actual water status of the soil.

Crops under irrigation

The most important crops currently grown under irrigation in relation to income are presented in Table 3.7.

Table 3. 7: Crops grown in terms of income at Riet River Irrigation Scheme (1999) (N = 43)

	Crops in order of importance	Number of respondents	%
1	Wheat	12	27.9
2	Lucerne	10	23.3
3	Ground nuts	8	18.6
4	Seed maize	3	6.9
5	Potatoes	2	4.7
6	Cotton	2	4.7
7	Sunflower seed	1	2.3
8	Dry beans	2	4.7
9	Vineyard	2	4.7
10	Vegetables	1	2.3
Tota	ıl	43	100.0

Wheat and lucerne proved to be the two most important crops in relation to income grown on the irrigation scheme.

The most important crops grown in terms of area under irrigation are presented in Table 3.8.

Table 3. 8: Most important crops in terms of area under irrigation at Riet River Irrigation Scheme (1999) (N = 43)

Cr	ops in order of importance	No	%
1	Wheat	19	44.2
2	Lucerne	10	23.3
3	Ground nuts	5	11.6
4	Sunflower seed	4	9.3
5	Maize seed	2	4.6
6	Dry beans	2	4.6
7	Vineyard	1	2.3
Γota	ıl	43	100.0

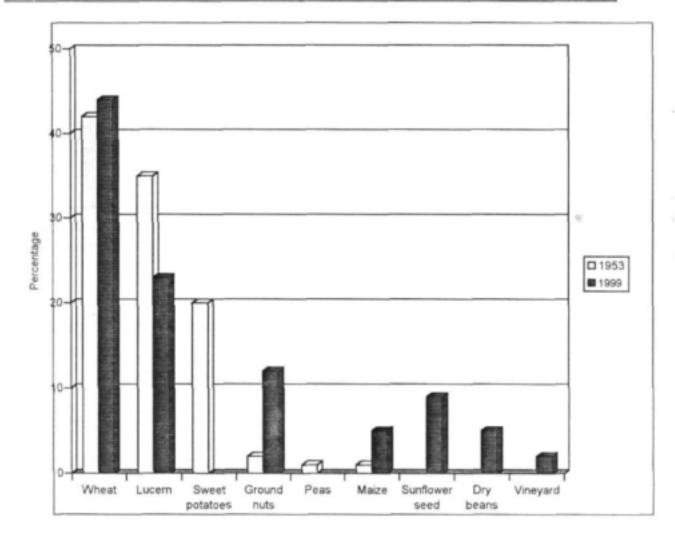


Figure 3. 3: A comparison of crops grown at Riet River Irrigation Scheme in 1953 and 1999

Winter wheat and lucerne also proved to be the most important crops in relation to area planted under irrigation.

Computers at Riet River Irrigation Scheme

Only 28 of the respondents owned computers at home. Of the 28 respondents with computers eight used theirs intensively in their farming enterprise. One respondent was also a dairy farmer and found the dairy computer programme very useful in managing this very intensive farming enterprise. Only one of the respondents used his computer in conjunction with his irrigation scheduling system.

Computers were used for general purposes, which included aspects such as the keeping of farm records, bookkeeping, financial control and tax returns. In most instances the respondents relied on their wives for managing the administration of their farming enterprise through computer programmes.

A large proportion (34.4%) of the respondents were not computer literate and therefore did not own one. Two respondents indicated that they were very anxious to become computer literate and realised that the technology could be very beneficial for them to manage their farming business. Thirteen (30.2%) of the respondents said that they were not interested in computers and that they could manage all their farming activities without such technology.

Irrigation scheduling

When questioned about irrigation scheduling at the irrigation scheme only two respondents indicated that they had not heard about it before. It would seem that the Southwest Co-operative played a major role in advocating irrigation scheduling at the irrigation scheme; since 51.2% of the respondents intimated that they first heard about irrigation scheduling from staff members of the Southwest Co-operative.

From the study it is evident that the farmers generally had very little contact with the local extension officer or other government officials in this regard. The second most important source of information regarding irrigation scheduling was fellow farmers (13.9%), followed by officials from the Department of Water Affairs (11.6%). Only two respondents (4.6%) mentioned the Riet River Research station as a source of information and two mentioned the local extension officer.

One of the main factors determining the success of an agricultural officer is the extent of effort he or she expends in communication activities with the farmers they serve. Many studies show clearly that people who have adopted many innovations have frequent contact with change agents (Van den Ban & Hawkins, 1996). It is quite clear from this study that the effectiveness of the local extension officer as a source of information is negligible.

When questioned about what they actually first heard about the purpose of irrigation scheduling, a wide range of answers were given. Twenty-one (48.5%) of the respondents said that it was mainly concerned with the efficient utilisation of water. Ten (23.2%) maintained that it was the process of applying water according to the actual needs of plants. Seven (16.2%) said that it involved the determination of soil moisture. One (2.6%) respondent thought that its main purpose was to control the water-table in the soil.

The respondents' own perception of the real purpose of irrigation scheduling also varied greatly. Again the majority (60.5%) maintained that its main purpose was optimum application of water according to the water requirements of specific plants. Eight (18.6%) considered it as a means of maintaining a full profile and to irrigate accordingly. Other views included aspects such as the control of the water-table, to secure maximum yields and to a lesser extent to use water more effectively. It must be stressed, however, that although various reasons were given for scheduling, profit maximisation did not feature prominently as one of them.

Irrigation scheduling at Riet River Irrigation Scheme

The situation regarding irrigation scheduling at Riet River Irrigation Scheme was discussed with various government officials and members of the Southwest Co-operative. There was general consensus that in comparison with other irrigation schemes that Riet River Irrigation Scheme has the largest area of land under irrigation scheduling. Although these farmers have been exposed to irrigation scheduling and all its positive features, a large percentage of them have shown very little interest therein.

Thirty-three (76.7%) of the respondents indicated that they had implemented irrigation scheduling before. Of these respondents only 28 (65.2%) are currently still implementing this system. A variety of reasons were given why they discontinued with irrigation scheduling and these are presented in Table 3.9.

Table 3. 9: Reasons for discontinuing irrigation scheduling at Riet River Irrigation Scheme (1999) (N = 43)

Reasons	Number of respondents	%
1. Still doing it	28	65.2
Heavy soils had to be adapted	1	2.3
 Data not regularly available 	1	2.3
 Own information & experience 	2	4.6
5. Crop yields decreased	1	2.3
6. Have never used it	10	23.3
Total	43	100.0

From the evidence presented in Table 3.9 it is evident that there are no substantial reasons given why the five respondents have discontinued with irrigation scheduling.

There was a general feeling that farmers were not adequately informed about all the beneficial characteristics of irrigation scheduling. It was also mentioned that the irrigation advisor who initially took too much responsibility upon himself spoiled the farmers. The irrigation scheduling model was advisor driven and not farmer driven, as it should have been. Farmers are inclined to expect too much support and attention from the advisor and are not prepared to take much of the responsibility upon themselves.

A very positive reaction was obtained from the respondents when they were questioned about the importance of irrigation scheduling throughout the irrigation schemes in RSA. On a scale of importance ranging from 1 to 10, (where 10 is very important) 81.3% of the respondents gave irrigation scheduling a value of 8 and more, while only 7% gave it a value of 4 and less. Some of the reasons for this positive reaction ranged from economic application of water as a scarce resource, securing of optimum yields, waterlogging is minimised and production costs are lowered.

Some of the negative aspects regarding irrigation scheduling which were mentioned were the lack of the required infrastructure, the great variation in soil types and water-table problems that are a common occurrence in many irrigation schemes.

The respondents were asked how simple they thought irrigation scheduling was when using the computer. Using a scale of 1 to 10 with one being difficult and 10 being simple, 18.5% of the respondents gave irrigation scheduling using a computer a value of 8 and higher. Eleven (25.5%) of the respondents remained neutral (5) and 28.1% gave values of 2 and less.

The reasons for their reactions are presented in Table 3.10.

Table 3. 10: The use of a computer in irrigation scheduling at Riet River Irrigation Scheme (1999) (N = 43)

Reasons	Number of respondents	%
 Too complicated 	10	23.3
Satisfied with present system	10	23.3
If the data will be available on time	8	18.7
4. Too general and not applicable for my conditions	1	2.3
Not computer literate	6	13.9
Difficult with flood irrigation	1	2.3
7. Depends on costs	1	2.3
Would like to do it in future	6	13.9
Total	43	100

The respondents were asked if they thought that it was possible to save water and money by using irrigation scheduling. On a scale of 1 to 10 where 1 is negative and 10 positive, 79% of the respondents gave a figure of 8 and higher that water could be saved and 72% a figure of 8 and higher that money could be saved.

The BEWAB model

It was also within the terms of reference of this study to establish the respondents' knowledge of the BEWAB irrigation model.

Only 10 (23.2%) of the respondents had not heard of it and 7 were not quite sure. Seven (16.3%) respondents heard from fellow farmers while five respondents (11.2%) heard about it from the University of the Orange Free State.

The respondents who had heard about BEWAB had a very limited and vague knowledge of the workings of the BEWAB model. It was established that only one respondent was in fact implementing this model. Two respondents alleged that the consultant from Southwest Cooperative had combined the two irrigation models in his irrigation programme. It was the intention of this survey to assess the respondents' knowledge of the irrigation scheduling model. They were asked to name the most important characteristics of irrigation scheduling. The responses are given in Table 3.11.

Table 3. 11: The main characteristics of irrigation scheduling at Riet River Irrigation Scheme (1999) (N = 43)

Characteristics	Number of respondents	%
1. The effective application of water	15	34.9
2. Irrigation according to plant requirements	8	18.6
3. Soil moisture is maintained	8	18.6
Secure good yields	4	9.1
Water-logging is reduced	3	7.0
Guess work is done away with	1	2.3
7. Not sure	4	9.1
Total	43	100.0

From the evidence in Table 3.11 it is quite apparent that the majority of respondents (72.1%) have a clear understanding of the fundamental principles of irrigation scheduling. These include effective application of water according to the requirement of plants and also maintaining soil moisture.

Finally an attempt was made to establish the respondents' perception of the important characteristics of a computer driven irrigation scheduling model.

Twenty-four (55.8%) of the respondents indicated that the computer based irrigation scheduling model would provide very accurate readings which would add to the effectiveness of the irrigation system. Ten respondents felt that this technology was easy to use and nine (20.9%) were not sure of the characteristics of the computer programme. This aspect was further pursued and the respondents were asked which characteristics should a computer based irrigation scheduling model comply with for them to implement it in their farming system. The results to this question are reflected in Table 3.12.

Table 3. 12: Important characteristics in computer based irrigation scheduling models (1999) (N = 43)

	Characteristics	Number of respondents	%	
1.	Data must be made available immediately	10	23.3	
2.	Must be cost effective	4	9.3	
3.	Sufficient data already available at Department of Water Affairs	6	13.9	
4.	Programme of consultant is adequate	12	27.9	
5.	Not applicable for lucerne & flood irrigation	2	4.6	
6.	Too much variation in soil	4	9.3	
7.	Not sure	5	11.6	
To	tal	43	100.0	

It is clear that the respondents did not react or respond very positively to the characteristics of a computer based irrigation scheduling model. Ten (23.3%) mentioned the immediate availability of data as being a deciding factor, while the cost effectiveness of the system was referred to by four (9.3%) as being important. Twelve respondents maintained that the programme implemented by the Southwest Co-operative consultant was more than adequate. Similarly, six (13.5%) respondents were quite satisfied with the data, which was made available to them by the Department of Water Affairs. The variability of their soil and flood irrigation applicable to lucerne production were also mentioned as inhibiting factors for the implementation of this model.

Sources of irrigation information

The survey revealed that in general the level of technical knowledge of the respondents on the settlement left much to be desired. The main sources of information regarding irrigation are presented in Table 3.13.

Table 3. 13: The main sources of information used on the Riet River Irrigation Scheme (1999) (N = 43)

Information source	Number of respondents	%
Southwest Co-operative	15	34.9
Agents (Fertilisers, seed & irrigation equipment)	7	16.3
Fellow farmers	6	13.9
Literature (Media)	5	11.6
Department of Water Affairs	3	7.0
Farmers days	3	7.0
Riet River Research station	1	2.3
University of Orange Free State	1	2.3
Own information	2	4.6
Total	43	100.0

It would seem that staff members of the Southwest Co-operative played an important role as a source of relevant information concerning irrigation to the respondents. Agents from various companies and organisations such as those who provide fertilisers, irrigation equipment, pest control etc. also featured prominently as a reliable source of information. It should be mentioned that the government departments such as Water Affairs and Riet River Research station played an insignificant role in this regard. The Government extension officer was in fact not even recorded as being a source of information on the irrigation scheme.

The quality of water

The respondents were generally satisfied with the actual quality of the irrigation water of the irrigation scheme. On a scale of 1 to 10 where 10 represents an excellent value, 75.2% of the respondents gave quality of the water a value of 7 and higher.

There was however some concern about the presence of foreign material found in the water. These aspects are reflected in Table 3.14.

Table 3. 14: The state of the water at Riet River Irrigation Scheme (1999) (N = 43)

Category	Number of respondents	%	
Good quality	19	44.2	
Contaminated with weeds and algae	17	39.5	
3. Contaminated with sludge and mud	3	7.0	
Reasonably clean	4	9.3	
Total	43	100.0	

The findings in Table 3.14 suggest that there is certainly a problem with the general maintenance of the canals throughout the irrigation scheme. This situation was confirmed during the time of the survey because the canals were generally not clean and water was contaminated with weeds, grass, algae and sludge.

3.5 PERCEPTIONS OF INSTITUTIONAL FACTORS AND THEIR INFLUENCES ON IRRIGATION SCHEDULING

Security of water rights

The majority of respondents (86%) were certain about their lawful rights of water and their future claim to access their listed quota water. There seems to be no uncertainty concerning the future of their rights to water.

Technology at Riet River - certainty of receiving water paid and asked for

There is a sluice and lock system in operation at the irrigation scheme. There are several pre-set openings at which the sluice set, opened and secured with a lock. You request a certain delivery and the sluice is set and locked according to the irrigation board. The sluice is then let open at a particular setting for a specific period for the water to flow

through and in this way the quantity of water delivered is measured. This is the responsibility of the water-bailiff.

The majority of respondents (67.5%) were perfectly satisfied that they were getting the right amount of water for which they had paid for. On a scale of 1 to 10, where 10 is very satisfied, 29 respondents gave it a value of 8 and more. Some concerns, however, were expressed in this regard. For instance these respondents found that their overhead irrigation systems used up the water allocation provided in the holding dams before the calculated time of water application. Fourteen respondents (32.6%) intimated that they did not trust the readings and felt that there was a lack of strict control over weekends. At the time of the survey one respondent indicated that there was an official enquiry regarding his water allocation.

Stealing of irrigation water does not appear to be a general problem as thirty-one (72%) of the respondents maintained that this was not possible. Two respondents were of the opinion that if water was stolen it would be from the government and not from fellow farmers.

Ten respondents who indicated the possibility of water being stolen said that the possibilities and opportunities do exist during severe drought conditions.

Should a farmer not use his full quota of water for the irrigation year, he will lose it. This system therefore does not provide any direct compensation or incentive for Riet River Irrigation scheme farmers to save water. They pay for the full quota whether they use it or not. Should a fellow farmer require more water than his own quota it is possible for him to buy excess water from others. This transaction is only a temporary arrangement and it does not mean that water rights change hands. Normally the same tariff is being paid for re-sold water as the official government tariff. Since only one respondent mentioned that he had too little water one can assume that there was not a ready market for excess water under normal circumstances.

The unreliability of the electricity supply to the settlement was also mentioned as a problem and water was lost when this occurred.

Cost of water

There was a general feeling amongst the respondents, government officials and consultants that the cost of water on the irrigation scheme in comparison with other irrigation schemes had become excessively high over the past few seasons. They maintained that this situation was the result of poor administration. There was a lack of control of the labour component responsible for the maintenance of canals. It was generally accepted that the local labour force was most ineffective and this was responsible for the escalation of the cost of irrigation water.

The government officials and consultant felt very strongly that farmers should only pay for the water that they actually use. This would encourage them to implement irrigation scheduling, as with the current system there is no incentive for them to save and use water cost effectively. It was also accepted that if irrigation scheduling was implemented it would be beneficial to pay per cubic meter for water.

Twenty-nine (67.4%) of the respondents would prefer to pay per cubic meter water used, since it will save water and ensure effective use thereof. It was suggested, however that the water allocations should be linked with their current overall scheduling as this will not influence the market value of their land.

Thirty-five (81.3%) of the respondents were not in favour of subsidised water. The main reason being that with the current economic situation in the country this was not a feasible option. They were convinced that the cost of water could become more realistic if the administration of the scheme was more cost effective. Only five respondents insisted that their water should be subsidised in future. The cost, which they were willing to pay/ha for water, is reflected in Table 3.15.

Table 3. 15: Acceptable cost for water per/ha at Riet River Irrigation Scheme (1999)
(N = 43)

Cost/ha	Number of respondents	%
R201-300	6	13.9
R301-400	16	37.2
R401-500	17	39.6
R500	1	2.3
Market related	3	7.0
Total	43	100.0

From the responses reflected in Table 3.15 it would seem that a tariff ranging from R300 to R500/ha would generally be acceptable to the irrigation farmers. Three of the respondents suggested that the cost of irrigation water should be market related and only one felt that a cost of more than R500 per ha would be acceptable.

The cost of water at the irrigation scheme was a topic of much discussion. The officials and consultant suggested that the cost of water could be calculated as a percentage of input costs. It could be 8% of the input costs of the average farmer on the irrigation scheme. The cost of irrigation water at other irrigation schemes should also be taken into account in determining the cost of water.

The design, management and administration of the Riet River Irrigation Scheme

Design

There was general consensus (60.4%) that the Riet River Irrigation Scheme was physically well designed and planned and provided the infrastructure for easy and effective irrigation and optimum crop production.

Fourteen of the respondents, however, complained about the layout of their property. Their layout was such that it could not accommodate a central pivot irrigation system. It should be mentioned, however, that this aspect should not be seen as an inhibiting factor for implementing scheduling in general, since the various irrigation systems could accommodate scheduling.

Management and administration

The new policy approach to water management is demand driven rather than supply driven. Computerised models have been developed with Water Research Commission funding, to manage water distribution with canal systems more efficiently (Benadé, Annandale & Van Zijl, 1997).

Efficient water distribution on government irrigation schemes can further be improved by transferring management responsibility to Water User Associations (WUA's). Participation of water users in water management leads to an improvement of water delivery services and a reduction of operation and management costs (Backeberg & Odendaal, 1998). Usually a government department or agency retains control over water resources and the main storage and distribution network. The function of the WUA's is to distribute water according to lawfully allocated entitlements and to collect fees for operations, maintenance and administration. The Riet River Irrigation Scheme is currently also in a process of change in the policy of water administration.

Irrigation farmers nominate and democratically elect at their farmers' society the representatives to the irrigation advisory board. Through these representatives they have some say in the whole system. According to the findings of this study there was no consensus on the influence which the advisory committee has on management. Thirteen (30.2%) respondents maintained that the advisory committee had no influence on management; while sixteen (37.2%) felt that the advisory committee made a substantial input and certainly contributed towards the management of the irrigation scheme. Ten

(23.3%) were of the opinion that government followed its own initiative irrespective of the contribution made by the advisory committee.

According to the officials and consultant it was clear that the farmers were not very satisfied with the influence which their representatives had on the overall administration of the irrigation scheme. They, however, felt that the present administration was functioning well under the current circumstances. With a few minor alterations it could then operate more efficiently and cost-effectively. The efficiency of the labour component was an aspect, which deserved serious attention and consideration in the near future. A more dedicated and efficient labour force could bring about a considerable reduction in the overall recurring costs and a more realistic cost for water.

When questioned on how the irrigation scheme should be managed various divergent suggestions were made. Fifteen (34.8%) respondents suggested that management should become privatised and run on a cost-effective basis. Thirteen (30.2%) of the respondents felt that management should remain as it is but that it should become more efficient and cost-effective. The over-employment of labour should be streamlined and managed more efficiently. Seven (16.3%) suggested that there should be a water board and that maintenance and cleaning of the canals be given out on contract.

Administration

Irrigation farmers request or order water from the Department of Water Affairs office by filling in a form in which they stipulate the exact quantity of water required and the period during which they want it. The form must be handed in or posted at the latest on the Thursday of the week previous to the week during which they require the water. Forty one (95.3%) of the respondents confirmed that they have not encountered any problems or difficulties in obtaining their required allocations. The general consensus was that the

Department of Water Affairs was always very helpful and willing to assist the irrigation farmers in this regard.

From the consultants' point of view the administration and management of the Riet River Irrigation Scheme was such that it certainly encouraged irrigation scheduling. Water was always available and could be requested or cancelled at very short notice. The provision of water was therefore very flexible and well adapted to the day to day needs of the irrigation farmers.

The role and potential role of extension concerning irrigation scheduling

There were mixed feelings concerning the role that government agricultural extension officers could play in the implementation of irrigation scheduling. A need was expressed for the services of well-qualified people in the field of irrigation technology to serve the irrigation farmers and thereby promote irrigation scheduling.

Table 3. 16: Extension and its role to alleviate the problem of non-scheduling on Riet River Irrigation Scheme (1999)

Aspect	Category number of nominations					
		Yes		No	1	Insure
Can extension play a role to alleviate the problem of non- scheduling	33	(76/7%)	7	(17.9%)	3	(7.0%)
Are there people available to address the situation?	17	(39.5%)			26	(60.5%)
Are those people trained to supply scheduling advice?	17	(39.5%)	1	(2.3%)	25	(58.2%)
	Num	ber quoted		umber of minations	Do	n't know
How many advisors are there that you are aware of?	31	(72.1%)		1		11

It is clear from the evidence in Table 3.16 that a large proportion of the respondents (76.7%) were convinced that extension could play a meaningful role in alleviating the

problem of non-scheduling on Riet River Irrigation Scheme. The people were well informed about the activities of the advisor as 72.1% were aware of the activities of the official from Southwest Co-operative operating on the Irrigation Scheme.

The respondents were asked about possible solutions to alleviate the problem of nonscheduling at Riet River Irrigation Scheme and these are reflected in Table 3.17.

Table 3. 17: How can non-scheduling be addressed at Riet River Irrigation Scheme?

(1999)

	Category	Number of respondents	%
1.	Don't know/no plans	8	18.6
2.	More qualified personnel made available	24	55.8
3.	Encourage farmers through good extension	6	13.9
4.	If people could pay for water as required they will implement scheduling	2	4.6
5.	Only supply water to those who do scheduling	1	2.3
6.	Because water supply is unlimited there is no incentive for scheduling	1	2.3
7.	One official who is well qualified and is permanently on the scheme should be sufficient	1	2.3
To	otal	43	100.0

The evidence in Table 3.17 suggests that there is an overall need for more qualified people to assist and encourage the local irrigation farmers to implement irrigation scheduling.

At the time of the survey the impression was gained that the respondents did not particularly fancy the idea of having a state extension officer for scheduling. The state extension officer was required only for general advice on farming. The previous state extension officer serving the area left much to be desired and this is possibly the reason for their reaction in this regard.

3.6 KNOWLEDGE OF RIET RIVER IRRIGATION FARMERS REQUIRED FOR IRRIGATION SCHEDULING

Knowledge of plant requirements

New developments in irrigation technology plus complementary advances in plant breeding, crop production and agronomy "packages" have increased the potential productivity and profitability of irrigation agriculture. A reliable, timely and well-managed water supply and its effective use are among the basic requirements for high yielding agriculture (Carruthers, 1983:13). In order to accomplish this the irrigation farmer must have a good working knowledge and understanding of the requirements of plants at their different plant growth stages.

Thirty-three (76.6%) of the respondents had a reasonable idea of the plant requirements and root depth at the different plant growth stages. In general terms the respondents did not know the detail which specialists consider important to make scheduling a success. Apart from the twenty (46.5%) respondents with less than 10 years farming experience, they relied on their practical experience in giving an account of the cycle in which they irrigate their different crops. They had a good understanding of the timing and quantity of irrigation water applied for the different plant growth phases, without a proper understanding thereof.

Knowledge of the soil

The respondents' knowledge of their different soil types is an aspect that left much to be desired. Only twelve (27.9%) had a reasonable idea of the field capacity of their soil types Table 3.18.

Table 3. 18: The respondents' knowledge of the field capacity of their soils at Riet River Irrigation Scheme (1999) (N = 43)

Category	Number of respondents	%	
Good knowledge	12	27.9	
Not sure	7	16.3	
No idea	24	55.8	
Total	43	100.0	

It can be concluded that 72.1% of the respondents had no idea or were unsure of the field capacity of their soils. Furthermore they did not consider this aspect of their soil as being very important in planning their irrigation programme.

Table 3. 19 Respondents' knowledge of the wilting point of their main soils at Riet River Irrigation Scheme (1999) (N = 43)

Category	Number of respondents	%
Good knowledge	9	20.9
Not sure	7	16.3
No idea	27	62.8
Total	43	100.0

As in the case with their knowledge of the field capacity of their soils, 62.8% had no idea of the wilting point of their main soils (Table 3.19).

Table 3. 20: The respondents' knowledge of the ground water status of their soils at Riet River Irrigation Scheme (19999) (N = 43)

Category	Number of respondents	%	
Good knowledge	10	23.3	
Not sure	7	16.3	
No idea	26	60.4	
Total	43	100.0	

From the findings reflected in Table 3.18, 3.19 and 3.20 it is quite evident that the respondents' knowledge of their soil is indeed very limited.

The general view expressed by the respondents at the time of the survey was that they depended upon other sources such as the irrigation consultant and the Department of Water Affairs to incorporate all these aspects of their soil when providing them with the irrigation data. A sound knowledge of the technical aspects of their soils was therefore not important.

To irrigate effectively it is essential that the available water in the soil be known. The different methods of determining the water in the soil are presented in Table 3.21

Table 3. 21: Methods of determining the available water in the soil at Riet River Irrigation Scheme (1999) (N = 43)

Category	Number of respondents	%		
Done by consultant	11	25.6		
Supplied by Department of Water Affairs & auger	3	7.0		
The use of a soil auger	11	25.6		
Soil profile & spade	3	7.0		
Rely on own experience	4	9.2		
Not done	11	25.6		
Total	43	100.0		

Fourteen (32.6%) of the respondents depend on other sources such as the consultant and government department for data concerning the water available in their soil. It was established that fourteen of the respondents have the skills to determine their own water content in the soil. It is significant to mention that eleven (25.6%) did not consider it important to determine the water content in their soil.

On a scale of 1 to 10, where 10 is very important they were asked about the importance of a soil auger in determining this irrigation requirements 28 (65.1%) of the respondents gave it a value of 8 and higher.

The water content of their soil prior to planting was also assessed and is presented in Table 3.22.

Table 3. 22: Water status of soil prior to planting at Riet River Irrigation Scheme (1999) (N = 43)

Category	Number of respondents	%		
Full profile	31	72.2		
50% wet	1	2.3		
Moist soil (cannot plant in wet soil)	4	9.3		
Application of 60 mm before planting	1	2.3		
No idea	5	11.6		
Very low	1	2.3		
Total	43	100.0		

The majority of farmers (72.2%) maintained that they made sure that they planted their crops in a full soil profile. Five of the respondents had no idea of the water status and one preferred to plant in a very low soil profile which would be filled up after planting.

Climatic conditions

Irrigation efficiency requires sound decisions by irrigation farmers when to irrigate and how much water to apply per irrigation. It is therefore important for him to be aware of all the factors, which could assist him in achieving this situation. They were questioned about the importance of the rain-gauge in determining the correct application of water to their crops.

On a scale of 1 to 10, where ten is very important, 29 respondents (67.4%) allocated the importance of the rain-gauge in determining the actual water application to crops, a value of

8 and higher. Nine (20.9%) did not even own a rain-gauge and did not think that it is worth using when irrigating their crops.

Despite the fact that Riet River Irrigation Scheme was situated in a very low rainfall area, thirty-seven of the respondents indicated that they used the rain-gauge regularly to determine the rainfall. They felt that these records were important to determine their irrigation programme.

3.7 CONCLUSIONS

Various factors including the physical, human and institutional aspects were investigated. From the findings it can be concluded that age, educational standard and vocational training of the respondents did not appear to be inhibiting factors for the implementation of irrigation scheduling.

Since the modern irrigation scheduling models are computer-driven it is a serious problem for future irrigation development on the irrigation scheme. Only one respondent currently used his computer for irrigation purposes, while 28 used it for general farming administration tasks. The reason for not using their computers for irrigation scheduling can well be because they are not well trained in this technology. It is therefore suggested that these irrigation farmers be exposed to training programmes in computers.

One of the positive findings of the study was that most of the respondents had a sound knowledge of the benefits of irrigation scheduling. The reasons given by those respondents for discontinuing irrigation scheduling were not evident. It can be concluded that irrigation scheduling was advisor-driven and not farmer-driven. The great variation in soil types and water-table problems encountered in the area must not be lost sight of. These factors will certainly influence the implementation of irrigation scheduling.

The respondents' general level of technical knowledge is a matter of great concern with regard to the implementation of irrigation scheduling. A strong contingent of well qualified people and an effective extension service is required to ensure that the technology for irrigation scheduling is effectively transformed to local participants.

The water on the irrigation scheme was said to be of good quality but a major problem was that it was contaminated with weeds, algae and sludge, which was a serious hazard especially for overhead irrigation. This issue will certainly have to be dealt with in future.

There was general satisfaction with the Department of Water Affairs as far as the allocation and supply of water was concerned. The supply system was very flexible and did not have an inhibiting effect on irrigation scheduling in any way.

The cost of water and the fact that they were compelled to pay for the full quota, whether they used it or not, must be seen as one of the major obstacles in irrigation scheduling. There were strong indications on the part of the respondents and officials that if irrigation farmers were to pay only for the water which they ordinarily used, there would be an incentive to use water more cost-effectively. Under these conditions irrigation scheduling would become an attractive proposition. Also, if administration were seen more cost-effectively the overall cost of water would also become more realistic and affordable.

3.8 BIBLIOGRAPHY

BACKEBERG, G.R. & ODENDAAL, P.E., 1998. Water for agriculture: A future perspective. Proceedings of the 30th Ordinary General Meeting of the Fertiliser Society of South Africa. 24 April 1998, Sun City Hotel, Pilanesberg.

BENADÉ, N., ANNANDALE, J.G. & VAN ZIJL, H., 1997. The development of a computerised management system of irrigation schemes. Report to the Water Research Commission by Rand Afrikaans University. WRC Report No 513/1/97: Pretoria.

BOTHA, C.A.J. & LOMBARD, P.P., 1991. The influences of education, training and experience on farming related behaviour of commercial project farmers. Paper presented at the Annual Conference of the SASAE, 22-26 April 5.

CARRUTHERS, I.D., 1983. Irrigation investigation: A problem palliative or panacea for agricultural development? In: Carrathers I.D. (ed.). 1983 Aid for development of irrigation. OECD, Paris.

CROUCH, B.R. & CHAMALA, S., 1981. Diffusion and adoption of innovations. In: (eds.) Crouch B.R. & Chamala, S., Extension Education and Rural Development I. John Wiley & Sons, Chichester.

GERTENBACH, L.G., 1953. Die Rietrivier besproeiingskema. M.A.-graad in Geografie. Universiteit van Stellenbosch.

KINSEY, B.H. & BINSWANGER, H.P., 1993. Characteristics and performance of resettlement programs: A review. World Development, 21(9):1477-1494.

LUNDAHL, M., 1979. Peasants and poverty: A study of Haiti. Croom Helm, London.

LIPTON, M., 1977. Why poor people stay poor. Temple Smith, London.

LOMBARD, P.P., 1992. Suksesbepalende veranderlikes in ontwikkelende landbou. MSc Agric. verhandeling. Universiteit van Pretoria.

LOMBARD, P.P., 1994. 'n Keuringsmaatstaf vir die voorspelling van boerderysukses in ontwikkelende landbou. PhD verhandeling. Universiteit van Pretoria.

NEL, G., 1999. Personal Communication. Riet River Irrigation Scheme.

NEL, K., 1999. Personal Communication. Riet River Irrigation Scheme.

SARTORIUS VON BACH, H.J., VAN ZYL, J. & KOCH, B.H., 1993. Managerial ability and problem perception: A case study of economic survival and failure in mixed dryland agriculture. Preliminary unpublished article.

SMITH, T.L. & ZOPF, P.E., 1970. Principles of inductive sociology. Philadelphia, F.A. Davis Co.

VAN DEN BAN, A.W. & HAWKINS, H.S., 1996. Agricultural extension. Blackwell Science Ltd., Massachusetts, USA.

VAN ROOYEN, C., 1989. Skeduleringsplan vir die hele skema. Landbouweekblad. 1 Desember 1989, Kaapstad.

CHAPTER 4

THE ACCEPTABILITY OF SWB FOR LOSKOP IRRIGATION FARMERS

4.1 INTRODUCTION

During the early 1940's the first farmers settled in the Kruis River Valley³. This is not far from the present Loskop Dam. As long ago as 1886 the first farms namely Lagersdrift and Kalkfontein were pegged out in the Olifants River Valley. However, initial development was slow due to malaria and cattle diseases such as East Coast Fever. After the turn of the century many farmers trekked with their cattle from the Highveld to the Olifants River Valley during the winter. Farmers soon discovered that the soil was fertile and the water plentiful, so they started planting wheat. As time went by, they stayed longer each winter until they settled in the area. Particularly during 1917 to 1924 the numbers grew abundantly. Natural vegetation gave way to homesteads and patches of wheat lands, which were cultivated under dry-land conditions.

The old Transvaal Irrigation Department soon realised the potential of the Olifants River for irrigation, and between 1905 and 1907 a reconnaissance survey was carried out. The report highlighted two aspects, viz. 1) that an irrigation scheme should not be started until the valley was more densely populated and 2) not before there was a prospect for a railroad into the area. In the meantime, irrigation from the perennial stream was to be encouraged to determine climatic effects and soil fertility.

The first private dam was built on the farm Rooikraal during 1917, with government assistance. With irrigation, the yield of wheat production on Rooikraal increased from 150 to 8000 bags per annum. About 270 ha were served by this currently defunct Rooikraal Dam Irrigation Scheme. Other small irrigation schemes, involving weirs and direct

pumping from the river were developed during around about 1925. These irrigation schemes proved to be quite successful. Therefor the Hereford Irrigation Board was established, serving an area located about 20 km downstream of Loskop Dam. The proposed Hereford Scheme included an improvement of the diversion weir at Kameeldoring and a 51 km canal extending as far as Moses River. A total of 2140 ha could then be irrigated. The Land Bank granted a loan and work started 1928 under the supervision of the Irrigation Department. The various contracts were completed during May 1930 and the cost totalled £62000 (pounds). The loan was redeemed within 20 years.

This success encouraged the Loskop farmers, and they petitioned for the establishment of the Loskop Irrigation District. The then Minister instructed during 1929 that the Irrigation Commission investigates the possibility of a Loskop Scheme. The Commission recommended that the Hereford Scheme, as well as the other private Schemes that were being developed, be studied, after which approval would be given to a larger scheme at Loskop. During 1933 a soil and topographical survey of the dam basin and an area of 68000 ha was undertaken. The Irrigation Department and the Irrigation Commission also prepared various reports on the success of agricultural crops under the Hereford Scheme.

In response, a special subcommittee of the Cabinet decided to recommend the scheme to Parliament. Provision on the Loan Estimates was finally made for the year 1934/5 and construction of the dam on the farms Loskop and Vergelegen, where the Olifants River floes through a narrow "poort" (Kranskop), began during 1934 and was completed by 1938. Construction of the canal system started in June 1935. During the Second World War and specifically during the period 1940 to 1943 the work was interrupted. However, the canal system was completed in 1948. During 1979 the Loskop Dam wall was raised with a further 9 metres, since there was a decreased catchment run-off, caused by the raising of the upstream Doornpoort Dam. The latter became necessary because of the development in the Witbank area and an increase of the Rondesbosch Dam at Middelburg.

³ For more detail regarding the historical developments, see: Agrimodel, 1996: 4-5.

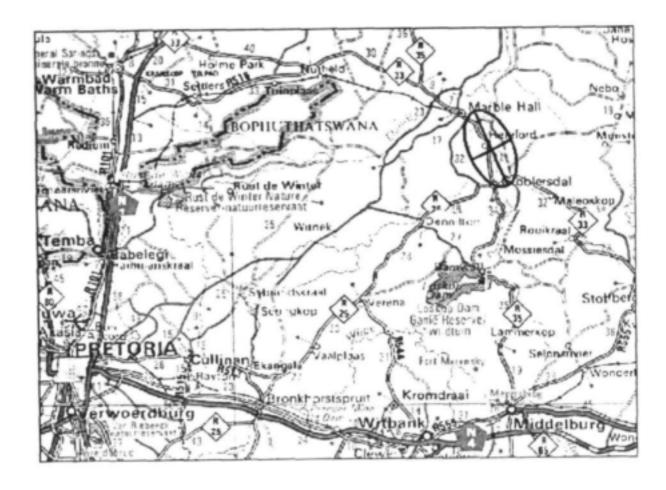


Figure 4. 1: Location map of Loskop Irrigation Scheme

In the late 1960's the Selons River Irrigation Scheme was developed to store sufficient of the summer flow of the river to irrigate approximate 270 ha riparian land. The Selons River Irrigation Scheme extracts all its water requirements from the Selons River, some 6-7 km below the Loskop Dam. This scheme, however, is considered part of the Loskop Valley Area.

Soil types of the Loskop Irrigation Scheme

The Land Type inventory description indicates the dominant soils and occurrence thereof for each Land Type. This is shown in Table 4.1.

Table 4. 1: Dominant soils of the Loskop Valley

Land Type	Dominant Soil Forms (Series)	Area (Ha)	% of total	
Ae23	Hu(33); Hu(35); Hu(36)	1 882	55.5	
Ae24	Hu(36)	6 576	60.5	
Ae25	Hu(27); Hu(36); Hu(38)	8 398	63.0	
Ah77	Hu(34); Hu(35); Hu(36); Cv(34); Cv(35)	2 160	50.0	
Bc1	Hu(24); Hu(26); Hu(36)	3 420	28.0	
Bc2	Hu(33); Hu(34); Hu(36)	9 471	51.0	
Bc3	Hu(33); Hu(34); Hu(36)	6 142	58.0	
Bc4	Hu(26); Hu(36)	1 464	29.4	
Bd4	Cv(35); Cv(36); Av(25); Av(35); Av(36)	7 154	16.5	
Ea4	Hu(27); Hu(36); Hu(37); Sd(21); Sd(22)	5 341	58.5	
Fb3	Hu(36)	804	10.0	
Ib21	Hu(36); Oa(36)	916	7.6	
TOTAL		53 783	35.6	

Table 4.1 only shows the occurrence of the dominant freely drained soils deeper than 450mm. Table 4.1 indicates that within the broad plinthis catena soil pattern (Bc group), except for Land Type Bd4, red apedal, freely drained soils are dominant.

Climate of Loskop Irrigation Scheme

Rainfall and temperature

The summer climate is warm to hot, semi-arid to arid with a long term, mainly summer average rainfall of 600mm. Summer rainfall is characterised by thunderstorms, with large downpours and quick run-offs. The winters are arid and mild to cold with occasional frosts. Six distinct climate zones, each different in rainfall, temperatures, Class-A pan evaporation and frost occurrences, are identified. The mean annual rainfall is the highest for the mountainous areas, although there are no significant differences.

Table 4. 2: Average rainfall for Loskop Irrigation Scheme

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainfall/mm	103.3	88.3	45.2	49.5	8.9	16.4	9.1	2.8	27.8	39.9	68.5	96.0

Table 4. 3: The average, minimum and maximum temperature for the Loskop
Irrigation Scheme

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Maximum temperature	31.3	30.7	29.6	27.5	24.4	22.0	29.5	24.8	28.3	30.3	31.2	31.5
Minimum temperature	18.0	17.9	16.2	12.7	8.1	4.6	3.7	6.8	11.0	15.0	16.4	17.6
Average temperature	24.7	24.3	22.9	20.1	16.3	13.3	16.6	15.8	19.7	22.7	23.8	24.61

Damaging hailstorms occur mainly in the periods, January to March and August to November respectively, with the highest probability of occurrence in October month.

4.2 RESEARCH METHODOLOGY REGARDING WATER MANAGEMENT

The research methodology was chosen to best achieve the objectives of the research. This section outlines the methodology adopted to investigate the various interacting groups of factors which determine the success of irrigation systems, including the physical, human and institutional aspects. The selection of the study area, orientation and planning of the survey, questionnaire design, information sources, sampling and interviewing procedure and analysis of data are discussed.

Selection of research area

The Loskop irrigation scheme was chosen since SWB was launched there. This created opportunities to make the measurements and observations. The Loskop scheme consists of several different areas, served by a network of different irrigation channels. The farmers served by the Loskop irrigation channel system were the focus of the investigation.

Orientation and planning

All the research stakeholders were brought together and discussed the project in detail. They were the project leader, questionnaire surveyors, representatives of the Loskop irrigation Board, local Loskop agricultural extension staff, the SWB programmer and designers, local irrigation scheduling consultants, and a crop specialist of the Agricultural Research Council. Based on the outcomes of these discussions the project was planned further.

The discussions gave the stakeholders a proper overview and good understanding of the geographical area, the practice of irrigation scheduling in the area, the basic local socio-economic and socio-political situation, and the sociological aspects of the broader local irrigator communities that may influence the research.

Information sources

All the Loskop stakeholders proved to be very valuable sources of information for planning the research. The consultants and programmers played a big part by freely supplying information on the technicalities of SWB and in training the local surveyors and irrigation consultants who became more intimately involved in the project.

WRC research reports on the area, as well as other reports and documents were used to gather sufficient relevant information for the research.

The respondents supplied the core of the data by participating in the questionnaire based semi-structured interviews and by giving their perceptions and opinions concerning SWB and other relevant matters.

Questionnaire objectives and design

The questionnaire was designed with several objectives in mind:

- to estimate the general perceptions of Loskop farmers of the practice of irrigation scheduling
- to estimate the human and environmental factors of Loskop farmers, that generally influence the acceptability of irrigation scheduling models
- to identify the specific human and environmental factors of Loskop farmers, that influences the use of scheduling models and of SWB.

Several semi-structured interviews were conducted with crop specialists, the SWB programmers, and local irrigation consultants. General and specific Loskop related information regarding the different aspects of crop production, irrigation scheduling, and irrigation water use was gathered in this way. The identified irrigation scheduling problems and practices were then conceptualised, followed by questionnaire construction. The

questionnaire was then tested with several irrigation and crop specialists and several Loskop irrigation farmers, after which it was adapted as required. This part of the questionnaire was then finalised.

Since SWB is an innovation, the respondents were unaware of it. Therefore the model had to be introduced and explained to them, and then their perceptions could be estimated. This proved to be a challenge since it was realised that the manner of presentation would directly influence respondents' perceptions, which would directly influence the outcomes of the estimated acceptability. Therefore, based on the experience of Benadé (1998) when he was faced by a similar situation, presentation files were prepared. These files consisted of computer print outs of a variation of screens that are used frequently when using SWB. The number of screens was restricted to ten. The print outs were put into plastic flip-files similar to those that are used for school projects. They followed each other in a logical sequence, starting with the first screen that shows when SWB is started. The selection of print outs represented a selection of screens that gives a substantial overview of the capabilities and operation of SWB without making it appear too difficult, yet reflecting the intrinsic value and challenges when using SWB. The selection of screens was made in cooperation with the consultants who introduced the model to farmers and with the programmers.

The presentation file was used as part of the questionnaire and followed during the interviews, after a respondent had given his/her perceptions of irrigation scheduling in general.

The survey

The survey started when two local consultants were engaged and undertook to introduce SWB to Loskop farmers. They were trained in the use of SWB. This proved to more difficult than anticipated. The model is complex and a prototype that needed to be made user friendly. So the consultants had to spend considerable time experimenting with the use of the model, before they were willing to take it to farmers. Many questions concerning the technicalities and practicalities of SWB surfaced during this time and several sessions with the programmers and designers were required before the consultants felt confident with the use of SWB. After this time, the consultants went out to fill out the questionnaires during their interactions with prospective SWB users at Loskop. This did eventually not materialise, since they soon became so absorbed in their own activities when servicing the farmers that they ran out of time to fill out the questionnaires. Unfortunately much time was lost as a result.

After consultations with the research manager of the WRC and members of the project steering committee it was decided that the project leader will train another surveyor who was part of the discussions, is an experienced agriculturist and extensionist, and who is well informed of irrigation scheduling in general. The two then filled out the questionnaires in the form of semi-structured interviews, with a sample of Loskop irrigation farmers.

Sampling procedure

The complete address list of Loskop irrigation farmers was acquired from the Loskop Irrigation Board and the irrigation farmers who would qualify as respondents were identified. Respondents were selected in terms of:

- availability
 - irrigation farmers who resided in the area or who could be reached wee interviewed
- experience
 - since irrigation scheduling is important to all irrigation farmers, there was no minimum limit to farming experience
- □ ownership
 - semi-structured interviews were conducted with farm owners or their managers who take decisions concerning irrigation scheduling activities
- permanency

irrigation farmers who were in the process of selling their property or who were known to be in the process of retirement were excluded.

There were 105 irrigation farmers on the list who qualified for inclusion in the survey. From this list a random sample of 35 percent was drawn. In the end 31 interviews were made during March 1999.

Interviewing procedure

All the questions that were to be asked to respondents were typed in the form of a structured questionnaire. The presentation file was a separate document. Respondents were put at ease by generally explaining to each one what the survey was about, and by spending ten to 15 minutes talking about agricultural matters in general. The first section of the questionnaire was then filled out in a semi-structured and informal manner with respondents, and then the presentation file was used. After the presentation file the rest of the questionnaire was filled out, also in the same informal style. The two surveyors did the first five interviews together, to get a good idea of what was wanted, how the questions were to be interpreted for farmers, and to align their interview styles. Farmers were not contacted in advance to make appointments, since the local consultants advised against it. Farmers were surveyed in their fields and in their homes, wherever they were located. They did not complain about this manner of doing and gave good responses to the questions.

Data analysis

The information were codified and computerised for analysis. Frequency distributions, bivariant analyses and Pearson correlation matrices, and qualitative analysis techniques were used.

4.3 DEMOGRAPHIC PROFILE OF RESPONDENTS

Age

The age distribution of respondents is shown in Table 4.4.

Table 4. 4: The age distribution of Loskop respondents (N = 31)

Age distribution (years)	Number of respondents	
20 - 30	2	
31 - 40	10	
41 - 50	11	
51 - 60	7	
> 60	1	
TOTAL	31	
AVERAGE	44 years	

Table 4.4 shows that the majority of farmers (67.7%) are between 31 and 50 years old. The oldest respondent was 61 years old and the youngest was 23. The latter was the son of an older retiring farmer who is busy taking over from his father and who already has the on-and off-farm decision-making authority and power concerning irrigation scheduling. The generation of farmers at Loskop seems to be below 50 years old, since 74 % farmers are younger than 51. In terms of SWB this is encouraging since it is a computer based scheduling model that represents new generation technology. However, "...proper application of SWB requires more than a basic knowledge of computers, which one seldom finds with older Loskop irrigation farmers" (Mynhardt, 1998).

Education

The formal education of Loskop respondents is shown in Table 4.5.

Table 4. 5: The education of Loskop respondents (N = 31)

Level of education	Number of farmers
School only (std.10)	14
School only	4 ,
(technical / agricultural)	
Post-school (agricultural)	4
Post-school (other)	4
Post-school (technical)	5
TOTAL	- 31

The biggest number of farmers, viz. 45% have passed the normal academic school standard 10 (now called grade 12), while 13% have passed grade at technical schools. The latter is more applicable for farming than the former, but not considered as sufficient to face today's challenges to commercial farming. 58% respondents don't have post school qualifications, but have only a formal school qualification. Post-school qualifications were obtained by 42% respondents, of which 69% are either agricultural or technical related and therefore considered applicable for farming purposes.

Education as such is important for farming success, but applicable experience can also help farmers achieve success.

Experience

The experience of Loskop respondents is shown in Table 4.6.

Table 4. 6: The experience of Loskop respondents (N = 31)

Farming experience only (years)	Number of respondents	Type of experience before farming	Number of respondents	Total years of experience	Number of respondents
0 -10	8	Nothing	11	0 -10	3
11 - 20	9	Non-agricultural	8	11 - 20	8
21 - 30	8	Technical	8	21 - 30	13
>30	6	Agricultural related	3	> 30	7
		Not answered	1		
TOTAL	31		31		31

According to Table 4.6 the distribution of farming experience is quite evenly.

Table 4.6 also shows that 35% respondents have not had any experience prior to farming. Similarly, 35% percent have had technical or agricultural related experience before going into farming. 26 percent of respondents have had some kind of non-agricultural working experience before they entered farming.

A total of 20 respondents (64.5%) have a total number of 21 years or more experience, while 14 (45%) respondents have more than 20 years of farming experience. This is ample experience to expect them to be well seasoned in all farming's challenges and difficulties.

42 years were the highest number of total years experience and 5 years the least. The average number total of years' experience is 23.7 years.

Size of farm

The size of respondents' land under irrigation is indicated in Table 4.7. It shows that 23% respondents' irrigation land size is smaller than 40 hectares. By official proclamation the smallest size of listed irrigation land in the Loskop area is 30 hectares. The biggest size of irrigation land amongst the respondents was 800 hectares and the second biggest was 400 hectares. Both these are big enterprises and to be successful they demand extremely good management and control. The greatest number (13 or 42%) respondents fall in the category

of between 131 and 300 hectares. There are 18 (56%) respondents with land bigger than 120 hectares, or with four or more irrigation plots. There is a tendency for irrigation farmers to buy/rent more plots to increase the size of farming enterprises at Loskop. Only seven respondents (22%) have only one irrigation plot.

Table 4. 7: Size of respondents' land (N = 31)

Size of irrigation land (ha)	Number of respondents
0 - 40	7
41 - 130	9
131 - 300	13
> 300	2
TOTAL	31

4.4 CROPS UNDER IRRIGATION

Loskop irrigation farmers seem to plant a variety of crops. Table 4.5 shows the most important crops in terms of revenue for Loskop irrigation farmers.

Table 4. 8: Most important irrigated crops at Loskop, in terms of revenue (N = 31)

	Number of respondents for whom crop is:				
CROPS	most important in terms of income	second most important in terms of income			
Tobacco	10	2			
Cotton	8	12			
Wheat	4	9			
Vineyard	3	2			
Potatoes	2	2			
Citrus	1	1			
Soya	1	1			
Chillies	1	0			
Seed sunflower	1	0			
Green mealies	0	1			
Seed maize	0	1			
Not reported	0	1			
TOTAL	31	31			

Tobacco seems to be the most popular irrigated crop in terms of revenue and cotton the second most popular (Table 4.8). Nineteen percent respondents also plant these two crops in combination. As most important revenue earner, 3% respondents each also plant tobacco in combination with vineyard, wheat and potatoes. When cotton is planted as most important earner of revenue, it goes in combination with wheat (16% respondents), green mealies, potatoes and seed maize (3% respondents each).

According to Table 4.8, permanent crops like vineyard and citrus together comprise 13% of the most popular irrigated crops. They also comprise 10% of the second most important revenue earning irrigated crops of respondents. Crops for niche markets, like seed maize, seed sunflower and chillies are planted by the minority of respondents (3% each) as most or second most important irrigated crop.

Another dimension of importance of crops for respondents, is the size of land allocated to crops. Table 4.6 shows the most important crops at Loskop, in terms of size of their cultivated area.

Table 4. 9: Most important irrigated crops at Loskop, in terms of size of cultivated area (N = 31)

	Number of respondents for whom crop is:				
CROPS	most important in terms of size of cultivated area	second most important in terms of size of cultivated area			
Cotton	12	11			
Tobacco	9	1			
Wheat	4	11			
Vineyard	I	1			
Seed maize	1	1			
Citrus	1	0			
Soya	1	0			
Chillies	1	0			
Seed sunflower	1	0			
Potatoes	0	3			
Green mealies	0	2			
Not reported	0	1			
TOTAL	31	31			

Table 4.6 shows that cotton is the most important crop in terms of size of area of cultivation (39% respondents) followed by tobacco (29% respondents). In terms of second most important crop regarding size of cultivation, wheat and cotton are similar (35% respondents each). The combinations of crops planted, as well as importance of crops in terms of revenue and size of area cultivated remain the same for 81% respondents.

From Tables 4.8 and 4.9 it appears that:

- vineyard and potato cultivation are important revenue earners for those who cultivate them, but those cultivated areas are not big;
- the farmer who cultivates chillies and the one who cultivates seed sunflower, do it on the largest part of their land;
- green mealies is not the biggest revenue earner for any farmer and it is not cultivated by any farmers on the biggest part of land;
- seed maize is not the biggest income earner of any farmer, but there is a farmer who plants it on the biggest part of his farm.

4.5 METHODS AND TYPES OF IRRIGATION

The situation regarding the application of irrigation technology at Loskop is constantly changing. Irrigation farmers constantly change these technologies by behaving in one or more of the following manners:

- evaluate technologies current under use and/or
- accept new technologies as they are and/or
- accept new technologies and adapt them to their specific context and/or
- discontinue technologies and/or
- revert back to old technologies when newer ones fail them and/or
- make use of consultants for a while and then drop out and/or
- experiment with technologies on different crops and sizes of fields and so on.

These constant changes make it difficult to estimate the current situation. The following has however become evident:

- Many respondents (70%) see the pivot system as "the ultimate" in irrigation technology.
- Conventional manual sprinkler irrigation is the most widely used (80%) as only system or in combination with other systems. Conventional manual sprinkler irrigation is where labourers carry sprinkler pipes from one site to the next, usually on a time scheduled application basis.
- Pivots seem to be used in tandem with conventional manual sprinkler irrigation. Twenty % of respondents muse of pivots only.
- Only one respondent uses flood irrigation in all his fields. Very few other respondents still use it in large parts of their fields. 15% respondents used flood irrigation on small fields or parts of fields and then in combination with conventional manual sprinkler irrigation.
- Drip irrigation does not seem to be very popular and is only practised on specialised permanent high yielding crops e.g. vineyard and citrus.

4.6 COMPUTERS AND IRRIGATION AT LOSKOP

The use of SWB at least requires the use of a Pentium I computer with a Windows programme. It is therefore important that farmers have this equipment or have access to this type of equipment. According to local consultants (Du Toit, 1998; Mynhardt, 1998 and Venter, 1998) more than 90% of computer owning Loskop irrigation farmers do not have computers suitable for operating SWB. The hardware lacks hard disk capacity and/or does not run Windows. Therefore most of their clients have to either upgrade or replace their current computers before they can be served with SWB.

Table 4.10 shows the availability of computers, whether the computers are used in the farming enterprise and for which purposes.

Table 4. 10: The availability, use of and applications of computers of Loskop irrigation farmers (N = 31).

Is a computer available?	Number of respondents	Use of computer in farming	Number of respondents	Application of computer by respondents	Number of respondents
Yes	22	Yes 21		Bookkeeping	7
					14
No	9	No	10	Computer old	1
				No computer	9
TOTAL	31	TOTAL	31	TOTAL	31

According to Table 4.10 29% respondents do not have computers or do not have access to a computer. Of the 71% who have computers 96% use them in their farming. The computer owning respondent who does not make use of it has indicated that the model is too old. The owners of computers either use them for bookkeeping (22% of the total number of respondents) or irrigation scheduling purposes (45% of the total number of respondents).

4.7 IRRIGATION SCHEDULING AND PERCEPTIONS THEREOF AT LOSKOP

Perceptions of scheduling in general

When asked, 90% respondents said that they had heard of irrigation scheduling before. Only three (10%) said they had never heard of irrigation scheduling before. These respondents were respectively 23, 49 and 53 years old. Table 4.8 indicates the original information sources of respondents, the time since they had heard of scheduling and what they had heard.

As can be expected there were several respondents (13%) who could not remember from whom they had first heard of scheduling. Of those respondents who remembered 50% first heard from the local extension officer. Mr Basie du Toit was an extension officer in the area for many years, and many respondents mentioned his name in connection with irrigation scheduling. Four respondents mentioned the local co-operative as original source. The University of Pretoria was active in doing pea research in the Loskop area during the late 1980s. The researcher also taught farmers about irrigation scheduling during the time.

It was more difficult to establish the time when respondents had heard of scheduling and 42% could not supply this information. Of the 18 respondents who could supply information 56% said that they had heard of it during or after 1995 and 39% indicated to a time before 1990.

Table 4. 11: Original sources of scheduling information, time lapse since first communication and what respondents had heard regarding irrigation scheduling (N=31)

Original source of information	Number of respondents	Time lapse since first communication	Number of respondents	What respondents had heard	Number of respondents
Have not heard	3	Have not heard	3	Have not heard	3
Forgot	4	Forgot	1	Forgot	4
Co-operative	4			Irrigate to	
Fellow farmers	2	Between 1995 and now	10	meet plants' needs	9
Farmers' society	1			Can save water	8
Landbou- weekblad	1	1990 – 1994 1 8		Guarantees good crop yields	1
University of Pretoria	3				
The local research station	1	Before 1990	7	Must measure soil water content	1
The local extension officer	12	Unsure	9	Scheduling works well	5
TOTAL	31	TOTAL	31	TOTAL	31

Respondents could not supply detail of what they had heard originally regarding irrigation scheduling. What most (71% of the total) remember is that scheduling must be done according to plants' needs, that it can save water and that irrigation scheduling "works well." Whether they reflect their recent perceptions of scheduling into their answers is unclear.

When respondents were asked what irrigation scheduling is:

- □ 1 (3%) did not answer
- □ 5 (16%) did not know at all
- 19 (62%) had an idea, and
- 6 (19%) knew what it was.

The details of the practice of irrigation scheduling of respondents were not investigated. In response to a question whether they practice irrigation scheduling (N = 30):

- 8 (27%) said no, and
- 22 (73%) said yes.

Table 4.12 shows the matrix of the number of respondents who say they do or don't practice irrigation scheduling and their knowledge of scheduling. It shows that 17 of the 22 respondents who do scheduling only have an idea of scheduling. This means that they cannot do it properly themselves, but 50% (of the 22) indicated that they were being serviced by one of the local irrigation consultants. They do not do scheduling neither in all their fields nor on all their crops, but only smaller sections of their fields. The rest are either practising scheduling themselves or are assisted in this by their sons or a manager. Of the 50% who do scheduling themselves, 80% seem be doing irrigation scheduling on certain parts of their fields only, and then more on a time schedule than anything else.

Table 4. 12: Respondents' irrigation scheduling knowledge and their practice thereof (N = 30)

Knowledge of scheduling	Number of respondents who practice scheduling	Number of respondents who don't practice scheduling
Does not know	1	4
Has an idea	17	2
Knows well	4	2
TOTAL = 30	22	8

It is interesting to note (Table 4.12) that six respondents have an intimate knowledge of scheduling, yet only four of them apply it.

The perceived importance of irrigation scheduling and the efficient use of water and saving of money

Respondents rated the importance of irrigation scheduling for themselves as well as other farmers very high. This, together with a variety of other issues concerning irrigation scheduling is shown in Table 4.13.

Table 4. 13: The perceptions of respondents of issues related to the importance of applying and difficulty to apply irrigation scheduling (N = 31).

Importance of scheduling	Number of respondents	Reasons for scheduling	Number of respondents (N = 28)	Difficulty to do scheduling	Number of respondents
Very important	18	It saves money	10	Very easy	13
Quite important	11	It saves water	8	Quite easy	9
Important	2	It secures crop yields	8	Easy	2
Unimportant	0	One can't farm without it	2	Not easy	7
Non response	0	No response	3	No response	0
TOTAL	31	TOTAL	31	TOTAL	31

Table 4.13 indicates that all respondents regard irrigation scheduling as important, and 58% regard it as very important. It is also evident that respondent regard irrigation as important to save money and water and to secure crop yields. Only 23% regard scheduling as "not easy."

The matrix in Table 4.14 shows how the practice of scheduling and respondents' perception of the importance of scheduling interact.

Table 4. 14: Respondents' perception of the importance of scheduling and their application thereof (N = 30).

Perception of the importance	Number of respondents		
of scheduling	Applying scheduling	Not applying scheduling	
Very important	13	5	
Quite important	6	4	
Important	2	0	
TOTAL	21	9	

According to Table 4.14 there is a relationship between the application of scheduling and the perception thereof as important or very important.

Table 4.15 shows the relationship between respondents' perception of the difficulty to apply scheduling and their application thereof.

Table 4. 15: The application of scheduling and respondents' perception of the difficulty of applying scheduling (N = 31)

Difficulty to do scheduling	Number of respondents who		
	Do apply scheduling	Don't apply scheduling	
Very easy	11	2	
Quite easy	4	5	
Easy	2	0	
Not easy	5	2	
TOTAL	22	9	

According to Table 4.15 there are 35% respondents who apply scheduling who also perceive it as "easy." The reasons may be that:

- 50% of those who apply scheduling are assisted by local consultants, and
- 50% apply it on a time schedule more than anything else.

Respondents were asked how important it is for farmers to save water in future, and to indicate how big the role of irrigation is to save water and money. Their responses are shown in Table 4.16.

Table 4. 16: Respondents' perceptions regarding the importance for farmers to save water in future, and how big the role of irrigation is to save water and money (N = 31)

Importance for farmers to save water in future	Number of respondents	Role of scheduling to save water	Number of respondents	Role of scheduling to save money	Number of respondents
Very important	19	Very important	20	Very important	17
Quite important	10			Quite important	7
Important	2	Important	1	Important	5
Unimportant	0	Unimportant	2	Unimportant	2
TOTAL	31	TOTAL	31	TOTAL	31

From Table 4.16 it is clear that all respondents regard the issue of farmers saving water in future as an important one. The role of scheduling to save water is regarded by 65% as very important and by 26% as quire important. Two respondents said that scheduling as such would not necessarily play an important role in saving water or money. They argue that scheduling is not an isolated issue, and cannot be effective in saving water by itself. They rightly pointed out that there are many factors, which go hand-in-glove with scheduling and that could make it ineffective and actually nullify its positive effects.

In this regard they gave examples such as:

- the fact that they currently pay for a certain quota of water, whether they use it or not, and
- the issues of regularly monitoring the amounts of water put down and servicing irrigation equipment.

Should a farmer not use his full quota water for the irrigation year, he will lose the water – it cannot be transferred to a following year. There is therefore no direct financial compensation or incentives for Loskop irrigation farmers to use less water. They have to buy the full quota whether they use it or not. Should there be other farmers who want to buy excess water off others, they can do so. Usually the same tariff is being paid for re-sold water as was the original price. In times of drought, there usually is a big demand for water, but then very few irrigation farmers are willing to sell, since they also are in need of the water. So the water market is not very lucrative at the Loskop scheme. Irrigation farmers are not allowed to "store" water for themselves "behind the dam wall" for longer than the water year. They may store water for themselves in dams on their own plots for as long as they wish. High levels of evaporation during summer and the high costs of this practice do not make this a viable option.

4.8 PERCEPTIONS OF INSTITUTIONAL FACTORS AND THEIR INFLUENCES ON IRRIGATION SCHEDULING

Security of water rights

Half of the respondents seem to be unsure of the differences between their lawful rights to water and their claim to access their scheduled quota water, which is tied to the land, per 25,7 hectares. In the case of Loskop the two are tied – selling of land also means selling of the listed quota. Opinions varied between five years (mentioned by four farmers) to 40 years (mentioned by one farmer) and lifelong (mentioned by one farmer).

Water not used during the water year, starting 1st May every year and ending 30 April, may be leased to interested parties. The Irrigation Board handles this lawful temporary trade in water.

There seems to be much uncertainty concerning the future of rights to water. Farmers mention the new legislation and things that could happen, but do not seem well informed of the debate. Seven farmers explicitly mentioned that they would strongly resist if they were to receive less water than their current scheduling. Many (70%) seemed cynical and apathetic of the changes that are coming. One farmer said that he does not expect any problems, while another mentioned that he would solve that problem when he gets there.

Loskop irrigation farmers also talk of the future system of licensing farmers for five years to have access to irrigation water.

Technology at Loskop - certainty of receiving water paid for and requested

Loskop irrigation farmers at the lower end of the canals seem to have more problems than others with the accuracy of water delivery, since there are more opportunities for water to get lost on its way to them through the canal system. Uncertainties also stem from the water levels in the dam since irrigation farmers pay for their full quota despite the availability thereof. In dry years the delivery is more erratic and all get less water, therefore some irrigation farmers report some uncertainties.

Table 4.17 shows how respondents feel about the certainty of getting the quantity of water asked for and the possibilities of water getting stolen on its way to them.

Table 4. 17 Perceptions of respondents about getting the quantity water they ask for, and the possibility of water getting stolen on its way to them (N = 31).

Certainty of getting water paid and asked for	Number of respondents	Chances of water getting stolen on its way to farmer	Number of respondents	
Very sure	20	Very small	17	
Sure			1	
Unsure	1	There is a chance	9	
Very unsure	7	Chance is good	4	
TOTAL	31	TOTAL	31	

Table 4.17 indicates that the majority of respondents (65%) are very sure that they get the water the pay for and request. Only 23% are very unsure if they get the water they pay for and request. Most respondents (58%) indicate that the chances are small or very small for water to get stolen on its way to them. Although 29% said that there is a chance for water to get stolen, they did not indicate that it actually happens. Respondents who indicated the possibility of water being stolen said that the possibilities and opportunities do exist, but only 13 percent indicated that they actually deemed this a problem. They indicated the extent to which it could happen without them knowing of it as being high.

Stealing of irrigation water does not seem to occur much and is not a general problem. One respondent (an Irrigation Board member) indicated that there were only two cases of such irregularities officially reported on the whole Loskop irrigation scheme during the preceding year. The way in which water is supplied to farmers on the scheme makes it difficult to steal water. The sluices are set and locked properly at certain opening settings. Offenders have to deliberately cut the locks, pump water from the canal or obstruct the water flow in some manner in order to acquire another farmer's water.

Three respondents said that it is only during times of drought or short spells of drought when the canal system cannot cope with the demand for water, that farmers are tempted or will attempt to pilfer others' water. A few (four) other respondents said that a few cases have been reported where it was a problem. In these cases canals were apparently blocked with sandbags and water pumped from the canal, or simply furrowed into a dam or onto farmers' fields. Allegedly there were also a couple of cases reported where irrigation farmers' sluices were being tampered with. In all cases the irrigation Board compensated the irrigation farmers by giving them the benefit of the doubt and supplying them with the amount of water they claimed they had lost. However, stealing of irrigation water does not seem a common occurrence at the Loskop irrigation scheme. On average only three cases per annum are reported for the whole irrigation scheme.

In general the respondents seemed to trust the Irrigation Board and other farmers concerning this issue.

The cost of water

Several issues regarding the cost of irrigation water is shown in Table 4.18.

Table 4. 18: Perceptions of the cost of irrigation water and manner of payment for water (N = 31)

The cost of water	Number of respondents	Is the water expensive?	Number of respondents	Manner of payment for water	Number of respondents	Preferred payment manner	Number of respondents
Does not know	4	Unsure	1	Per cubic metre	17	Per cubic metre	20
Unsure	11	No	8	Per hectare	12	Per hectare	8
Has an idea	14	Relatively	4	Does not matter	2	Does not matter	3
Knows exactly	2	Yes	18				
TOTAL	31	TOTAL	31	TOTAL	31	TOTAL	31

Only two respondents knew exactly what they pay for their irrigation water. A further 45% had an idea of the cost of irrigation water, while 35% said they were unsure but could look it up quickly if required. Four respondents admitted that they did not know what irrigation water cost them. The majority (58%) respondents said that irrigation water is expensive. Not one indicated that it actually is cheap. Regarding the payment whether per cubic metre

or per hectare, respondents do not seem to be in agreement. The Irrigation Board indicated that farmers actually pay per listed hectares.

Two respondents said that it does not matter how it is done at the moment – whether one says it is in one or the other format is not the issue. They argue that they have to pay for a quota of water. This could be measured in any manner; it will still remain the same amount of water or money. They also said that they would prefer to pay for the water they actually use, but indicated that it will probably not be possible to run the irrigation scheme in this manner. The costs they pay for water is for the delivery service and upkeep of the whole scheme more so than for the water itself.

Respondents also indicated the following:

- Three respondents said they would prefer to pay per cubic meter water used, since it will save water and ensure the effective use thereof.
- Some (four) said that the system is not devised to make measuring per cubic meter used a viable proposition.
- One said: "We pay for the distribution costs and upkeep of the system, so it does not matter how you measure it, we have to pay a certain minimum to keep the system in place".

In response to a question of whether irrigation should be subsidised at Loskop, respondents had the following to say:

- One respondent said: "During times when the dam flows over, the Board should give us water at no cost".
- Another one said: "The dam has been built and paid for a long time ago, and the price of water has not come down."
- One respondent said: "Subsidy is not necessary, water is a national asset".
- One respondent also said: "If one gets subsidy, everyone must get it".

- Three respondents said that: "I do not want subsidies, just a fair price for my products".
- One respondent said: "Farmers must show or prove what they actually do with their irrigation water. It should not be easily come by".
- Two respondents said: "Subsidy on water will obviously be welcome, but the state will not allow that to happen".

The issue of subsidies did not seem to be controversial. Respondents seem to anticipate government not to be sympathetic towards the issue, while others implied that farmers would have to learn to survive without government intervention. Several (six) respondents wanted to know whether the information they supply, or their opinions will be made known to "Asmal" (the then honourable Minister of Water Affairs and Forestry), leaving the impression that there is a political side to this issue as well.

The design, management and administration of the Loskop irrigation scheme

Respondents seem to be quite content with the overall management of the Loskop irrigation scheme. The way in which they have a voice in the management system, was described as follows by a respondent:

"We farmers nominate and democratically elect at our farmers' societies the representatives to the Irrigation Board. Through these representatives we have a say in the whole system".

The management system of water delivery to respondents' plots were described by a respondent as follows:

"At Loskop we use the 'Sluice and Lock system". There are several pre-set openings at which the sluice can be opened, set and locked with a lock. You ask for a certain delivery and the sluice is set and locked accordingly by the irrigation board. The sluice is then let open at a specific setting for a specific period for the water to flow through, and so the quantity of water delivered is measured. If you are unsure, the delivery may be checked and specifically measured for accuracy".

Another respondent said:

"Each plot has a listing (quota) of 102 litres/second maximum, or water can be requested at 51litre/second or 68litre/second depending on the need of the farmer".

Irrigation farmers request or order water from the Loskop Irrigation Board's offices by filling out a form in which they indicate the quantity of water needed and the day during which they want it. The form must be handed in or posted at the latest on the Thursday of the week previous to the week during which they want the water. It is during periods of peak water requirements, as during intense heat spells and droughts, that water delivery by the irrigation board cannot keep up with demand. During such times, every farmer knows that he will not receive less than 51 percent of his entitlement.

Two respondents said:

- "Canals were being designed to accommodate a maximum of 51cubic metre per hour, which is not sufficient during dry, hot spells".
- "Balancing dams ("Balanseer damme") do not have sufficient capacity".

There are also periods of two consecutive weeks during which irrigation farmers clean and service the canals. The board then refunds them for this service. During these two weeks particularly the vegetable farmers find it difficult since the water requirements of vegetables demand irrigation during the two weeks. Irrigation farmers have to plan carefully for these periods.

One vegetable farmer said:

"The two dry weeks period to clean canals do not befit vegetable farmers, the time is just too long".

Water delivery over weekends is also said to give some difficulty. A farmer can only get water delivered over weekends if they ask before ten o'clock on a Friday and if there is a sufficient amount of water requested on that specific canal system to warrant delivery. If not, the water losses are too high and water delivery will not take place.

Said one respondent:

"We would like better access to water over weekends".

In cases when it starts raining while a farmer is receiving his requested water, he cannot cancel the delivery in a period shorter than 24 hours. This results in water being wasted.

Perception of the role and potential role of agricultural extension concerning irrigation scheduling

Respondents were asked to respond to several questions concerning agricultural extension and its role in irrigation scheduling. Their perceptions are shown in Table 4.19.

Table 4. 19: Agricultural extension and its role to alleviate the problem of nonscheduling at Loskop (N = 31)

	Number of	r category		
Question	Yes	No	Unsure	TOTAL
Can extension play a role to alleviate the problem of non-scheduling?	29	2	0	31
Are there people available to address the situation?	21	7	3	31
Are those people trained to supply scheduling advice?	16	9	6	31
How many advisors are there on Loskop, whom you are aware of?	Number quoted 20	Number of nominations 1	Don't know	31
	5	1	7	
	4	6		
	3	3		
	2	6		
	1	4		
	0	3		

The majority of respondents (94%) believe that agricultural extension can play a role to alleviate the problem on non-scheduling at Loskop (Table 4.16). Only 6% respondents said extension could not play a role.

They pointed out that extension has been active in the area for many years and that:

"... if by now extension could not make a difference it is impossible to do so."

Many (68%) respondents believe there are enough people (extension officers, advisors, consultants etc.) to address the situation of non-scheduling at Loskop. Respondents seem to be split up in two camps of 50% each concerning the matter of whether the available people have been trained to advise, assist or consult farmers regarding scheduling. The respondents clearly do not know how many irrigation advisors there are in the Loskop area, but 23 (74%) said that there are five or less.

The respondent who said there are 20 people available, qualified his statement as follows:

"Many farmers have been trained so far in irrigation scheduling. They can, through their farmers' societies be utilised to assist the other farmers."

Respondents were asked to comment on how to address the situation of non-scheduling at Loskop. Their comments are shown in Table 4.20. Seven (23%) did not have any plans or did not know what to answer. Many of respondents did make comments, but did not have specific ideas of how to address the situation. In this regard Table 4.20 shows that:

- Four said that it is important to address the situation, but did not necessarily know how.
- One said that it would be very difficult to address the situation.
- Another said that farmers must have money to farm properly.

Table 4. 20: Respondents' perceptions of how the situation of non-scheduling could be addressed (N = 31).

Respondents' ideas of how the situation could be addressed	Number of respondents
Don't know / no plans	7
It is very important	4
It will be very difficult	1
Encourage farmers	1
Farmers must have money to farm properly	1
Personal contact	1
Make use of commercial firms, state cannot play role any more	5
Extension	2
Advisors must have practical experience, and be local people	2
Study groups	3
State extension staff must help	1
Irrigation Board must take action	2
Sell water per cubic meter	1
Farmers using production credit must be forced to make use of an advisor	1
Make use of organised agriculture, and all other agricultural role players	7

It is interesting to note that 12 respondents (39%) said that commercial firms and other role players than the state (only) should be involved to address the situation. Respondents were not asked to comment in detail and their responses were not discussed with them. However, it is clear that Loskop farmers will have to be consulted to address his problem over a wide front and that all role players should be involved in a concerted effort.

Respondents' perceptions regarding the outlay of Loskop

The majority of respondents, 84% and 90% respectively, believes that the physical planning and outlay, as well as the administration of Loskop do not discourage the application of irrigation scheduling. This is shown in Table 4.21.

Table 4. 21: Respondents' perceptions of the outlay and administration of Loskop and their influence on irrigation scheduling application (N = 31).

Question	Encourages	Discourages	No answer or uncertain	TOTAL
Is the Loskop scheme built such that it encourages or discourages irrigation scheduling?	26	3	2	31
Is the administration of water such that it encourages or discourages irrigation scheduling?	28	1	2	31

Overall, respondents did not have problems with the outlay of the scheme, nor with the administration thereof.

4.9 THREE DOMAINS OF KNOWLEDGE OF LOSKOP FARMERS REQUIRED FOR IRRIGATION SCHEDULING

Irrigation scheduling specialists supplied a list of must-know aspects of plants and the soil, and must-do aspects concerning the climate, if a farmer wants to apply scheduling successfully. These aspects were then checked with scheduling consultants, who indicated that chances are slim that farmers would know the answers to the question, or that farmers apply what is recommended. Notwithstanding these aspects were taken up in the questionnaire to test farmers' knowledge and estimate their use of climate monitoring devices.

Knowledge of plant requirements and soil characteristics

It was evident that respondents did not know the detail of plants, which specialists considered important to make scheduling a success. Yet, apart from the seven respondents with less than 10 years farming experience, they all fell back on the practical experience in explaining the cycles in which they irrigate their different crops. They seemed to have a good understanding of the timing and quantity of irrigation water applied for the different plant growth phases, without a proper understanding of the reasons thereof.

Regarding soil characteristics, respondents fared worse than for knowledge of plants. Only two respondents could contribute to the questions about soil characteristics. Only one had an intimate knowledge of soil characteristics (see appendix A). The knowledge of respondents who made use of consultants was not evaluated.

Table 4.22 supplies the levels of knowledge of respondents regarding plants and soil characteristics. Nine (29%) of the respondents who attempted to answer the questions, were very unsure and could not make any meaningful contributions, while 36% did not know at all. It seems the consultants knew the farmers well enough to issue the word of warning they did.

Table 4. 22: Respondents' knowledge of plants and soil characteristics (N = 31).

Knowledge of plants	Number of respondents	Knowledge of soil characteristics	Number of respondents
Uses consultant	6	Uses consultant	9
Knows very well	3	Knows very well	1
Has a good idea	3	Has a good idea	0
Has an idea	3	Has an idea	1
Seems unsure	8	Seems unsure	9
Does not know at all	8	Does not know at all	11
TOTAL	31	TOTAL	31

It became evident that respondents did not have the knowledge levels deemed as essential requirements by specialists.

Monitoring of climatic conditions

Respondents were asked to indicate which climate monitoring devices they use in general, and also specifically referring to irrigation scheduling. Their responses are shown in Table 4.23.

Table 4. 23: Monitoring of climatic conditions by respondents (N = 31)

Use of rain- gauges	Number of respondents	Use of rain- gauges in irrigation	Number of respondents	Use of evapo- transpiration pan	Number of respondents
Well integrated with scheduling	2	Well integrated with scheduling	11	Well integrated with scheduling	0
Yes	28	Yes	9	Yes	2
Don't use	0	Don't use	10	Don't use	28
Unanswered	1	Unanswered	1	Unanswered	1
TOTAL	31	TOTAL	31	TOTAL	31

Table 4.23 indicates that although 90% respondents make use of rain-gauges, only two (6%) integrates them well with scheduling. The latter means that they actively make use of measurements of rainfall to determine the amount of water needed to apply by their irrigation systems. Ten (33%) respondents do not make use of rain-gauges in their irrigation systems. One respondent still uses flood irrigation and therefore cannot use it actively to measure water put down with a rain meter. Table 4.23 also shows that 11 (36%) respondents make use of rain-gauges directly in their scheduling activities. This means they use rain-gauges to assess the water put down by their irrigation systems. Only one does it on a regular basis while the rest do it at the beginning of the season to calibrate their systems.

The use of evapo-transpiration pans seems to be out of fashion. Only two respondents still make use of such instruments, and then it is not well integrated with their scheduling activities.

Regarding the use of mini-maxi thermometers:

- 33% respondents use it
- 42% respondents do not use it, and
- 25% respondents integrates it well in their scheduling activities.

4.10 PERCEPTIONS OF RESPONDENTS OF THE ACCEPTABILITY OF SWB

The presentation file was used to assess the following attributes of the innovation (SWB). The model was explained to respondents, after which they could ask questions and discuss the model. Then they were asked different questions to make the assessments of their perceptions. Both surveyors came to the following conclusions concerning the use of the presentation file, after the survey:

- It is an acceptable way to present the SWB model to respondents, if the presentation is made objectively
- Respondents understood the basics of SWB after the presentation
- The complexities of SWB are masked to a great extent, therefore respondents
 - could be misled and conclude that the model is very easy to apply and sustain in practice
 - computer illiterates could come to the conclusion that SWB is straightforward and will be mastered very quickly (field experience proved that it takes dedication and that applicators go through a steep learning curve)

The results discussed in section 4.10 should be read against those conclusions.

The acceptability of SWB for farmers was tested by making use of the description of Rogers (1983) of the attributes of an innovation. In this case some of the attributes were estimated by more than one measurement. Table 4.24 shows the seven different attributes and the number of measurements (total = 17) that were made per attribute.

Table 4. 24: The attributes of SWB and their number of measurements (adapted from Bembridge, 1991)

Measurements per attribute(*)	Attribute		
1	Cost and		
2	Risk		
3	Complexity		
4			
5	Visibility		
6	Divisibility		
7			
8			
9	Compatibility		
10			
11			
12	Utility		
13			
14			
15	Group action		
16			
17			

(*) For statistical purposes

Table 4.25 shows how the different measurements of the attributes of SWB correlate with one another. This implicates that the correlations show the level of overlap between the different attributes, i.e. those which are highly correlated essentially measure very similar variables or dimensions of similar variables.

Table 4. 25: Correlation matrix of the different attributes of SWB (the innovation).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1																
2	0.612885	1															
3	0.350419	0.393035	1														
4	0.036648	0.063754	0.373509	1													
5	0.083225	0.028074	0.725	0.567734	1												
6	-0.15893	-0.24117	0.466874	0.565993	0.713651	1											
7	0.381227	0.00509	0.396636	0.311532	0.747942	0.350707	1										
8	0.165073	0.142222	0.586912	0.572271	0.766075	0.688126	0.476083	1									
9	0.211523	0.228584	0.595509	0.530592	0.703783	0.594329	0.434363	0.976625	1								
10	0.09111	0.109397	0.575957	0.479913	0.579248	0.793748	0.18201	0.845853	0.807491	1							
11	0.528366	0.291267	0.3125	0.186754	0.11875	0.258448	0.084993	0.374543	0.318056	0.473108	1						
12	0.274638	0.177187	0.103807	0.359811	0.062284	0.008308	0.395266	0.102611	0.148363	-0.01913	0.103807	1					
13	-0.52014	-0.63099	0.079589	-0.01903	0.270604	0.426788	0.052914	0.26552	0.227501	0.389771	-0.20892	-0.19608	1				
14	-0.12139	-0.11132	-0.25347	0.053858	-0.02253	0.069124	0.156599	-0.19487	-0.18052	-0.12457	-0.17602	0.110703	-0.14704	1			
15	-0.44978	-0.16473	-0.37937	0.045344	-0.26556	-0.01349	-0.32674	-0.375	-0.36421	-0.3213	-0.30824	-0.04026	-0.21605	0.678091	1		
16	0.374976	0.154789	0.253917	0.216777	0.551362	0.169353	0.641272	0.340633	0.298492	-0.00955	0.099753	-0.06025	-0.39263	-0.03269	-0.22935	1	
17	0.496684	0.353821	0.091593	0.169685	0.045796	-0.07086	0.157772	0.113173	0.093221	-0.06391	0.269054	0.16734	-0.54528	-0.53035	-0.43782	0.611326	1

In a later section a model to predict how readily SWB would be acceptable to respondents is built. Each of the attributes was measured on a 1-10 scale and by one or more measurements of the aspects that make up the attribute. The differential contributions of the attribute of the innovation (SWB) have not been measured. Therefore the assumption is made that they all contribute equally to predict the acceptability of SWB. Those characteristics that were measured by more than one of its aspects, will be totalled, and then divided by the number of aspects measured. The highest score is 70.

Therefore the acceptability of SWB = 0.5(perception of costs) + 0.5(perception of complexity) + (perception of visibility) + 0.5(perception of divisibility) + 0.25(perceptions of compatibility) + 0.5(perception of utility) + 0.5(perception of group action)

Cost and Risk

This is an estimation of the perception of respondents of the difference in cost between their current irrigation scheduling activities and SWB (Rogers, 1983: 210-232; Bembridge, 1991: 186). They were also asked to estimate whether the use of SWB would hold greater risks than their current method of scheduling. Respondents' reactions are shown in Table 4.26.

Table 4. 26: Respondents' perceptions of the differences in costs and risk between their current scheduling activities and SWB (N = 31)

Perceived costs of SWB	Number of respondents	Perceived risks of SWB	Number of respondents	
Costs the same	10	No risk	9	
More expensive	10	Risk same as now	14	
Much more expensive	10	Greater risk	8	
Not answered	1	Not answered	0	
TOTAL	31	TOTAL	31	

According to Table 4.26 only ten respondents perceive SWB as costing the same as their current scheduling. The rest (65%) believes SWB will cost them more than currently. This can be attributed to the following:

- The necessity to buy a new computer (or to upgrade) and to buy the SWB programme.
- The need to be taught the programme or mentored by a consultant, which would cost money.
- Costly changes they will have to affect in their current systems to accommodate the use of SWB.

Only 26% respondents perceive the application of SWB as a greater risk than their current method of scheduling.

Complexity

Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers, 1983: 210-232; Bembridge, 1991: 186).

Table 4. 27 Respondents' perceptions of the complexity of SWB (N = 31)

Perceived understand-ability of SWB	Number of respondents	Perceived ease-of- use of SWB	Number of respondents	
Very easy	22	Very easy	25	
Not easy nor difficult	4 Not easy nor difficult		3	
Difficult	4	Difficult	3	
Not answered	0	Not answered	0	
TOTAL	31	TOTAL	31	

The consultants who took SWB into the field and introduced it to farmers said:

"SWB is not an 'easy' model to understand, nor is it easy to use. It takes lots of time getting used to, and requires one to spend a lot of time using it, before it becomes friendlier to use. Yet it is impressive in what it can do for you."

Therefore one can expect respondents to indicate similarly. Yet, Table 4.27 shows the opposite. The way in which it was presented to them may have influenced them to perceive it the way they did. Another way will have to be found to measure this dimension more accurately.

Visibility

This is also called "observability" and means the degree to which the results of an innovation are visible to others (Rogers, 1983: 210-232; Bembridge, 1991: 186).

SWB is a computer model, which can be demonstrated to respondents. Yet, the complexity of the model could scare off potential users, especially computer illiterates. Furthermore, when one would have to install a computer to illustrate the model, respondents could also be scared off. Therefore the presentation file was used. After the presentation file had been shown to them, most respondents asked questions about this aspect so they had some guidance in this respect.

There is another dimension to this issue - the ability of a respondent to "see" how she/he will apply SWB in practice:

- what the effects of SWB will be,
- how it will influence his/her day-to-day activities,
- what it will require to apply it properly, and
- the implications on the household.

All of those were implied by this measurement.

Table 4. 28: The ability of respondents to visualise the application of SWB (N = 31)

Ability to visualise the utilisation of SWB	Number of respondents
Very easily	18
Rather easy	13
Not at all	0
TOTAL	31

Respondents did not hesitate to indicate that they find it easy to visualise the application of SWB.

Divisibility

Divisibility is also called "trialability" and means the degree to which an innovation may be experimented with on a limited basis (Rogers, 1983: 210-232; Bembridge, 1991: 186).

Table 4. 29: Respondents' perceptions of the divisibility of SWB (N = 31).

Willingness to try SWB alone	Number of respondents	Willingness to try SWB with assistance	Number of respondents
Very willing	19	Very willing	28
Willing	7	Willing	3
Unwilling	5	Unwilling	0
Not answered	0	Not answered	0
TOTAL	31	TOTAL	31

Most respondents (84%) were willing to try SWB by themselves. Only 16% were unwilling to try SWB by themselves. When told that they could be assisted when they try SWB, all were willing.

Compatibility

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 1983: 210-232; Bembridge, 1991: 186).

Table 4. 30: Respondents' perceptions of the compatibility of SWB with their current application of scheduling, and their farming systems (N = 31)

Compatibility of SWB with current scheduling	Number of respondents	Compatibility of SWB with farming system	Number of respondents
Highly compatible	23	Highly compatible	24
Compatible	4	Compatible	3
Not compatible	4	Not compatible	3
Not answered	0	Not answered	0
TOTAL	31	TOTAL	31

The minority respondents (10-13%) indicated that SWB is not compatible with their current application of scheduling.

Respondents were asked to describe the goals they want to achieve in the farming enterprises. Thereafter they had to indicate whether SWB would be compatible with those goals. Table 4.31 shows the results.

Table 4. 31: Farming goals of respondents and their compatibility with SWB (N = 31)

Farming goals of respondents	Number of respondents	Compatibility between farming goals and SWB	Number of respondents
To make money / maximise profit	22	Highly compatible	23
To achieve optimum production and optimum use of water	4		
To survive without unskilled labour	1	Compatible	6
To enjoy farming, for nostalgic purposes	3		
To make enough money to retire in comfort	1	Not compatible	2 -
TOTAL	31	TOTAL	31

Similarly respondents were asked to indicate what they want to have achieved at retirement.

The results were as follows:

- consistent with what they want to achieve in farming, viz. to make money, 16 (52%)
 said they want sufficient money to retire in comfort;
- three who had said they wanted to make money, said they want their children to be able to farm when they retire;
- 75% of those who said they wanted to optimise production, indicated they want to have sufficient money to retire in comfort;
- two respondents who farmed for their enjoyment, said that they wanted to be able at retirement " ... to look back and say that it was enjoyable", the other one, like many others, wanted to have sufficient money to retire in comfort.

Utility

Utility is also called "relative advantage" which means the degree to which an innovation is perceived as better than the one it supersedes (Rogers, 1983: 210-232; Bembridge, 1991: 186).

Table 4. 32: Respondents' perceptions of the utility of SWB (N = 31)

Satisfaction with current scheduling method	Number of respondents	Extent to which SWB will be an improvement over current scheduling method	Number of respondents	
Very satisfied	16	Big improvement	18	
Satisfied	12	Improvement	11	
Unsatisfied	2	No improvement	2	
Not answered	1	Not answered	0	
TOTAL	31	TOTAL	31	

Most respondents (52%) said they are very satisfied and 39% were satisfied with their current scheduling method. Yet, only two indicated that SWB would not be an improvement over their current scheduling method. This shows that most really perceived SWB very positively.

Group action

Some innovations are only perceived as acceptable when certain groups in the community do so and approve thereof (Bembridge, 1991: 186). Table 4.33 shows respondents' willingness to use SWB in connection with groups, and not necessarily as individuals.

Table 4. 33: Respondents' willingness to use SWB as individuals (N = 31)

Willingness to apply SWB as the first farmer in the area	Number of Willingness to appression of SWB as the only farmer in the area		Number of respondents
Very willing	16	Very willing	19
Willing	4	Willing	3
Unwilling	11	Unwilling	9
Not answered	0	Not answered	0
TOTAL	31	TOTAL	31

The farmers who indicated their unwillingness to apply SWB as the first (or only) farmer in the area, quantified their statements by saying one of the following:

- "If nobody else does it, there's something wrong with it and I will not try it."
- "I do not want to pay 'school fees' for other people."
- "Let others try it out first and sort out the problems, then I will use it. Then the others can also help me with it."
- "I am never first to try out something new."

Two respondents seemed quite thrilled to think of being seen as the "first" and "only" farmer to use SWB. However 90% indicated that it does not matter to them what others do or think, they want to know SWB will improve their current financial position and make farming easier, then they will accept it.

Calculating the probable acceptance of SWB by Loskop farmers

(Also refer to section 4.10).

The following parameters were used to estimate SWB's probable acceptability to a respondent:

61 - 70 (i.e. > 86% score)	probably highly acceptable
51 - 60 (i.e. score 73-85)	probably acceptable
<51 (i.e. score lower than 73%)	probably unacceptable

The results of these calculations are shown in Table 4.34.

Table 4. 34: The calculated acceptability of SWB for respondents (N = 31).

Probable acceptability of SWB	Number of respondents
Probably highly acceptable	4
Probably acceptable	14
Probably not acceptable	13
TOTAL	31

According to Table 4.34:

- □ 13 (42%) respondents will probably not accept SWB
- □ 14 (45%) respondents will probably accept SWB, but not necessarily easily
- □ 4 (13%) respondents will probably accept SWB easily

Willingness to pay for scheduling advice

Most respondents said that they would be willing to try SWB, were they helped by a consultant. Therefore they were asked to indicate if they would be willing to pay for such a service. Table 4.35 shows the results.

Table 4. 35: Willingness of respondents to pay for an irrigation scheduling service (N = 31)

Willingness to pay for a scheduling service for SWB	Number of respondents		
Very willing	23		
Willing	7		
Unwilling	1		
Not answered	0		
TOTAL	31		

Most (97%) respondents were willing to pay for assistance with SWB. They were then asked how or how much they would be willing to pay. They were unsure of the method of payment.

Table 4.36 shows the different ways which respondents indicated as possibilities for payment of irrigation scheduling services. They made several suggestions simultaneously, because they were unsure and speculative. Therefore the total number of nominations shown in Table 4.36 do not equal the number of respondents.

Table 4. 36: Proposed methods of payment for scheduling assistance (N = 31).

Method suggested	Number of respondents
Link payment with crop yield increases / successes	8
Per pipe installed	5
Depends on inputs of service provider / visiting time	4
Per month / per season	7
Per hectare	7
Per crop	3
Do not know	3
Not prepared to pay for advice	2

Regarding how much they were willing to pay, many (55%) respondents said they wanted to know the amount the service provider would charge, compare these costs to the perceived advantage they would get, and then they would decide whether they would make use of irrigation scheduling services. Generally however, they are unsure of what method of calculating the cost should be and they also made several suggestions. Some follow below:

- "It depends on the (quality) service".
- "I am unsure" or "I do not know."
- "R10/ha/month."
- "In total R300-500 per month."
- "R250/pipe/m (on 25ha cotton, 4 pipes)."
- "R2500 per season."

Generally they want to pay per month or after the season when they have received payment for their crops. It seems that they would use payment per month to make estimations of scheduling running costs per month.

4.11 REASONS WHY LOSKOP FARMERS DON'T (PROPERLY) APPLY IRRIGATION SCHEDULING

Many respondents (73%) said they apply irrigation scheduling and 11 respondents said they are being serviced by an irrigation consultant (refer 4.7.1). The following aspects concerning the non-application of irrigation scheduling were mentioned by respondents, but not necessarily directly in the context of non-application:

- "The meters (Tensio-meters) are expensive and they don't last long, costing money."
- "The meters (Tensio-meters) need to be constantly checked for accuracy and calibrated, which costs money and takes a lot of time."
- "I still use the old Irro-meters since they work well."

- "Scheduling is okay as long as it does not take too much time and money."
- "Computer model scheduling seems okay, but it must not be expensive and take too much time."
- "It is frustrating to come back home at night and then you still have to feed the computer with all sorts of information. And then wait for the recommendation. And then sometimes not be able to apply what is recommended."
- "What I want from a computer scheduling model is that it works easy, it must tell me fast and easy the amount of water I need to put down."
- "I only want to put in the data and then see what (amount of water and when) is needed."
- "Scheduling must not be too much effort for what you get out of it."
- "A computer virus caused much damage to my scheduling."
- "I had a breakdown in scheduling activities when the quality of service I got went down and eventually stopped."
- "I did use tension-meters earlier but stopped I do not know why. Maybe I got lazy."
- "I did schedule earlier, but don't do it any more. Laziness..." (A local consultant indicated that he discontinued this farmer's services, since his "... own programme became too full, and he therefore got those who are not really interested out of the system." Incidentally this is one of the farmers who indicated that he farms for the enjoyment thereof.)
- "A person who wants to tell me about scheduling must be farming also so that he knows what he is talking about."
- "Sometimes I get advice from my consultant, e.g. to put down a certain amount of water, which my system cannot handle."
- "My farming and irrigation systems were not developed to accommodate scheduling properly."
- "Farmers' system are, in many cases, not suitable for scheduling."
- "I do not want to work with computers. My son must do that."
- "The form of my farm prohibits me from using a pivot system. It is narrow and long."

These quotations clearly indicate that there are a variety of factors concerning irrigation scheduling are rendered important by irrigation farmers. These factors are shown in Table 4.37.

Table 4. 37: Important factors concerning irrigation scheduling, as reported by respondents.

Factor	Explanation					
Cost	The start-up costs must be low. The running cost must be low.					
Time	The get the scheduling recommendations from the system must not take long. The time to run the (computer) irrigation scheduling programme must be short.					
Ease of application	The scheduling activities must: be easily understandable be easy to apply fit into the other farming activities					
Irrigation systems adapted to scheduling	The way in which irrigation is done must be able to accommodate scheduling activities. Especially in the case of permanent crops, the whole orchard, vineyard or field must be planned from the beginning to accommodate scheduling.					
Computer literacy and application	In the case of computer based scheduling models, the model must be easy to apply: the initial set-up must be easy – plug-and-play type of model there must be the minimum of screens for users (farmers) the recommendations must be clear and easy understandable the programme must be user-friendly the manual must be in simple straightforward language and easily understood by users there must be a back-up system to solve technical problems					
Timeous, continuous and continuing service by a consultant	Many users need assistance by a consultant or a manager. This varies from user to user and includes: help with installation of field tools and the computer and irrigation system, taking field measurements, putting data into the computer, checking for accuracy, running the programme, interpreting the recommendations, to decision-making regarding the application of the recommendations. The assistance service must be regular, on time and continuous.					

Consultants agree that farmers find security in the fact that they regularly visit them and interact with them regarding scheduling and other farming activities. Among other things, consultants said:

- "A farmer seems to feel more secure when he knows you will be visiting him on the same time every week and that you will be checking and assisting."
- "Most farmers want you to assist them with decision-making regarding water application in terms of time and quantity."
- "Farmers do not want to be bothered with measurements that are too technical and take up their time."
- "If you stop your service to a farmer, the chances of (him) continuing are very small."

4.12 ADAPTATIONS TO THE SWB MODEL

The SWB model has been introduced to Loskop irrigation farmers during the beginning of 1998. It therefore created an opportunity to analyse the changes that need to be made to this model to increase its acceptability for users. This means that the last goal of the research could be achieved on this irrigation scheme, namely to make initial changes to the SWB model, to increase its acceptability.

Since the first individuals to accept SWB were consultants, the feedback concerning changes to the practical application of the model came from them. Many of the changes are not focused of the acceptability of the model, but on the practical application thereof.

Changes made to the program

The following changes to SWB were requested:

Write an "Icon import" function.

- Change the programme to (more easily) accept a smaller number of measurements per point in the field.
- Write software for linking the neutron probe with the applicant's computer to directly off-load field data.
- Rather change the hourly recommendations for pivots from hours to the % setting of the pivot. When you set up the programme for pivots, read in the specifications of the pivot.
- Upgrade the security of the system in terms of pirate copies.
- Decrease the number of screens a farmer can see build in choice settings for those.
- Create facilities to back-up field and recommendation data.
- All data screens must have a print option and function.
- Sort out the complexity with handling permanent crops' planting dates and starting dates.
- The screen for assistance must have contact numbers of people closer to the farmer than Pretoria.
- An Afrikaans version would be welcome.

Changes required in future

Changes for the future are not clear and will surface as the programme matures in the field. Since not all crops are taken up in the model and climatological data are not area- and field specific, localised information and feedback would increase the usability of SWB. Adaptations regarding those should be made on a continuous basis.

4.13 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The presentation file is a suitable way of measuring the perceptions that influence the acceptability of SWB.

- The application of irrigation technology is constantly changing, making it difficult to measure the "status quo."
- Forty-five percent respondents make use of computers for irrigation scheduling purposes.
- Respondents are aware of irrigation scheduling, and 81% had an idea or knew well what scheduling is.
- There is a tendency among irrigation farmers who apply scheduling themselves to apply a schedule based on time rather than anything else.
- There is a relationship between perceiving scheduling as important and the application thereof.
- Respondents perceived scheduling as being a major contributor to save money and water.
- The fact that respondents pay a flat rate for irrigation water seems to motivate against saving water.
- Respondents perceive the cost of water to be high, but do not have a particular choice of payment for it.
- Respondents are politically aware, yet unsure of the current debate concerning water rights.
- The general administration of water at Loskop does not seem to be a problem to respondents, and they are satisfied.
- Respondents do not know of all the consultants who support irrigation farmers at Loskop, nor do they know if consultants are qualified to give irrigation scheduling advice.
- Respondents believe that extension can play a role to alleviate the problem of non-scheduling at Loskop, but do not seem to have substantial proposals regarding the issue. There seems to be some discontent with the state extension services, and respondents seem inclined to shift to the private sector for scheduling services and -advice.
- Respondents do not have sufficient knowledge of the soil, plants and climate as were deemed necessary by academics and specialists.
- Rain-gauges are not well integrated with irrigation scheduling activities.

- SWB was perceived favourably by respondents. There may be an inclination towards over-optimism concerning SWB.
- It was estimated that 13% respondents might accept SWB easily. This is consistent with the guidelines of Rogers (1983: 247) regarding adopter categories.
- It was estimated that 45% respondents may accept SWB, but not necessarily easily. This is higher (11%) than the guidelines of Rogers (1983: 247) regarding adopter categories
- Respondents are quite willing to pay for scheduling advice and -services, but are unsure of the method and amount. There is a tendency to link payment with increased crop yields and income.
- Reasons for not using irrigation scheduling revolves around cost, time, ease-of-application, field geography, computer literacy and -application, and consistency and continuance in irrigation scheduling services.
- Several technical changes had to be made to the SWB program to make it userfriendlier, especially for consultants.
- Future changes are unclear and will unfold as SWB application matures in the field. However, measures should be made to continue the upgrading of SWB and to secure the program.

Recommendations

- As a research tool, use of the presentation file should be developed further.
- Loskop farmers should be persuaded to change from time based scheduling activities to more accurate scheduling technologies and application. The perception that scheduling is important should be cultivated further at Loskop, since it is related to scheduling application. Farmers' knowledge concerning irrigation related issues might be upgraded.
- The milieu for computer based scheduling at Loskop is positive and conducive for change. The SWB model might be accepted in a way similar to most innovations, in spite of the fact that it is technology intensive and -dependent. SWB should be refined on a continuous basis and advertised among consultants and Loskop farmers. The

private sector should be getting involved with SWB application. Farmers need to be informed of irrigation advice service providers. The Loskop Irrigation Board may find it worthwhile to play a leading and facilitative role in this regard.

- There seems to be good reason to believe that SWB will be accepted in the "normal" way and the fact that respondents are positive about paying for scheduling advice should be taken advantage of by consultants and other extension providers.
- When irrigation scheduling advice is provided, it must be on a continuing basis, cost effective, timeous, and easy for farmers to understand and apply.
- SWB needs to be upgraded continuously to reflect and apply the local climatic data and conditions, and to make it user-friendlier for farmers and consultants. This upgrading should be planned for and may be accommodated by the WRC in some way or other.

4.14 REFERENCES

AGRIMODEL, 1996. A base line reference to opportunities for agricultural development and investment in the Loskop Valley of Groblersdal district. Draft copy of the report to the Provincial Consultative Development Council, Mpumulanga Province. Drafted by EC Butler, SG Ferreira and JL van Zyl.

BEMBRIDGE, T.J., 1991. The practice of agricultural extension: A training manual.

Development bank of Southern Africa: Halfway House.

BENADé, N., 1998. Personal communication. Private consultant and programmer.

DU TOIT, B., 1998. Personal communication. Private Irrigation Scheduling Consultant and irrigator, Loskop.

MYNHARDT, P., 1998. Personal communication. Private Irrigation Scheduling Consultant. Loskop.

ROGERS, E.M., 1983. Diffusion of innovations. 3rd edition. New York: The Free Press.

VENTER, J., 1998. Personal communication. State agricultural extension technician, Loskop.

CHAPTER 5

LESSONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 LESSONS, CONCLUSIONS AND RECOMMENDATIONS FROM THE RUST DE WINTER IRRIGATION SCHEME

These lessons, conclusions and recommendations stem for this research that was done regarding computer-based irrigation scheduling at resource-poor, disadvantaged irrigation schemes, as it was found at the Rust de Winter Irrigation Scheme.

- Even before land is allocated for re-distribution or any other purposes, proper extension services and support should be planned and put in place. This should not be left until after the land has been allocated and handed over. Beneficiaries and prospective farmers should find extension staff on sire when they start their farming enterprises.
- Ground level support for the implementation of sustainable irrigation practices is imperative. Irrigation scheduling and -practices are complicated and beneficiaries will require committed support and timeous, continuous advice form extension workers and advisers.
- Consultants seem to be expensive and can therefore only be used for a short and often limited period of time. Measures should be put in place to cater for the medium and long term irrigation scheduling needs of beneficiaries.
- Every beneficiary's farming and other basic life skills must be developed. This may be effected through the involvement of farmers and their organisations in the planning as well as the development of training strategies.
- Recommendations concerning irrigation scheduling models, and the successful adoption and application thereof are dependent on:
 - the socio-political milieu (particularly land tenure and security issues)

- beneficiaries' farm management capabilities
- irrigation scheme design and management
- plot design and outlay
- soil types and climate of the area
- labour availability
- an agricultural commodities' market.
- Irrigation scheduling does not function in isolation, and cannot be effected appropriately as a group of stand-alone irrigation related activities. Other important issues which influence its effectiveness are, as in this case:
 - wide community support for and during the whole process of intervention
 - · a viable and practical implementation plan
 - · appropriate prices for land (both purchase and lease) and water
 - access to affordable credit.
- Effective irrigation scheduling can only be effected once appropriate institutional measures, on-farm management and commitment and appropriate infrastructure are in place.

5.2 LESSONS, CONCLUSIONS AND RECOMMENDATIONS FROM THE RIET RIVER IRRIGATION SETTLEMENT

These lessons, conclusions and recommendations stem from this research that was done regarding the continued and discontinued application of irrigation scheduling models, with specific reference to the BEWAB model.

Respondents' age, level of formal education and vocational training did not interfere with the application of irrigation scheduling. Extension workers cannot change these

- variables, and in this case they work in the favour of adoption of new irrigation scheduling technologies.
- The availability of computers may be a seriously inhibiting factor. Obviously can computer based irrigation scheduling technologies not be applied when suitable computers are unavailable. In this case they were unavailable to many farmers, since they did not have them.
- Lack of computer literacy and basic computer skills may be stifling the application of computer based irrigation scheduling models. Farmers will have to be trained in computer applications and -use before, during and after they accept computer-based irrigation scheduling models.
- Respondents know the benefits of irrigation scheduling. This provides an appropriate starting point for extension work concerning computer-based irrigation scheduling models.
- It is unclear why irrigation scheduling models at large are discontinued. However, in this case irrigation scheduling was advisor-driven and not farmer-driven. When the advisor stops driving the process, scheduling comes to a standstill on many farms. Farmers should be brought to a point where they run scheduling by themselves, unless they prefer to have it done by a consultant for them. Even then they are involved in the process and must understand the basic functioning of scheduling.
- Variations in soil types and water-table problems may lead to the rejection of irrigation scheduling. In cases where there are large variations in soil types in the same fields, scheduling becomes problematic with most conventional irrigation systems, which cannot deal with the required variations in site-specific water application.
- A basic working knowledge of resources is required to do effective scheduling. This is a matter of great concern, since it is almost absent in Rietrivier. This lack of knowledge should be upgraded to a level where farmers know and understand the basics and basis of water movement in plants, the soil and climatic environment of their fields.
- The quality of irrigation water should be monitored and checked regularly by the authorities. Major problems can occur with contaminants like weeds, algae and sludge,

- especially for overhead irrigation. Farmers pay for their water and have a right to clean irrigable water.
- Institutional arrangements must be flexible and farmers must have a direct say in the management of irrigation schemes. In this cases there were some concerns that can be addressed through proper management of the scheme at large. Farmers must identify with the scheme to such an extent that they take ownership of the system through proper representation on an Irrigation Board or another governing body.
- Irrigation scheme management must be affordable, cost-effective and transparent. Alternative ways of running irrigation schemes should always be sought in an attempt to optimise all its resources.
- The price of water should reflect commodity and market prices. Increasing the price of water while at the same time farmers receive less for their produce will put them in a very awkward position.
- In terms of water, farmers should pay for what they use. This could be difficult to operationalise on irrigation schemes. But it may contribute significantly to more effective use of water resources.

5.3 LESSONS AND CONCLUSIONS FROM THE LOSKOP IRRIGATION SCHEME

These lessons, conclusions and recommendations stem from this assessment of acceptability of the SWB computer-based irrigation scheduling model.

- Availability of computer equipment with acceptable capacity may be a problem.
- Awareness of irrigation scheduling is not a problem, but the perception that scheduling is acceptable when used on a time basis only, is widespread and may cause difficulties. Loskop farmers should be persuaded to change from time based scheduling activities to more accurate scheduling technologies and application. The perception that scheduling is important should be cultivated further at Loskop, since it is related to scheduling

- application. Farmers' knowledge concerning irrigation related issues might be upgraded.
- Farmers who apply irrigation scheduling also perceive it as important.
- Framers believe that irrigation scheduling can help them to save money and water.
- When farmers pay for water irrespective of whether they use it or not, they perceive it as wasteful.
- The cost of water is a matter of concern to farmers, but they do not have a particular preference for manner of payment, i.e. volumetric or per area.
- Farmers do not know their current and future status concerning their rights to irrigation water.
- The administration of water can stifle irrigation scheduling activities and application.
- Irrigation advisors are not sufficiently involved with making farmers aware of their services.
- There is a need for a role player to take initiative concerning irrigation scheduling in terms of facilitating the needs of farmers and service providers.
- For effective computer based irrigation scheduling a basic knowledge is required of:
 - the soil, plants and climate,
 - · soil water content measuring,
 - · the scheduling programme, and
 - the general workings of a computer.
- The attributes of SWB seem to make it acceptable to the more innovative farmers. The milieu for computer based scheduling at Loskop is positive and conducive for change. The SWB model might be accepted in a way similar to most innovations, in spite of the fact that it is technology intensive and -dependent. SWB should be refined on a continuous basis and advertised among consultants and Loskop farmers. The private sector should be getting involved with SWB application. Farmers need to be informed of irrigation advice service providers. The Loskop Irrigation Board may find it worthwhile to play a leading and facilitative role in this regard.

- There seems to be good reason to believe that SWB will be accepted in the "normal" way and the fact that respondents are positive about paying for scheduling advice should be taken advantage of by consultants and other extension providers.
- Willingness to pay for irrigation scheduling advice does not seem to be a problem. The issues of how much, when and how to pay are still unclear.
- The application of irrigation scheduling becomes viable to farmers when it is perceived as:
 - not too expensive,
 - not too time-consuming,
 - · challenging but not difficult to apply,
 - suitable for specific fields,
 - supported by capable, knowledgeable, accessible and committed irrigation scheduling services providers.
- When irrigation scheduling advice is provided, it must be on a continuing basis, cost effective, timeous, and easy for farmers to understand and apply.
- SWB needs to be upgraded continuously to reflect and apply the local climatic data and conditions, and to make it user-friendlier for farmers and consultants. This upgrading should be planned for and may be accommodated by the WRC in some way or other.

5.4 ARCHIVING OF DATA

- This report is available in this format from the Water Research Commission. Copies are also kept at the University of Pretoria.
- All original documentation, e.g. forms, questionnaires and stiffies are available at the Department of Agricultural Economics, Extension and Rural Development, University of Pretoria.

ANNEXURE A

LOSKOP QUESTIONNAIRE

VRAELYS OOR DIE AANVAARBAARHEID VAN SWB VIR BOERE OP DIE LOSKOP SKEMA Opnemer:......Datum:..... Boer: Naam en van: Plaas naam en grootte: Ouderdom: Aantal hektaar onder besproeing: Opleiding: skool ander Kursusse bygewoon: Aantal jare boerdery ervaring: Ander werkservaring: Gewasse onder besproeiing: Aanduiding van rotasie van gewasse: (by mielies, koring, mielies) U belangrikste gewasse in terme van inkomste: U belangrikste gewasse in terme van oppervlakte onder besproeiing: Besit u 'n rekenaar?

Gebruik u 'n rekenaar in u boerdery?

Verduidelik asb.

DIE PERSEPSIE VAN BESPROEINGSKEDULERING IN DIE ALGEMEEN.

- 1. Het u voorheen van besproeiingskedulering gehoor? JA / NEE / ONSEKER
- 2. Indien wel, waar en wanneer?
- 3. Wat het u daaromtrent gehoor?
- Wat dink u is besproeiingskedulering? (Beskryf asb)
- Doen u tans besproeiingskedulering?
- (Indien die boer dit nie nou doen nie, maar dit wel voorheen gedoen het: Waarom doen u dit nie meer nie?)
- 7. Hoe belangrik dink u is besproeiingskedulering?

```
1/2/3/4/5/6/7/8/9/10 (1 = onbelangrik; 10 = baie belangrik)
```

8. Hoe belangrik dink u is dit dat boere besproeiingskedulering toepas?

```
1/2/3/4/5/6/7/8/9/10 (1 = onbelangrik; 10 = baie belangrik)
```

- 9. Waarom sê u so?
- 10. Hoe maklik dink u is besproeiingskedulering?

```
1/2/3/4/5/6/7/8/9/10 (1 = uiters moeilik; 10 = baie maklik)
```

11. Hoe nodig dink u is dit dat boere in die toekoms meer water bespaar?

```
1/2/3/4/5/6/7/8/9/10 (1 = onbelangrik; 10 = baie belangrik)
```

12. Tot watter mate dink u kan skedulering 'n rol speel om WATER te bespaar?

```
1/2/3/4/5/6/7/8/9/10 (1 = geen rol; 10 = baie groot rol)
```

13. Tot watter mate dink u kan skedulering 'n rol speel om GELD te bespaar?

$$1/2/3/4/5/6/7/8/9/10$$
 (1 = geen rol; 10 = baie groot rol)

DIE INSTITUSIONELE FAKTORE WAT WATER GEBRUIK EN -SKEDULERING BEINVLOED

A DIE SEKURITEIT VAN WATERREGTE EN -TOEKENNING.

- 14. Vir hoe lank het u die reg om die water te gebruik?
- 15. Is dit lank genoeg?
- 16. Kan u u waterregte verkoop aan iemand anders?
- 17. Hoe seker is u dat u die hoeveelheid water sal kry waarvoor u betaal (het)?
- 18. Hoe seker is u dat u die hoeveelheid water sal kry wat u aangevra het?
- 19. Tot watter mate kan iemand anders dalk u toekenning (of 'n deel daarvan) steel sonder dat u wet daarvan?

1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = die kans is uiters goed)

- 20. Wat gebeur as u nie u volle toekenning water gebruik nie?
- □ Sal u dit verloor?
- Sal u minder betaal?
- Kan u dit verkoop aan iemand anders?

Opmerkings:

B WATER PRYSE/TARIEWE

- 21. Wat kos besproeiingswater hier by u? (Loskop)
- 22. Dink u dit is duur?
- 23. Hoe word die tariewe bereken per kubieke meter of per hektaar?
- 24. Hoe sou u die berekening verkies: per kubieke meter water of per hektaar?

Waarom?

25. Dink u dat besproeiingswater hier gesubsideer behoort te word?

C TEGNOLOGIE

26. Tot watter mate kan die hoeveelheid water wat u verbruik akkuraat gemeet word?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = dit kan baie akkuraat gemeet word)
```

27. Hoe seker is u dat u die hoeveelheid water sal kry waarvoor u betaal het?

```
1/2/3/4/5/6/7/8/9/10 (1 = heeltemal onseker; 10 = 100% seker)
```

- 28. Hoe word die hoeveelheid water gemeet wat aan u toegeken word, sodat u die regte hoeveelheid kry?
- 29. Hoe word die hoeveelheid water gemeet wat u gebruik, sodat u nie meer gebruik as wat u toekom nie?

D BESTUUR

30. Tot watter mate het u 'n inspraak in die bestuur van die water op die skema (bv dmv mense wat aangestel is om u te verteenwoordig, of u kan openbare vergaderings bywoon, ens)

```
1/2/3/4/5/6/7/8/9/10 (1 = geen inspraak; 10 = volle inspraak)
```

Verduidelik asb

- 31. Hoe werk die aanvra van water vir besproeiing?
- 32. Hoe word die toekennings gedoen? (Hoe word besluit wie kry hoeveel water en wanneer?)

KENNIS BENODIG OM SKEDULERING TE KAN DOEN

33. Vir die opnemer: Vul asb die volgende tabel in, volgens die belangrikste gewasse van die boer. Vra die boer wat is die verskillende stadia van die drie belangrikste gewasse wat hy verbou. Vind ook uit by die boer wat is die waterbenodigdhede tydens elke fase en wat is die worteldiepte tydens elke fase.

KENNIS VAN DIE PLANT

GEWAS:	STADIUM						
	1	2	3	4	5		
Water							
benodig							
Wortel diepte							

GEWAS:	STADIUM						
	1	2	3	4	5		
Water							
benodig							
Wortel diepte							

GEWAS:	STADIUM						
	1	2	3	4	5		
Water benodig							
Wortel diepte							

KENNIS VAN DIE GROND

34. W	eet u dalk	wat is	die	veldkapasiteit	van die	belangrikste	grondsoorte	op u	plaas?
-------	------------	--------	-----	----------------	---------	--------------	-------------	------	--------

□ Grondsoort veldkapasiteit
 □ Grondsoort veldkapasiteit
 □ Grondsoort veldkapasiteit

35. Hoe weet u dit?

36. Weet u dalk wat is die verwelkpunt van die belangrikste grondsoorte op u plaas?

□ Grondsoort verwelkpunt
□ Grondsoort verwelkpunt
□ Grondsoort verwelkpunt

37. Hoe weet u dit?

38. Weet u dalk hoeveel grondwater is vir elke grondsoort beskikbaar vir u plante?

Grondsoort

beskikbare grondwater

□ Grondsoort

beskikbare grondwater

Grondsoort

beskikbare grondwater

- 39. Hoe bereken u die hoeveelheid beskikbare water?
- 40. Wat is die aanvanklike water inhoud van die grond wanneer u plant?
- 41. Hoe weet u dit?

KENNIS VAN DIE WEER (KLIMAAT)

- 42. Gebruik u reënmeters om reënval te meet?
- 43. Gebruik u reënmeters om te meet hoeveel water u besproei?

Verduidelik asb

- 44. Gebruik u 'n verdampingspan?
- 45. Hoe gebruik u dit in u besproeiing?
- 46. Maak u gebruik van minimum en maksimum temperature?

Veduidelik asb

DIE AANVAARBAARHEID VAN SWB (DIE INNOVASIE)

Prosedure: Verduidelik aan die boer(-e) dmv die leêr hoe die SWB model werk. Laat 'n kort bespreking toe en vra dan die volgende vrae:

KOSTE (Cost):

47. Tot watter mate is die SWB model duurder as die skeduleringsmetode wat u tans gebruik?

1/2/3/4/5/6/7/8/9/10 (1 = baie duurder; 10 = heeltemal dieselfde)

48. Tot watter mate sal die gebruik van die SWB model vir u 'n risiko wees?

```
1/2/3/4/5/6/7/8/9/10
```

(1 = baie groot risiko; 5 = dieselfde as tans; 10 = absoluut geen risiko)

KOMPLEKSITEIT (Complexity):

49. Hoe eenvoudig is die SWB model vir u om te verstaan?

```
1/2/3/4/5/6/76/8/9/10 (1 = uiters moeilik; 5 = gemiddeld; 10 = baie maklik)
```

50. Hoe maklik dink u sal die SWB model wees vir u om te gebruik?

1/2/3/4/5/6/7/8/9/10 (1 = baie moeilik; 10 = baie maklik)

SIGBAARHEID (Visibility):

51. Tot watter mate kan u die SWB model visualiseer ("sien" hoe om dit te gebruik)?

1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 5 = redelik maklik; 10 = uiters maklik)

UITTOETSBAARHEID (Divisibility):

52. Tot watter mate sien u kans om die SWB model self uit te toets voordat u dit gebruik?

1/2/3/4/5/6/7/8/9/10 (1 = sien glad nie kans nie; 10 = sien heeltemal kans)

53. Tot watter mate is u bereid om die SWB model te toets saam met iemand anders, wat die model baie goed ken en verstaan?

1/2/3/4/5/6/7/8/9/10 (1 = sien glad nie kans nie; 10 = sien heeltemal kans)

VERENIGBAARHEID (Compatibility):

54. Tot watter mate is die SWB model verenigbaar met die metode van skedulering wat u tans gebruik? (maw: Tot watter mate kan u SWB by u huidige metode inpas of u huidige metode aanpas tot by SWB?)

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% verenigbaar)
```

55. Tot watter mate is die SWB model verenigbaar met die wyse waarop u tans boer? (maw tot watter mate kan SWB inpas by die wyse waarop u boer?)

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% verenigbaar)
```

- 56. Wat is u doelwitte in u boerdery?
- 57. Tot watter mate is SWB verenigbaar met hierdie boerdery doelwitte? (maw tot watter mate pas SWB in by u boerdery doelwitte? Of tot watter mate kan SWB help om u boerdery doelwitte te bereik?)

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% verenigbaar)
```

- 58. Wat wil bereik in u boerdery teen die tyd dat u aftree?
- 59. Tot watter mate is SWB verenigbaar met dit wat u wil bereik by aftrede? (maw tot watter mate pas SWB in by dit wat u wil bereik in u boerdery by aftrede? Of tot watter mate kan SWB help om u boerdery doelwitte by aftrede te bereik?)

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% verenigbaar)
```

60. Tot watter mate dink u mors u besproeiingswater?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = mors baie)
```

61. Tot watter mate wil u graag die vermorsing van u besproeiingswater verminder?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = wil baie graag)
```

62. Tot watter mate verhinder die huidige manier waarop u betaal vir u besproeiingswater, u eie oordeelkundige gebruik van besproeiingswater?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = uiters baie)
```

63. Tot watter mate was u voorheen suksesvol met die skedulering van besproeiing?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% suksesvol)
```

VERBETERING (Utility):

64. Tot watter mate is u tevrede dat u huidige metode van besproeiingskedulering voldoende is?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie tevrede nie; 10 = uiters tevrede)
```

65. Tot watter mate sal die gebruik van SWB 'n verbetering wees op die skeduleringsmetode wat u tans gebruik?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% verbertering)
```

GROEP AKSIE (Group action):

66. Tot watter mate sal u bereid wees om die SWB model toe te pas as u die eerste boer in die omgewing is wat dit gebruik?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% bereid)
```

67. Tot watter mate sal u bereid wees om die SWB model toe te pas as u die enigste boer in die omgewing is wat dit gebruik?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% bereid)
```

68. Tot watter mate sal u bereid wees om die SWB model toe te pas as u deur iemand (soos 'n konsultant / landbouvoorligter) daarmee gehelp word?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100%)
```

69. Dit mag dalk nodig wees om vir 'n besproeiingskedulering bystand- of adviesdiens te betaal. Tot watter mate is u bereid om vir so 'n diens te betaal?

```
1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = 100% bereid)
```

- 70. Hoe behoort die betaling vir so 'n tipe diens te wees, maw op watter basis behoort die betaling vir so 'n tipe diens bereken te word?
- 71. Hoeveel sal u bereid wees om te betaal vir 'n besproeiingskedulering bystand- of adviesdiens?

SKEMA VRAE AAN BOERE, VOORLIGTERS EN ANDER VERANDERINGSAGENTE

E VOORLIGTING

- 72. Kan voorligting 'n rol speel om die situasie tov nie-skedulering op die Loskop skema te verlig?
- 73. Is daar tans mense beskikbaar om die situasie tov nie-skedulering te verlig?
- 74. Is hierdie mense opgelei om dit te kan doen?
- 75. Hoeveel skeduleringsadviseurs is daar op die Loskop skema?

76. Hoe dink u kan die situasie tov nie-skedulering op die Loskop skema sinvol aangespreek word?

F SKEMA-UITLEG

- 77. Is die Loskop skema so uitgelê dat dit skedulering aanmoedig/ontmoedig?
- 78. Is die adminsitrasie/bestuur van water op Loskop so dat dit skedulering aanmoedig/ontmoedig?

ANNEXURE B

RIET RIVER QUESTIONNAIRE

VRAELYS OOR BESPROEIINGSKEDULERING OP RIETRIVIER, MET SPESIFIEKE VERWYSING NA BEWAB

Opnemer:Datum:
Opnemer omkring asb A of B Boer verteenwoordig Groep A (deur Dup Haarhoft bedien) of B
Boer se ouderdom:
Aantal hektaar onder besproeing:
Opleiding: skool ander
Kursusse bygewoon: (bv. Sweis, boerdery bestuur ens)
Aantal jare boerdery ervaring:
Ander werkservaring:
Gewasse onder besproeiing:
Aanduiding van rotasie van gewasse: (bv mielies, koring, mielies)
U belangrikste gewas in terme van inkomste:
U belangrikste gewas in terme van oppervlakte onder besproeiing:
Besit u 'n rekenaar?
INDIEN BOER 'N REKENAAR BESIT: Gebruik u 'n rekenaar in u boerdery?
Verduidelik asb.

DIE PERSEPSIE VAN BESPROEINGSKEDULERING IN DIE ALGEMEEN.

- 79. Het u voorheen van besproeiingskedulering gehoor? (Omkring) JA / NEE / ONSEKER INDIEN NEE DOEN VRAAG 4 INDIEN JA DOEN VRAAG 2 EN 3
- 80. Indien wel, waar, wanneer en by wie het u van besproeiingskedulering gehoor?
- 81. Wat het u daaromtrent gehoor?
- 82. Wat sê u is besproeiingskedulering? (Beskryf asb)
- 83. Noem asseblief u bronne van besproeiing-informasie, in volgorde van belangrikheid:
- 84. Het u voorheen skedulering gedoen?
- 85. Is u nog steeds daarmee besig?
- 86. Indien u skedulering op een of ander tyd gestaak het, verduidelik asb waarom?
- 87. Verduidelik asseblief hoe u skedulering doen op die GROOTSTE deel van u landerye

VRAAG 10 IS NET VAN TOEPASSING AS 'N BOER AANTOON DAT HY TANS SKEDULEER

88. Hoe tevrede voel u met hierdie wyse van besproeiingskedulering wat u beskryf het?

1/2/3/4/5/6/7/8/9/10 (1 = baie ontevrede; 10 = uiters tevrede)

Verduideliking as boer dit verskaf:

89. Hoe belangrik dink u is besproeiingskedulering?

1/2/3/4/5/6/7/8/9/10 (1 = onbelangrik; 10 = baie belangrik)

90. Hoe belangrik dink u is dit dat Suid-Afrikaanse boere besproeiingskedulering DEEGLIK TOEPAS?

1/2/3/4/5/6/7/8/9/10 (1 = onbelangrik; 10 = baie belangrik)

91. Waarom sê u so?

92. Hoe MAKLIK dink u is besproeiingskedulering met 'n rekenaar?

1/2/3/4/5/6/7/8/9/10 (1 = uiters moeilik; 10 = baie maklik)

- 93. Verduidelik asseblief hoekom u so sê.
- 94. Tot watter mate dink u kan skedulering 'n rol speel om u WATER te bespaar? 1/2/3/4/5/6/7/8/9/10 (1 = geen rol; 10 = baie groot rol)
- 95. Tot watter mate dink u kan skedulering 'n rol speel om u GELD te bespaar? 1/2/3/4/5/6/7/8/9/10 (1 = geen rol; 10 = baie groot rol)

BEWAB EN DIE TOEPASSING DAARVAN

96. Het u al gehoor van BEWAB? (Omkring) JA / NEE / ONSEKER

(Indien die boer onseker is, dui aan dat BEWAB 'n besproeiingskedulering model is. Indien hy dan aandui dat hy wel daarvan gehoor het, gaan na die volgende vraag)

INDIEN NEE.	GAAN	ASB NA	VRAAG	NOMMER	22
-------------	------	--------	-------	--------	----

91.	Kan	u	onthou	БУ	wie u	van	BEW	AB	genoor	net?	
	Pers	00	n/insta	nsie	:						

98. Indien u al van BEWAB gehoor het, wat u gehoor daaromtrent?

DIE VOLGENDE VRAAG IS NET VIR BOERE WAT TANS WEL SKEDULEER EN AL GEHOOR HET VAN BEWAB

- 99. Wat is die ooreenkoms tussen die manier waarop u skeduleer, (soos wat u verduidelik het: Vraag 10) met BEWAB?
- 100. Watter eienskappe van besproeiingskedulering is vir uself belangrik?
- 101. Watter van die volgende twee eienskappe van rekenaar gebaseerde besproeiingsmodelle is vir u die belangrikste? Kies NET EEN (merk die toepaslike een)

AKKURATE METINGS
MAKLIK OM TE GEBRUIK

102. Aan watter eienskappe moet 'n REKENAAR GEBASEERDE besproeiingskedulering model voldoen, voordat u dit sal oorweeg om dit te gebruik?

NEEM WAAR HOE DIE BOER REAGEER EN VUL 1-3 IN	Merk X
Die boer stel glad nie belang in rekenaar skedulering nie en het die volgende redes:	
2 Die boer is onseker en weet nie wat om te antwoord nie	
3 Dit lyk of die boer het 'n goeie idee het van wat hy nodig het in terme van rekenaar gebaseerde skedulering	
EIENSKAPPE WAT GENOEM IS:	

DIE INSTITUSIONELE FAKTORE WAT WATER GEBRUIK EN -SKEDULERING BEÏNVLOED

DIE SEKURITEIT VAN WATERREGTE EN -TOEKENNING

- 103. Kan u u waterregte verkoop of verhuur aan iemand anders? JA / NEE / ONSEKER INDIEN JA - Hoe dikwels verkoop/ verhuur en vir watter bedrag u dit aan iemand anders?
- 104. Het u genoeg besproeiingswater om voorsiening te maak dat u kan boer soos u graag wil?

Opmerkings deur die boer:

105. Hoe tevrede is u met die kwaliteit/gehalte van u besproeiingswater?

1/2/3/4/5/6/7/8/9/10 (1 = baie ontevrede; 5 = neutraal; 10 = baie tevrede)

Opmerkings deur die boer:

- 106. Tot watter mate is u seker dat u aan die einde van die seisoen die hoeveelheid water gekry het waarvoor u betaal (het)?
- (Bv: U is geregtig op en het betaal vir X aantal kubieke meter water, of vir X aantal hektaar se water. Hoe seker is u dat u wel X aantal water ontvang het?)

(omkring) 1/2/3/4/5/6/7/8/9/10 (1 = heeltemal onseker; 5 = neutraal; 10 = heeltemal seker

Skryf verduideliking hier indien boer dit gee:

107. Hoe seker is u dat u die hoeveelheid water kry WAT U PER KEER AANGEVRA HET?

(omkring) 1/2/3/4/5/6/7/8/9/10 (1 = heeltemal onseker; 5 = neutraal; 10 = heeltemal seker

Skryf die verduideliking hier indien boer dit gee:

108. Tot watter mate kan iemand anders dalk u toekenning (of 'n deel daarvan) vaslê (steel) sonder dat u weet daarvan? (bv water wat oppad in die kanaal na u is, uit die kanaal uitpomp)

(omkring) 1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 5 = neutraal; 10 = die kans is uiters goed)

Kommentaar, as die boer dit gee:

109. Wat gebeur met die water en u betaling as u nie u volle toekenning water gebruik nie?

Opmerkings:

TEGNOLOGIE

110. Tot watter mate kan die hoeveelheid water wat u ONTVANG akkuraat gemeet word deur die owerhede?

(omkring) 1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 10 = dit kan baie akkuraat gemeet word)

- 111. Hoe word die hoeveelheid water gemeet wat aan u toegeken word, sodat u die regte hoeveelheid kry?
- 112. Hoe word die hoeveelheid water gekontroleer/gemeet wat u gebruik, sodat u nie meer gebruik as wat u toekom nie?

WATER PRYSE/TARIEWE

- 113. Rietrivier boere beweer dat Rietrivier besproeiingswater baie duur is. Waarom dink u is dit so duur?
- 114. Hoe verkies u om te betaal vir water per kubieke meter water of per hektaar?

Waarom?

115. Tot watter mate dink u moet besproeiingswater op Rietrivier gesubsideer word?

$$1/2/3/4/5/6/7/8/9/10$$
 (1 = glad nie; 5 = neutraal; 10 = 100%)

Verduideliking as boer dit gee:

- 116. Wat dink u sou 'n billike prys wees om te betaal vir besproeiingswater?
- 117. Op watter wyse (manier) dink u behoort die prys vir u besproeiingswater bepaal (vasgestel) te word?

BESTUUR

118. Tot watter mate het u 'n inspraak in die bestuur van die water op die skema (bv dmv mense wat aangestel is om u te verteenwoordig, of u kan openbare vergaderings bywoon, ens)

1/2/3/4/5/6/7/8/9/10 (1 = geen inspraak; 10 = volle inspraak)

Verduidelik asb

119. Hoe dink u behoort die bestuur van water op Rietrivier te werk?

EVALU	Merk met X				
Boer het nie 'r	idee n	ie			
Boer het 'n go	eie idee				
Boer is baie se	lfversel	cerd en	vol planne		
DIE BOER GEMAAK:	HET	DIE	VOLGENDE	KONKRETE	VOORSTELLE

120. Gestel u as boer vra vir water gedurende die volgende week en ander boere doen dieselfde. Hoe word die toekennings gedoen? (Hoe word besluit wie kry hoeveel water en wanneer?)

KENNIS BENODIG OM SELF DEEGLIKE GEVORDERDE SKEDULERING TE KAN DOEN

- 121. Vir die opnemer: Vul asb die volgende tabel in, eers volgens die belangrikste somer- en dan die belangrikste wintergewas van die boer.
- a) Vra die boer wat is die verskillende stadia van die belangrikste somer- en wintergewasse wat hy verbou.
- b) Vind ook uit by die boer wat is die waterbenodigdhede tydens elke fase en wat is die worteldiepte tydens elke fase.

KENNIS VAN DIE PLANT

HOOF	STADIUM (skryf die stadia wat die boer noem hieronder by *							
SOMER GEWAS:	1*	2*	3*	4*	5*)			
Water								
benodig								
Wortel diepte								

HOOF	STADIUM (skryf die stadia wat die boer noem hieronder by *)							
WINTER GEWAS:	1*	2*	3*	4*	5*			
Water								
benodig								
Wortel diepte								

KENNIS VAN DIE GROND

122. Weet u dalk wat is die veldkapasiteit van die belangrikste grondsoorte op u plaas?

JA / NEE / ONSEKER

Indien JA, vra die boer om dit te verskaf

□ Grondsoort veldkapasiteit
 □ Grondsoort veldkapasiteit

123. Weet u dalk wat is die verwelkpunt van die belangrikste grondsoorte op u plaas?

JA / NEE / ONSEKER

Indien JA, vra die boer om dit te verskaf

□ Grondsoort

verwelkpunt

□ Grondsoort

verwelkpunt

124. Weet u dalk hoeveel grondwater is vir elke grondsoort beskikbaar vir u plante?

JA / NEE / ONSEKER

Indien JA, vra die boer om dit te verskaf

□ Grondsoort

beskikbare grondwater

□ Grondsoort

beskikbare grondwater

DIE VOLGENDE VRAAG IS NET VIR BOERE WAT DIE VORIGE VRAAG GEANTWOORD HET

- 125. Hoe bereken u die hoeveelheid beskikbare water?
- 126. Wat is die aanvanklike water inhoud van die grond wanneer u plant?
- 127. Het u 'n grondboor? JA / NEE
- 128. Tot watter mate gebruik u die grondboor? 1/2/3/4/5/6/7/8/9/10

(1 = nooit; 5 = af en toe; 10 = baie dikwels)

Verduideliking en opmerkings as boer dit gee:

KENNIS VAN DIE WEER (KLIMAAT)

129. Tot watter mate gebruik u reënmeters om reënval te meet?

1/2/3/4/5/6/7/8/9/10

1 = glad nie; 5 = neem wel lesings ietwat ongereeld en hou nie eintlik rekord nie; 10 = neem wel lesings en hou volledig rekord daarvan)

Verduideliking as boer dit gee:

130. Tot watter mate gebruik u reënmeters om besproeiingstoediening (hoeveel u besproei) te meet?

1/2/3/4/5/6/7/8/9/10

1 = glad nie; 5 = neem wel lesings ietwat ongereeld en hou nie eintlik rekord nie; 10 = neem wel lesings en hou volledig rekord daarvan)

Verduideliking as boer dit gee:

131. Gebruik u 'n verdampingspan? JA / NEE / SOMS

Kommentaar as boer dit gee:

DIE VOLGENDE VRAAG IS NET VIR BOERE WAT 'N VERDAMPINGSPAN GEBRUIK

- 132. Hoe gebruik u die verdampingspan in u besproeiing?
- 133. Maak u gebruik van minimum en maksimum temperature?

Verduidelik asb

134. Het u tensiometers? JA / NEE

Opmerkings as boer dit het:

DIE VOLGENDE VRAAG IS NET VIR BOERE WAT WEL TENSIOMETERS HET EN DIT GEBRUIK

135. Hoe gebruik u die tensiometers?

VOORLIGTING

136. Tot watter mate kan voorligting 'n rol speel om die situasie tov nie-skedulering op die Rietrivier skema te verlig?

1/2/3/4/5/6/7/8/9/10 (1 = glad nie; 5 = 'n redelike mate; 10 = uiters belangrike rol)

Verduideliking as dit gegee word:

- 137. Dink u daar is tans mense beskikbaar om die situasie tov nie-skedulering te verlig?
- 138. Is hierdie mense opgelei om dit te kan doen?

- 139. Hoeveel skeduleringsadviseurs is daar op die Rietrivier skema?
- 140. Hoe dink u kan die situasie tov nie-skedulering op die Rietrivier skema sinvol aangespreek word?

SKEMA-UITLEG

- 141. Is die Rietrivier skema so uitgelê dat dit skedulering aanmoedig/ontmoedig?
- 142. Is die administrasie/bestuur van water op Rietrivier so dat dit skedulering AANMOEDIG?

