



# ARDRI

**MID-FISH RIVER ZONAL STUDY:  
A DESCRIPTION AND ANALYSIS OF  
THE SOILS AND CLIMATE AND THE  
AGRICULTURAL LAND USE**

**SYSTEMS**



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## 1. INTRODUCTION

### 1.1 BACKGROUND INFORMATION AND TERMS OF REFERENCE

The Land and Agricultural Policy Centre (LAPC) contracted the Institute of Social and Economic Research (ISER) at Rhodes University to undertake a zonal study in the Eastern Cape Region, under the auspices of the Natural Resources Management (NRM) Project. The wider terms of reference for this zonal study are described in the final report. ISER, in turn, contracted ARDRI to describe the agriculture of the study area. Specifically, ARDRI was to describe the resource base and the agricultural land use systems and their impact on the environment.

## 2. METHODOLOGY

### 2.1 DESK TOP STUDIES

It has often been said that Ciskei must be one of the best researched areas in South Africa, and, within Ciskei, few areas have been more reported on than Tyefu location. The current study, therefore, made extensive use of existing reports, the most important ones being:

Loxton, Venn & Associates, 1984. Tyefu irrigation scheme. Department of Agriculture & Forestry.



Loxton, Venn & Associates, 1986. Lower Fish river irrigation project: Joint development proposal.

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Loxton, Venn & Associates, 1989. Lower Fish river irrigation project. Phase III. Project plan and evaluation. Ciskei Department of Agriculture, Forestry & Rural development via CAC.

Loxton, Venn & Associates, 1987. Resource base study and Agricultural potential. Department of Agriculture & Rural Development via CAC.

Loxton, Hunting & Associates, 1977. A plan for Tyefu irrigation scheme Pilot Project.

Loxton, Venn & Associates, 1976. A preliminary plan for an irrigation scheme at Tyefu tribal area.

Loxton, Venn & Associates, 1986. Lower Fish river irrigation project. Joint development proposal. Hill, Kaplan & Scott.

Loxton, Venn & Associates, 1987. Resource base study & agricultural potential. Dept. Agric. & Rural Development via CAC.

Loxton, Venn & Associates, 1989. Lower Fish river irrigation project. Phase III. Project plan & evaluation. Ciskei Dept. Agric. - Forestry & Rural Development via CAC.

Palmer, A.R., 1983. The Great Fish river valley: An international conservation area.

De Beer, N.J., 1986. Landbou ontwikkeling & gemeenskapsbetrokkenheid van die Tyefu & Amagasela stam owerhede. M.A. thesis. UPE.

Antrobus, G.G., Frazer, G.C.G., Levin, M., & Lloyd, H.R., 1993. The Agricultural economy of region D: Report No. 7, Unit for Statistical Analysis.

Laker, M.C., (coordinator), 1975. The Agricultural potential of the Ciskei. Confidential report by the Faculty of Agriculture, University of Fort Hare.

Williams, W., 1987. Voorlopige verslag oor die sosio-ekonomiese en bewuste-behoeftes opnames in die Gaga, Sheshegu en Mgwala stamgebiede. ARDRI, University of Fort Hare.

#### Other reports

The following publications gives some idea of the extent to which this area has been researched.



Bembridge, T.J., 1987. Requirements for successful irrigation projects with special reference to the Tyefu irrigation scheme. Ciskei Agric. J. 5, 10-16.

Black, W.T., 1901. The Fish river bush, South Africa, & its wild animals.

Burdett, P.D., 1988. The Sam Knott Nature Reserve. Pelea 7:69-72.

Daniel, J.B.M., 1981. Agricultural development in the Ciskei: Review and assessment. SA Geo. J. 63:3-23.

Holbrook, G., 1992. The structure of an irrigation scheme. M.A. thesis. Rhodes University.

Laurenson, L.J.B., 1984 Colonization theory and invasive biota: The Great Fish river. A case history. M.Sc. thesis. Rhodes Univ.

Troskie, D.P., 1990. Bepaling van die faktore wat die potensiaalbenutting van die Visrivier boerderygebied beïnvloed (microfiche). M.Sc thesis. US. (Ulimocor).

Von Maltitz, P.J.M., 1978. The theory of planning & models for the economic development of a region: The Fish river project. Ph.D thesis. UOFS.

## 2.2 FIELD WORK

### The research team

- collected primary information in the villages of Ndwayana, Qamnyana, Ndlambe and Sheshegu, using a combination of questionnaires, group workshops, and structured individual interviews;
- conducted interviews with staff of Ulimocor (CAC) and staff of the Ciskei Department of Agriculture based at Tyefu, Sheshegu, Alice and Peddie;
- analysed interviews of 17 commercial farmers on the west bank of the Fish river;
- supplemented the information on the commercial farms by visiting Mr R Dempsey, the Extension Officer in Grahamstown.

**2.2.1 Ndwayana:** Both the conventional questionnaire method and Participatory Rural Appraisal (thereafter PRA) were employed to gather information related to livestock and crop production issues in Ndwayana. After finishing 30 questionnaires, this method was abandoned because (i) it did not accommodate unforeseen types of information (ii) it made the interviewee feel uncomfortable and therefore less likely to give relevant or honest answers to the questions (iii) it wasted time, particularly when the would-be interviewee claimed to have no capacity to give answers to agricultural related issues or when they simply hid away when they saw the researchers coming.

The questionnaire method was replaced by a relatively friendly and participatory rural appraisal approach, PRA. The first PRA workshop encompassing all the Ndwayana residents was not really successful as it was learnt that:

- people from different blocks of the village did not feel comfortable with each other in discussing such issues as land and livestock. This related particularly to young women and extremely poverty stricken residents. Consequently, the workshop was dominated by the few prominent individuals who tended to speak on behalf of the rest of the village.
- it became difficult to handle the 120 participants, particularly when some tended to fight verbally over differences on some issues.

PRA workshops were therefore launched in each of the five blocks of the villages, namely: Upper Ndwayana, Lower Ndwayana, Kalikeni, Klofini and Kondile.

Ndwayana households can be subdivided into a number of socio-economic strata. The presence of these strata is evident in the location and size of the residences. Households belonging to the upper strata live in relatively big homes, which are found near the centre of the village. Households belonging to the lower socio-economic strata occupy small residences, which form the periphery of the settlement. Livestock owners from different strata were interviewed individually.

In the PRA workshops, people were asked to give solutions to every issue that they regarded as a problem. In most cases, they could not formulate a solution, or would choose from a range of solutions suggested to them by the researcher.

- 2.2.2 Qamnyana:** PRA workshops were held at each of the six settlements of the location, namely: Ntezana, Endulwini, Reyini, Emngcunubeni, Phantsi Kwedrayi and Kwaphahlothi. During the PRA sessions, participants were asked to map the village. Thereafter, residents were asked to identify on the map the most suitable location of essential amenities, such as water taps, dam, grazing and arable lands and dipping tank. Quantitative data on such items as type, number, breed and sex composition of animal species owned were obtained by talking to livestock owners at the end of each session. This was necessary, because issues related to livestock are regarded as secret. Questionnaires were used for this purpose. Stones and sticks were used and circles drawn on the ground to indicate the ratio or proportion of cattle, sheep and goats in the village. In addition a transect was done to gauge the potential carrying capacity of the veld and the potential productivity of the arable land, and lines were drawn on the ground to approximate the size of grazing land they claim inside the Double Drift Game Reserve.
- 2.2.3 Sheshegu:** PRA workshops were conducted in each of the five settlements of the location, namely: Lower Sheshegu, Mpolweni, Lalini, Esikolweni and Balurha. Two neighbouring black commercial farmers and some former farm labourers on a state owned farm (formerly white-owned) were also visited and consulted.
- 2.2.4 Ndlambe:** A single PRA workshop involving 60 food plot growers was conducted during which the perceptions of the growers with respect to the system of food plot production at Tyefu irrigation scheme were recorded.

### 3. HISTORICAL OVERVIEW OF LAND USE

The study area includes six distinctly different historical groupings, namely:

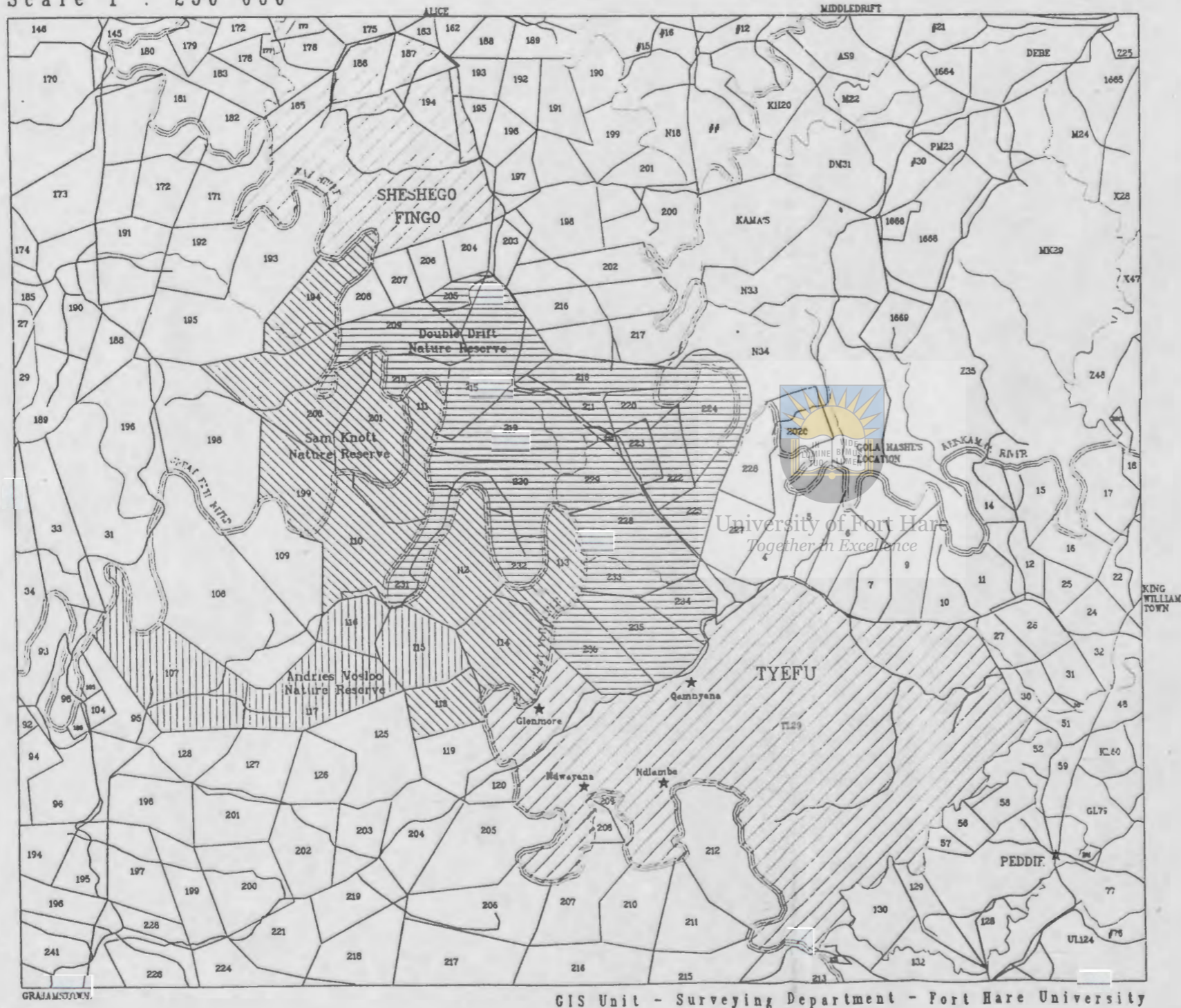
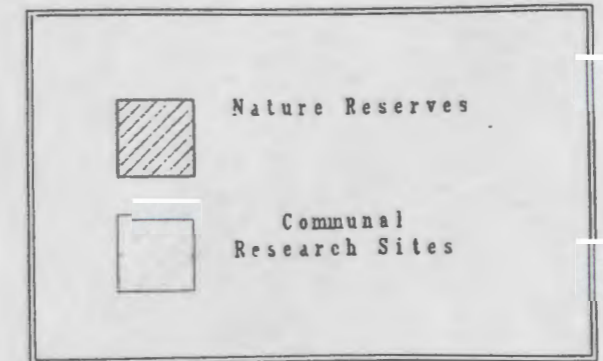
- The white farming community on the western side of the Great Fish River.
- Tyefu
- The Tyefu Irrigation scheme
- Sheshegu
- The Glenmore community
- The game reserves

The study area is shown in figure 1.

# Lower Fish River Project

## LEGEND

Scale 1 : 250 000



GIS Unit - Surveying Department - Port Harcourt University

Figure 1. Map showing the location of research sites

### 3.1 WHITE COMMERCIAL FARMERS

The farms, situated in the Albany district of the Eastern Cape, were originally established during the 1820's and 30's by the 1820 Settlers and their descendants. Livestock farming is the predominant enterprise, the main species being Angora goats (79%), sheep (10%), Boer Goats (6%) and beef cattle (5%). Because of the low rainfall, rainfed cropping is not practised at all. The average farm size in the region is 1169 ha. Average nett farm income in 1990 was estimated at R42 000 and in 1991 at R71 000 (Antrobus, Fraser, Levin & Lloyd 1993 & 1994).

At present, 350 hectare of land is under irrigation, lucerne being by far the most important crop. In the past, efforts to produce vegetables for the Port Elizabeth and East London markets largely failed, because of the long distance to the markets. Additional land, covering an area of approximately 1000ha, has been identified as potentially irrigable, of which approximately 500 ha is scheduled to be brought into production, once water from the Glen Melville scheme is available. Farmers have expressed the wish to become engaged in citrus production, once good quality water and infrastructure (such as a packing shed) are made available.

Most local white commercial farmers are involved with farming on a full time basis and depend solely on the income from their farms. Exceptions are few. The major problems faced by white farmers are high transport costs, a depressed economy, heartwater and predators. Generally, their future expectations appear to be focused on game farming more than on expansion of the irrigation enterprise, because the numbers of farmers with access to irrigable land is limited.

### 3.2 TYEFU LOCATION

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In 1835 Chief Joseph Mphahla and his followers settled in the Tyefu tribal area, previously known as Zulu location. The name "Tyefu" originated from Chief Tyefu Msutu, who gained control over the area. In 1959 the RSA government established the territory of the Mphahla Tribal Authority. The area was renamed Tyefu Tribal Authority in 1968 at the request of the community. In 1983 part of the Tyefu Tribal Authority area was excised to create the Mhala Tribal Authority under Chief H. Makinana of the AmaNdlambe tribe. The areas Kalikeni, Pikoli and Ndlambe were under the jurisdiction of the Mhala Tribal Authority. To the north of the Mhala Tribal area is the territory of what is now scheduled the Tyefu Tribal Authority. This area is located between the Committees Drift-Breakfast Vlei road and the boundary of the Mhala Tribal area. It includes Ndwayana village which refers to the combined areas under jurisdiction of both Tyefu and Mhala Tribal Authority.

The settlement pattern on the 24 219 hectare comprising Tyefu Location tends to be widely dispersed, with groups of dwellings loosely arranged in eleven settlements (figure 2). In 1988 the human population in the area was estimated at be 13 563 (Setplan, 1988).

### 3.3 TYEFU IRRIGATION SCHEME

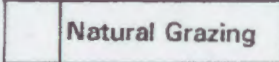

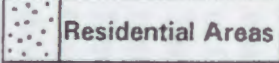

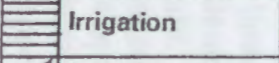

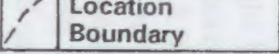

The potential of Tyefu for the development of an irrigation scheme was the subject of investigations by the South African Government in the mid-1930s. However, the high salinity of the Fish river water inhibited development. In 1975 the Ciskei Department of Agriculture and Forestry initiated feasibility studies, with the object of developing an irrigation scheme on the eastern side of the river. The Tyefu Irrigation Scheme started as a pilot project in 1977. The objectives of the pilot project were to investigate the suitability of the area for irrigated crop production and to get the local communities involved in irrigated cropping.

Irrigation water used by the scheme is pumped from the Fish river during periods of high flow and low salinity to storage dams, which were constructed on some of the local tributaries of the Fish river. This water is then gravitated to the irrigated fields. Yet, despite the dilution of Fish river water with runoff water, the general quality of the irrigation water was still considered to be poor. Ways and means of obtaining good quality water from the Orange river was, therefore, considered in earnest by the authorities. In 1981 the Department of Water Affairs (RSA) proposed a bulk water supply scheme to deliver water from the Orange river to the Fish river. In 1985 it was decided that water from the Orange river would be supplied to farmers on the west bank of the Fish river. Ciskei was expected to continue developments on the east bank of the Fish river after the South African Government shelved developments on the Ciskeian side. Presently, the Tyefu scheme is managed by the Ciskei Agricultural Corporation.

At the time of writing this report, access to Orange river water has been extended to the Ndwayana section of the scheme. In 1977, the pilot project started with the development of 121 hectare at Ndlambe, followed by 109 hectare at Pikoli in 1978, and 106 hectare at Kalikeni in 1981. The land was subdivided as follows:

- 33 "commercial" farms of 4 ha each
- 223 plots of 0,25 ha for subsistence food production allocated to persons who held dryland arable allocations before the scheme
- three tribal farms totalling 183 ha operated by Ciskei Agricultural Corporation on behalf of the tribal authorities
- 66 "allotments" of 0,10 ha each leased to persons who have no land rights but who wish to augment their domestic food supply.

The tribal farms were farmed as commercial units by CAC for the tribal authorities. Profits from these farms were channelled to the tribal authority for the upliftment of the living standard of the community. CAC provided a comprehensive range of services to these farms, including the supply of irrigation water, transport, production requisites, marketing and training.

	Natural Grazing		Gravel Road
	Residential Areas		Mhala Location
	Irrigation		Dip Tank
	Location Boundary		Dams

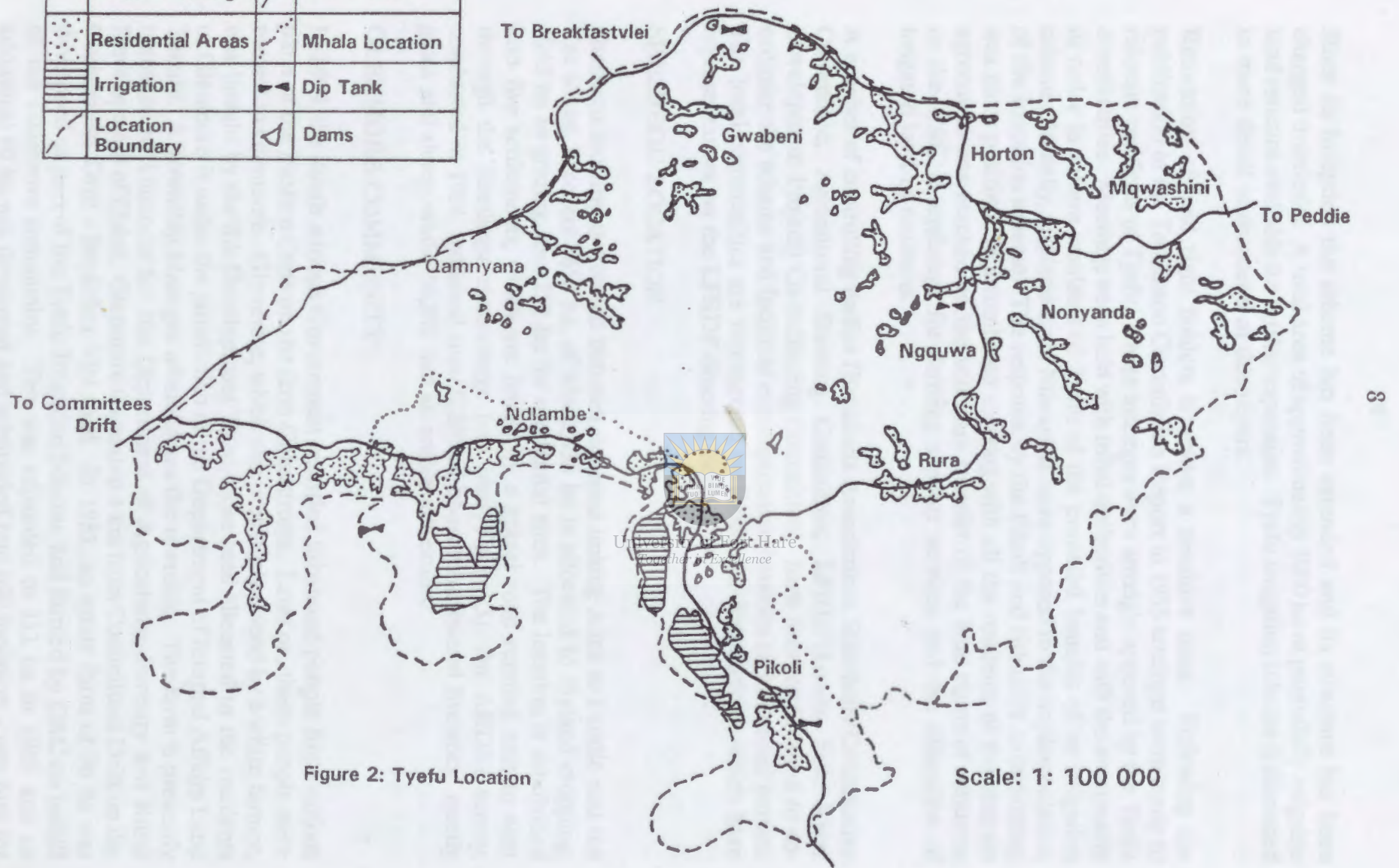


Figure 2: Tyefu Location

Scale: 1: 100 000

Since its inception the scheme has been extended and its structure has been changed drastically. A total area of approximately 1000 ha of potentially irrigable land remains available for further expansion. Tyefu irrigation scheme is discussed in more detail in chapter 6 of this report.

Relocation of land right holders is always a sensitive issue. Following the publication of the Tomlinson Commission Report in 1955 attempts were made to relocate residents of Tyefu. These attempts were strongly opposed by the Tyefu communities. Meetings were held with tribal authorities and with the community in order to inform residents of Tyefu of the potential benefits of an irrigation scheme. Initially, residents from Ndwayana were opposed to the implementation of the irrigation scheme. The response by the Pikoli and Ndlambe communities was more positive. In a combined meeting with all the residents of the area an agreement was reached on the voluntary transfer of the land rights of residents to the CAC in exchange for farming support services and the allocation of irrigated land to residents.

A number of controlling bodies (Residents Associations, Residents Consultative Committee, Agricultural Steering Committee, LFRDP(Lower Fish River Development Project) Co-ordinating Committee) have been established to co-ordinate the scheme and facilitate communication between all interested parties. The local communities are represented by Residents Associations, which have representatives on the LFRDP Steering Body.

#### 3.4 SHESHEGU LOCATION



Sheshegu location is situated between the road linking Alice to Peddie and the Kat River. It covers 5650 ha, of which 435 ha is allocated to dryland cropping, 4943 ha to grazing, and 252 ha for residential sites. The location is subdivided into five settlements, which are linked by a gravel road running east to west through the Sheshegu commonage (see also Figure 3). An ARDRI survey, conducted in 1984, indicated that 72,5% of households owned livestock, mostly goats and sheep, whilst 36,3% had an arable allocation.

#### 3.5 GLENMORE COMMUNITY

In 1979, the South African Government resettled urbanized people from various parts of the Eastern Cape on the farm Committuys. Later on, these people were moved to Glenmore. Glenmore, which was previously owned by a white farmer, was bought by the SA Development Trust. The land allocated to the residents of Glenmore is under the jurisdiction of the Department of Internal Affairs Land Tenure. A Township Manager administers the township. The farm is presently managed by Ulimocor for the Department of Agriculture, Forestry and Rural Development of Ciskei. Glenmore is situated 4 km from Committees Drift on the Committees Drift - Breakfast Vlei road. In 1981, an estate farm of 96 ha was developed as part of the Tyefu Irrigation Scheme and farmed by CAC on behalf of the Glenmore community. This was expanded to 111 ha in 1988 and an additional 60 ha was developed and subdivided into 600 foodplots - one plot for each household.

### 3.6 THE GAME RESERVES

**3.6.1 Double Drift Game Reserve:** The area known as Double Drift Game Reserve is enclosed by the Great Fish river and the Keiskamma river. Before the collapse of the Sebe government in Ciskei in 1989, it was known as the Lennox Sebe Game Reserve.

The San were the earliest human inhabitants of the Double Drift area. Khoi-Khoi pastoralists moved into the area around 300 AD, but they were displaced by the Xhosa and AmaMfengu around 1700 AD. Subsequently, the AmaNdlambe, the AmaHlubi and the AmaGqunukwebe tribes controlled the area until the frontier wars in the 1800's. In 1853 white farmers settled in the Double Drift area after the Frontier Wars in 1853. Raising livestock, mainly cattle and goats, became the main farming activity in the area. There was also some irrigated crop production, citrus being grown at Ripplemead farm in what is now called Double Drift (Ciskei Wildlife Resources Board, 1989).

In 1982, the South African Government bought the white owned farms and handed over management of the land to the South African Trust. Later, the land was transferred to the Ciskei Government, whereafter it was incorporated into a nature reserve in 1985. Ciskei Wildlife Resources took over the management of the nature reserve through Ulimocor (CAC). It was only in 1987 that the area was proclaimed a national nature reserve under the Nature Conservation Act No.10 of 1987. Ciskei Wildlife Resources became an independent organisation in 1989 (known as Ciskei Wildlife Resources Board, CWRB). In 1991 CWRB was incorporated into CONTOUR, a parastatal responsible for tourism development and management of the game parks in Ciskei. In the new provincial dispensation the game parks will become the responsibility of the Ministry of Agriculture and Environmental affairs.

In 1990, the game reserve was leased to Mr Fred Burchell with the objective of attracting tourists. He was also to be responsible for culling of game. However, after disagreement between Mr Burchell and CONTOUR, his lease was terminated in 1993 and CONTOUR is responsible for managing Double Drift Game Reserve at present.

Large areas of the game reserve were inhabited by previous farm labourers. In 1989, 250 of the labourers were still residing inside the game reserve. Resettlement of these people occurred in 1992, after successful negotiations between farm workers and reserve management.

**3.6.2 Andries Vosloo Kudu Reserve:** The Andries Vosloo Kudu Reserve, named after a previous Administrator of the Cape Province, was proclaimed a game reserve in 1973. The reserve is situated between Fort Beaufort and Grahamstown and forms part of the Great Fish river valley. It stretches eastwards from Fort Brown to Double Drift on the Great Fish River. The proclaimed area comprises 6493 ha.

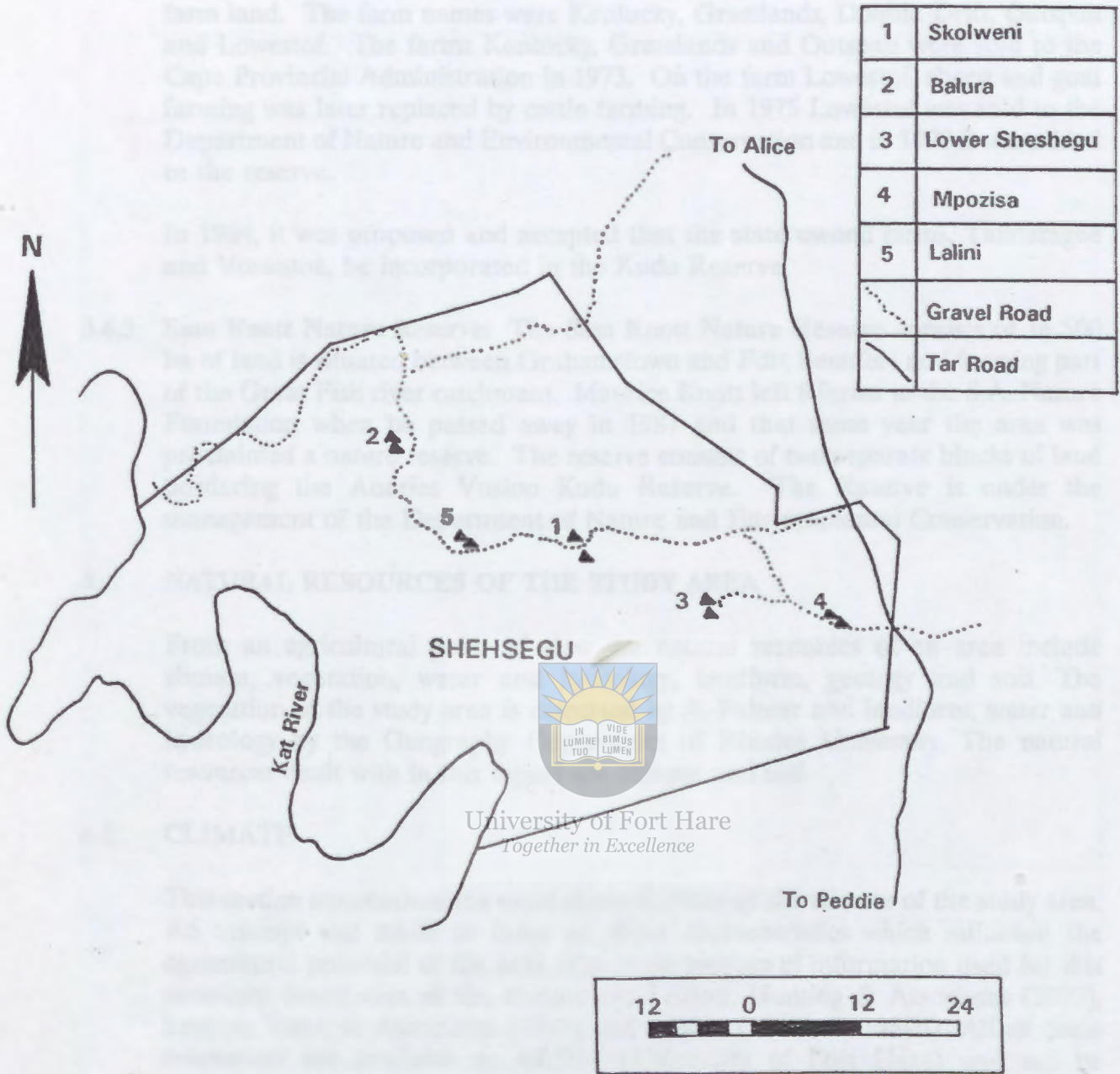


Figure 3: The Sheshegu Location

Before its proclamation as a game reserve the Andries Vosloo Kudu Reserve was farm land. The farm names were Kentucky, Grasslands, Double Drift, Outspan and Lowestof. The farms Kentucky, Grasslands and Outspan were sold to the Cape Provincial Administration in 1973. On the farm Lowestof, sheep and goat farming was later replaced by cattle farming. In 1975 Lowestof was sold to the Department of Nature and Environmental Conservation and in 1977 it was added to the reserve.

In 1984, it was proposed and accepted that the state owned farms, Tanderagee and Vorentoe, be incorporated in the Kudu Reserve.

- 3.6.3 Sam Knott Nature Reserve:** The Sam Knott Nature Reserve consists of 16 500 ha of land is situated between Grahamstown and Fort Beaufort and forming part of the Great Fish river catchment. Maurice Knott left 8 farms to the S.A. Nature Foundation when he passed away in 1987 and that same year the area was proclaimed a nature reserve. The reserve consists of two separate blocks of land bordering the Andries Vosloo Kudu Reserve. The Reserve is under the management of the Department of Nature and Environmental Conservation.

#### 4. NATURAL RESOURCES OF THE STUDY AREA

From an agricultural point of view the natural resources of an area include climate, vegetation, water and hydrology, landform, geology and soil. The vegetation of the study area is discussed by A. Palmer and landform, water and hydrology by the Geography Department of Rhodes University. The natural resources dealt with in this report are climate and soil.

##### 4.1 CLIMATE

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This section summarizes the main characteristics of the climate of the study area. An attempt was made to focus on those characteristics which influence the agricultural potential of the area. The main sources of information used for this summary description of the climate are Loxton, Hunting & Associates (1977), Loxton, Venn & Associates (1987) and Austin (1989a & 1989b). All of these references are available at ARDRI (University of Fort Hare) and can be consulted when more detailed information is required.

The climate of the area under investigation can be described as being warm temperate, dry semiarid.

- 4.1.1 Temperature:** The temperature data apply to the Tyefu irrigation scheme and mean values are based on a eight year record only (1977-1984) (Loxton, Venn & Associates, 1987). Mean monthly temperatures for Tyefu are presented in Table 1.

The summers in the Fish River Valley are hot, the mean monthly maximum temperature for the period December to February ranging between 29 and 30°C. During this period, extreme temperatures of 40°C and more may be recorded. It

Table 1. Temperature data for Tyefu weather station (1977 - 1984).

Month	Mean Max. °C	Mean Min. °C	Mean Daily °C
January	29,3	18,0	23,7
February	30,1	18,5	24,3
March	28,9	17,5	23,2
April	27,0	14,0	20,5
May	24,6	10,9	17,7
June	21,8	7,9	14,9
July	22,5	7,3	14,7
August	22,7	8,7	15,7
September	24,0	10,9	17,5
October	25,1	13,0	19,0
November	26,8	15,2	21,0
December	29,2	17,1	23,2
MEAN	26,0	13,3	19,6

Source: Loxton, Venn & Associates, (1987)

is these extremely high temperatures which may cause heat stress in crops, resulting in "leaf firing" in maize and damage to fruit in cactus pear orchards.

Winter temperatures, on the other hand, are generally mild. The mean monthly minimum temperature for the period June to August ranges between 7 and 9°C. The valley slopes are thought to be virtually frost free, but the lower lying areas are subject to ground frost, which can be expected for some 15 to 30 days each winter during the period July to August.

Diurnal temperature fluctuations are larger in the valley than on the plateau, the valley being subjected to lower night temperatures and higher day temperatures. Sudden fluctuations in temperature may occur throughout the year. Two weather effects are responsible for these abrupt changes in temperature. Sudden cooling is caused by the on-shore flow of very cold air of Antarctic origin, brought in by the passage of cold fronts and the ridging-in of the South Atlantic high pressure system. Rapid warming is caused by the off-shore Berg winds. During the eight year period of temperature monitoring, the maximum daily fluctuation was 32°C,

when the temperature dropped from 42 to 10°C within a 24 hour period.

**4.1.2 Rainfall:** The mean monthly and mean annual rainfall recorded at five stations located in or near the study area are presented in Table 2.

**Table 2. Mean Annual Rainfall (mm) at five location in and around the Mid-Fish River area.**

STATION	LONG E	LAT S	HT. (m)	Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean Annual (mm)
TYEFU	26°55'	33°11'	119	7	32,4	20,6	45,5	41,3	23,1	27,2	41,7	25,0	25,0	58,0	34,2	31,4	405
COMMITTEE'S DRIFT	26°50'	33°11'	150	12	21,8	47,4	62,5	41,3	15,8	19,9	13,4	37,4	20,1	38,5	35,5	44,6	399
LINE DRIFT	27°12'	33°04'	150	39	35,1	42,6	65,1	37,3	29,0	14,1	19,3	18,6	32,8	41,1	43,1	26,0	404
PEDDIE	27°07'	33°12'	305	98	42,5	55,2	64,5	40,9	39,9	23,3	25,0	31,2	41,0	58,4	53,3	46,4	524
FRASERS CAMP	26°55'	33°17'	575	59	45,1	53,6	71,7	42,0	34,9	20,4	22,5	26,2	43,7	56,5	58,8	46,8	525

Source: Loxton, Venn & Associates (1987).

Generally, the mean annual rainfall in the area is low, being less than 550 mm throughout the area of study. In the valley the mean annual rainfall is less than 450 mm and in places it is expected to be less than 400 mm. The wettest parts are found on the plateau in the south eastern and eastern parts of the area, where the mean annual rainfall ranges between 500 and 550 mm. Throughout the area the minimum annual rainfall expected 75% of the time is less than 380 mm and that expected 50% of the time is less than 500 mm.

The distribution of rainfall in this area is positively skewed. In other words, the proportion of years with an annual rainfall less than the mean is higher than that of years with an annual rainfall exceeding the mean. As a result, the median or middle value is lower than the mean. It is generally accepted that in this area the median is a more meaningful rainfall statistic than the mean.

The rainfall is erratic in quantity and distribution. The coefficient of variation of the mean annual rainfall is approximately 40%, illustrating the highly variable nature of the rainfall in this area. The seasonal distribution of the rainfall shows a maximum during the summer months (October through to April). However, the proportion of the rain falling outside the summer season, ranges between 25 and 30%, which is 10 to 15% higher than is the case in areas with true summer rain. Although the climate in the area is considered to be dry, the possibility of a very wet season occurring are real. Such wet seasons are often followed by floods and severe soil erosion.

There are two very useful sources which enable the estimation of rainfall for any locality in the area. The first source is a national data base developed by Dent, M.C., Lynch, S.D. & Schultze R.E. (1987). This data base provides the mean and median monthly and annual rainfall for any given locality in South Africa. The second source is a local data base developed by Austin (1989a), which is called CIRADA. The latter data base is able to provide a wider range of rainfall statistics and emphasizes rainfall probability, a useful tool in agricultural planning. It also includes the rainfall statistics (total expected rainfall at four levels of probability) for 26 selected growing seasons. Both data bases are computerized and were developed using data obtained from the same weather stations. They differ in that the national data base takes into account the effect of relief or altitude when interpolating between stations. CIRADA, on the other hand, uses a more straight-forward technique of interpolation and is, therefore, less sensitive in identifying local differences in micro climate than the national data base. A superficial comparison of the rainfall predictions provided by the two data bases, performed on data for the area under investigation, indicated differences of up to 20%.

**4.1.3 Evaporation and radiation:** The mean monthly Class A pan evaporation at Tyefu is presented in Table 3. These data are based on a short term record of four years only. When compared with two long term records, namely, those of Alice and Eccca, the values recorded at Tyefu appear to be somewhat high. The difference in evaporation between Tyefu and the other two stations may be due to the location of the evaporation pan. According to Doorenbos and Pruitt (1977) pan location may account for errors as high as 15%.

As is the case in most dry parts of the Eastern Cape, Tyefu enjoys high levels of radiation and light is probably the least limiting factor of all the climatic variables influencing the agricultural potential of an area.

**Table 3. Class A Pan Evaporation at three localities in the Eastern Cape (mm).**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Tyefu	257	240	186	177	136	120	120	114	131	168	201	244	2094
Ecca	224	183	165	129	103	90	100	121	124	173	202	229	1843
Alice	214.6	178.4	152.3	119.8	112.5	92.6	110.9	131.1	142.3	160.7	172.3	209.7	1797.2

Source: Loxton, Venn & Associates (1987) & Van Averbeke (1991).

**4.1.4 Wind:** There are no stations in the area that record wind direction and velocity. Brutsch (1993) indicated that between Port Elizabeth and East London the wind blows mainly from a WSW and a ENE direction during summer and from a WSW to NW direction during winter. High velocity winds do occur throughout the region and windbreaks in the form of trees (eg. *Casuarina cunninghamnia* or Beefwood) should be considered when planting crops such as citrus. Wind damage is a major factor responsible for reducing the quality of citrus, thereby reducing the monetary value of the fruit.

**4.1.5 Conclusion:** The climate of the lower Fish River area is characterised by severe water deficits throughout the year in most years. Several factors contribute to the severity of the water deficits, namely, low rainfall with an erratic and partly unseasonal distribution, high summer temperatures and high rates of evaporation. The high level of water deficiency with respect to plant growth is a major factor limiting the potential of the area for agricultural systems based on rainfed production.

## 4.2 GEOLOGY AND SOILS

**4.2.1 Geology:** The geological substrate of the study area consists mainly of a variety of sedimentary rocks, which have a very limited potential for exploitation.

Deposition of the rocks, which form the geological substrate of the area, dates back to the Karoo sequence. Just south of the line Peddie-Qamnyana, the oldest deposits, belonging to the Ecca Group, are found. In the area of study, the Ecca sediments consist mainly of "blue or black shales". Soils derived from these shales appear to be highly erodible and in many places the soil cover has been removed, leaving behind a blue-black moonscape void of any form of vegetation, except for the occasional clump of bush.

North and northeast of the Ecca deposits, rocks belonging to the Beaufort group occur. These rocks consist mainly of light coloured siltstones, mudstones and fine sandstones. In places igneous rocks in the form of dolerite dykes and sheets occur.

The possibilities for economic exploitation of the various substrates is limited. The main ways in which geological materials are exploited are:

- a) stone quarrying for road building
- b) kaolinitic clay used in the ceramic industry
- c) clay for brick making
- d) some recent deposits along the Fish river are used as building sand.

Els (1970) indicates the presence of phosphate containing deposits in Jaji location, which is situated along the Fish river southwest of Peddie (south of the southern boundary of the area of study). He also mentions the presence of phosphate bearing shales in the tongue of the Upper Dwyka shales near the mouth of the Great Fish river (phosphatic horizons forming part of the undifferentiated Prince Albert and Whitehill formations). Els (1970) refers to both sources of phosphate as being patchy and unlikely to be of any economic importance.

**4.2.2 Soils:** Broadly speaking, the soils of the Mid-Fish River study area can be subdivided into three major groups, namely:

- 1) the shallow soils of the plateau and valley slopes;
- 2) the moderately deep soils of the valley bottoms of the ephemeral rivers feeding into the Fish river; and

3) the moderately deep to very deep soils on the Fish and Ecca river terraces and adjacent pediments.

Most of the soils in the area are eutrophic, meaning that little leaching of bases is taking place. In fact many of the soils are alkaline (soil pH test exceeds 7 and in some cases approaches 9), due to the presence of free lime or alkaline salts such as sodium carbonate. Alkalinity and sodicity (high exchangeable sodium content) are most expressed in the soils situated in the Fish river valley. The use of saline irrigation water is thought to have contributed to the alkalization and sodification of these soils. Most soils are extremely deficient in phosphorus, which is regarded as a major factor limiting plant growth.

In what follows, the three major soil groups and their agricultural potential are briefly discussed. Most of the information presented relates to the eastern side of the study area, which was described by Loxton, Hunting & associates (1979) in a comprehensive study of the Fish and Kat river basins and subsequent detailed studies of the irrigable soils in the Fish river valley (Loxton, Venn & associates, 1987). The available information with respect to the South African side of the Fish river is limited to the Ecca and Fish river valleys (Nell, 1987 and Nell, 1989).

**4.2.3 Shallow soils of the plateau and valley slopes:** By far the largest part of the area, constituting the plateau and the slopes of the river valleys, are covered by shallow, grey and grey-brown litholic soils. In relatively level topographic positions (the plateau surface or interfluves) the soils consist of a shallow, fairly continuous soil mantle with a depth of approximately 200 mm and a texture which is sandy loam on the Beaufort sediments (north and east of the Fish river) and a gravelly clay loam on the Ecca (and Dwyka) sediments (west and south of the Fish river). This surface layer of soil usually overlies a gravelly layer consisting mainly of rock fragments in varying degrees of weathering and some tongues of soil. As a result of their shallow rooting depth, the water holding capacity of these soils is limited to about 40 mm. In places where weathering of the underlying rock is minimal the soils are classified as Mispah (Soil Classification Working Group, 1991). Where weathering of the rock is more advanced, soils of the Glenrosa type are found.

The valleys of the Fish river and its ephemeral tributaries dissect the plateau in many places. The slopes of these valleys are usually very steep and in this high energy environment the formation of soil is minimal. Generally, the surface of the valley slopes is covered with stones. The occurrence of soil is limited to patches, where the roots of trees slow down the erosion process and the addition of organic litter contributes to the process of soil formation.

Considering the low rainfall of the area and the shallow rooting depth and low water holding capacity of the soils, the plateau and valley slopes are considered to be totally unsuited for cultivation. Generally, the potential of the land for grazing and browsing is also limited for the same reason. Moving in a northeastern direction into the Keiskamma basin, the rainfall increases and conditions conducive for soil formation improve. Here soils are deeper and the potential of the land for agriculture is higher. No further discussion is provided as these lands fall out of the area of investigation.

- 4.2.4 Moderately deep soils of the valley bottoms of the ephemeral rivers:** Occasionally, relatively deep layers of weathered material have been deposited on the foot slopes and in valley bottoms of the ephemeral tributaries of the Fish river. Usually, the soils developed from this material show evidence of clay migration, resulting in an increase in clay content with depth. Being situated in a bottomland position, the soils are subject to additions of water from higher lying areas through the processes of run-on and seepage. As a result, these soils are sometimes imperfectly drained as evidenced by the occurrence of grey colours and mottles in the subsoil layers. Common soil types are Tukulu, Kroonstad, Sepane and Valsrivier. The agricultural potential of these soils, especially for grazing and browsing, is higher than that of the shallow soils found on the crest of the plateau and on the valley slopes. However, the distribution of these soils is limited to a few scattered areas, which are small in extent and, therefore, the overall contribution of these soils to the general agricultural potential of the area is of minor importance.
- 4.2.5 Moderately deep and deep soils on the fish and ecca river terraces and adjacent pediments:** Most of the moderately deep and deep soils in the study area are found on the alluvial terraces of the Fish and Ecca rivers. Loxton, Venn & associates (1987) identified two main terrace positions, namely, the high (old) terraces and the low (young) terraces.

The high terraces or their remnants occupy positions between 20 and 120 m above the bed of the Fish river. On these remnants soil development has proceeded for a considerably long time and this has resulted in the reddening of the soil material. In some places the remnants of the old terrace have been well preserved, but in others the terraces have been degraded and are now appearing in the landscape as colluvial slopes. Often the contact between soil and underlying rock substrate is marked by a non-massive, permeable calcrete layer. Most of the red soils show only weak structural development in the subsoil and generally the soils are classified as being of the Hutton type. Most of the soils tend to be calcareous. Permeability of the soils is generally good, but in some areas the permeability of the soils is adversely affected by the presence of a dense subsoil layer.

On the low terraces brown and grey soils are found. Generally, these soils show little evidence of profile development. The most recent sediments (dating back to the 1974 floods) hardly show any sign of profile differentiation and are extremely sandy, making them susceptible to wind erosion. These soils are classified as Dundee soils. Oakleaf type soils are found in slightly higher positions. Here, evidence of profile development comes in the form of thin discontinuous cutans of clay and organic matter. The presence of these cutans indicates the downwards migration of these two substances in the soils. Maximum profile development occurs in the Valsrivier type soils, where the migration of clay has resulted in a significant increase in the clay content of the subsoil. Valsrivier type soils appear to occur only along the western (South African) banks of the Fish river. They also form an important soil type in the Ecca river valley. The accumulation of clay in the subsoil of the Valsrivier type soils causes a reduction in permeability. This, in turn, makes these soils susceptible to salinization (the accumulation of salts more soluble than gypsum within the

rooting zone of the soil).

Below some of the scarps, within and along the Fish river valley, pediments are found. The soils on these pediments tend to be gravelly and are most often yellow-brown in colour. Clovelly type soils are the dominant soil type on these pediments. The soils tend to be susceptible to erosion because of their low infiltration rates. The infiltration problems of these soils are caused by the high fine sand content which makes them prone to surface crusting (capping). The stripping of the vegetation growing on these soils, by overgrazing and chopping of wood, has contributed to the problem. The destruction of the vegetation cover has caused a reduction in the organic matter content of the soils, which, in turn, lead to the degradation of soil structure and soil porosity.

In Figure 4, the distribution of the main soil types is presented for the eastern side of the Fish river. The map is based on the natural resource survey of the Fish and Kat river basins (Loxton, Hunting and Associates, 1979) and that of the Keiskamma basin (Hill, Kaplan, Scott & partners, 1977). From Figure 4 it is clear that the distribution of potentially arable soils on the eastern side of the Fish river is limited mainly to the Fish river valley itself. Relatively large areas of potentially arable land of variable quality occur in the vicinity of Peddie and also in the north east of the study area south of Middeldrift. Note, however, that most of these lands form part of the Keiskamma watershed, falling outside the focus of our attention. The distribution of soils on the western side of the river is not shown. As far as could be established, soil surveys covering the western side of the river are limited to the valleys of the Fish river and the Ecça river (Rudman and Ellis, 1985; Nell, 1987 and Nell, 1989). At the time of writing we had not been able to lay our hands on a copy of the maps presented by these authors. Seemingly, the soils on the plateau on the western side of the Fish river have not been mapped. All indications are that the distribution pattern of potentially arable soils characterizing the eastern side of the river are repeated on the western side.

- 4.2.6 **Conclusion:** For all practical purposes the availability of soils suitable for cultivation is limited to the alluvial plains and old river terraces of the Fish river and some of its tributaries such as the Ecça river. By far the largest part of the area, namely the plateau and slopes of the ephemeral river valleys, is covered by a very shallow mantle of soil which, on steep slopes and in eroded areas, has often been reduced to a few remaining patches and clumps.

Figure 4. Generalised soil map of the area east of the Fish River.

# Lower Fish River Project

Scale 1 : 250 000



## Legend

Legend	General soil type	General suitability rating for use as arable land
	Associations of young alluvial and colluvial soils of river terraces, lower pediment slopes and bottomlands.	Moderate to high
	Eutrophic and calcareous red soils derived from alluvium and parent materials consisting of a mixture of Karoo sediments and dolerite.	moderate to high
	Eutrophic moderately deep greyish soils generally associated with clay enrichment and ferruginous gravel in the subsoil.	low
	Eutrophic moderately deep grey and greyish brown soils with distinct signs of hydromorphy in the subsoil.	low
	Eutrophic greyish brown litholic soils derived from Karoo sediments with soils of the Glenrosa type dominating.	marginal
	Eutrophic greyish brown litholic soils derived from Karoo sediments with soils of the Mispah type and stony or rocky phases there of dominating.	not suitable

## 5. DRYLAND CROP PRODUCTION

### 5.1 INTRODUCTION

Dryland crop production involves cropping systems which rely on rainfall for the supply of water to the crop. These systems are referred to as dryland production systems only when the climatic conditions result in a water deficit during some part of the year.

Generally, the level of management required to sustain production in dryland cropping increases with an increase in the degree of water deficiency.

Under conditions where the degree of water deficit is relatively minor, as is the case in areas with a subhumid climate, appropriate management practices usually involve drought avoidance and some form of water conservation. In most cases the incorporation of a fallow period in the cropping system is the only form of water conservation required. During the fallow period the soil water reservoir is replenished in preparation for the next growing season. Drought avoidance refers to practices aimed at preventing the crop being subjected to water stress by matching the growing season to that period of the year during which rainfall is most abundant. This is achieved by selecting an appropriate crop or cultivar and or suitable planting date. Crops or cultivars are selected in terms of the length of their growing season. The selection of a suitable planting date is governed by two factors mainly, namely the time of onset of the rainy season and the temperature requirements of the crop being planted.

As conditions become drier, successful dryland production becomes more reliant on the effectiveness of the water conservation practices being employed. In many semi-arid parts of the world considerable progress has been made towards establishing sustainable cropping systems. Two main groups of practices have contributed to this development, namely crop residue management and extension of the fallow. The objective of extending the fallow period is to increase the amount of water stored in the soil profile before planting. During the growing season, stored soil water supplements water supplied to the crop in the form of rain. The quantity of water stored in the soil profile is a determining factor when deciding on whether to plant or not. If the soil water reservoir is insufficiently replenished, planting is deferred to a later date and the fallow period is extended to enable further recharging of the soil profile.

Elsewhere in the world the efficiency by which water is captured and stored during the fallow period has been doubled by the adoption of appropriate ways in which to manage crop residues. Conventionally, fallows were managed by means of clean cultivation, whereby weeds were controlled mechanically. In the process of controlling weeds the crop residue was usually ploughed under, leaving the soil surface unprotected from the elements. Over the years this conventional way of fallow management caused severe land degradation, one of the main causes being a reduction in the organic matter content of the surface soil, which, in turn had a deleterious effect on soil structure. The destruction of soil structure made the soils susceptible to wind erosion and was responsible for reducing infiltration rates, thereby increasing the hazard of run off and associated sheet,

rill and gully erosion. When it was realised that clean cultivation was an unsustainable practice, new systems of fallow management were adopted. These systems have in common their use of crop residue as a mulch. A mulch is a layer covering the soil surface. Many materials may be used to generate a soil mulch, but by far the most common type of mulch is the crop residue mulch. Leaving the residue on the soil surface for as long as possible requires weeds to be controlled by means of chemical methods or by means of mechanical implements which uproot the weeds without much soil disturbance e.g. sweeps. All these practices are referred to as conservation tillage or minimum tillage.

The presence of a residue mulch protects the soil against direct irradiation and reduces wind velocity at soil level, both effects resulting in a reduction in the rate of water evaporation from the soil surface and thereby increasing the efficiency by which water is stored during the fallow period.

Generally, these methods of crop production in semi arid areas are effective and economically viable only when the following requirements are met:

- a) the soils are sufficiently deep to provide adequate storage capacity;
- b) the area being cropped is sufficiently large to warrant the cost of converting from conventional to conservation tillage practices, which often involves the purchasing or hiring of special equipment.

Under extremely dry conditions, dryland farming becomes a very involved activity. Water conservation can no longer rely on crop residue management only, because the quantity of residue produced is very small as a result of the severe water deficit. Technologies such as water harvesting are used to increase the quantity of soil water available to the crop. Planting densities are reduced to very low levels for the same reason.

## 5.2 DRYLAND CROPPING IN THE STUDY AREA

Dryland crop production in the Fish river area has all but ceased. At present, not a single white commercial farmer is involved with dryland crop production. On the eastern side of the river most land allocated for the purpose of dryland cropping has been abandoned. Some rainfed cropping is still being practised on a few fields along the Fish river and on the plateau in the vicinity of Peddie.

Locally, most rural African communities practice a system of mixed agriculture involving crop production and animal husbandry. The emphasis of the system lies heavily on animal production and crop production is of secondary importance. Generally, two systems of crop production are employed, namely an intensive and a relatively extensive system. The relatively extensive cropping is practised on arable land, which may be located at some distance from the residences. On these lands, maize is by far the most commonly planted crop. Other field crops that feature here are beans and a variety of pumpkins and melons. All of these crops feature prominently in the local diet. However, from a plant physiological point of view they can all be classified as being mesophytic, meaning that they require a relatively high and consistent supply of water in order to produce high yields.

Characteristic of the local field crop production system is a trend for the level of inputs and management to be reduced as the risk of crop failure increases. Chiefly, the increase in risk is associated with a deterioration in the growing conditions, which are mainly a function of climate (drought hazard) and soil quality. In most cases the arable fields, which usually range in size from 0,5 ha to about 2 ha, are arranged in large blocks with a communal fence protecting the crops from grazing animals during the summer growing season. After the harvest, livestock are given access to the arable lands where they feed on the crop residues. This source of feed supplements the deteriorating pasture during the winter months. It is noteworthy that ownership of the yield obtained from a particular field rest with the individual grower, but the crop residue remaining on the land is regarded as communal property, in the sense that any animal owned by a member of the community is allowed access to the cultivated lands during the fallow period.

The more intensive type of cropping is practised in home gardens, which form an integral part of the individual residential sites and to which livestock has normally no access. Crops commonly grown in home gardens include potatoes, cabbage, beans, melons and pumpkins, but, even here, maize is the main crop that is being planted. Plants growing in the home gardens tend to receive more attention than those in the fields, especially with regard to manual operations such as planting and weed control. However, when it comes to practices requiring capital expenditure, such as chemical fertilization and pest control, the approach tends to be as conservative as with the field crops. It should be remembered that traditional crop production is not market orientated, most of the food grown being consumed by the family and their livestock. Farmers, therefore may be prepared to invest their labour but appear reluctant to risk cash expenditure.

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In all of the four settlements studied by ARDRI, namely Qamnyana, Ndlambe, Ndwayana and Sheshegu, rainfed production of field crops had, for all practical purposes, been abandoned completely. During our investigation, crops were found to be actively growing in some home gardens in Sheshegu. In Ndwayana and Ndlambe the need for a home garden has largely been removed by the allocation of irrigated food plots to most of the residents. In Qamnyana, where residents do not have access to irrigated food plots, some evidence of home garden activity was observed, but none of the gardens were planted.

### 5.3 CONCLUSION

When comparing conditions in the Mid-Fish river area with those of other semiarid parts of the world, where dryland cropping is a sustainable way of farming, there are a lot of factors mitigating against a possible revival of local dryland crop production. The main factors are:

- a) the area of land where the soil is sufficiently deep to warrant water conservation practices is limited in size and distribution. Most of this land is located in the Fish river valley and some of its tributaries. This is also the land which has a moderate to high potential for irrigated crop production and for which irrigation water is available.

b) the local dryland cropping system involves the planting of mesophytic (drought sensitive crops) which are used mainly for home consumption and as supplementary feed for domestic animals and not for marketing. As a result, the introduction of new crops that are better adapted to dry conditions may meet with considerable resistance from the growers.

c) the function of the fallow (crop residues) within the animal production system, namely as a source of winter feed, is in opposition to the requirements of sustainable dryland cropping in semiarid areas, namely, the use of crop residue as a mulch with the intent of increasing the efficiency by which water is stored during the fallow period.

## 6. IRRIGATED CROP PRODUCTION

### 6.1 INTRODUCTION

The objective of irrigation is to remove the limitation of water deficiency in crop production. Two types of irrigation can be identified, namely supplementary irrigation and full irrigation. Supplementary irrigation is practised in areas where the major part of the water requirements of the crop are met by means of rainfall. The crop is irrigated during short periods of water deficit. Supplementary irrigation usually requires some form of portable irrigation equipment and the demand for irrigation water tends to be modest. Full irrigation is practised in areas where the major part of the water requirements of the crop are met by means of irrigation, rainfall making a modest contribution only. As a result, the irrigation system is usually fixed in place enabling irrigation of the crop whenever the need arises.

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The water deficit in the lower Fish river area is so large that for all practical purposes rainfall can virtually be ignored. Loxton, Venn & associates (1987) estimate the annual expected effective rainfall to be in the order of 130 mm. On the other hand, the demand for water of an annual actively growing crop is estimated at 1500 to 2000 mm. In other words, less than 10% of the water requirement of an annual crop is expected to be met by means of rain. The rest needs to be supplied by means of irrigation.

The potential of the Lower Fish River area for irrigated crop production has long been recognized. A history of the developments leading to the Tyefu irrigation scheme was presented in chapter 3 of this contribution. In what follows, recent developments with regard to irrigated crop production along the Fish river are discussed. Attention is focused on three main issues, namely

- a) a description and assessment of the production systems used on both sides of the river at present;
- b) the hazards associated with these production systems with respect to resource degradation;
- c) options for the future.

## 6.2 PRODUCTION SYSTEMS USED ON BOTH SIDES OF THE RIVER AT PRESENT

### 6.2.1 Production systems on the eastern side of the river (the Tyefu irrigation scheme):

Initially, the Tyefu irrigation scheme involved three irrigated production systems, namely small food plots (0,25 ha each), commercial mini farms (4 ha each) and tribal estate farms.

Food plots were introduced in order to compensate residents with land rights for the loss of arable land as a result of the introduction of the scheme. The objective of the food plots was to enable the holder to produce sufficient food for their family and, when possible, earn a small income from the sale of excess produce.

The mini commercial farms were introduced to enable local people to make a living from irrigated farming. The objective was to encourage the emerging African small farmer to adopt a commercial approach towards agriculture.

The objective of the tribal estate farms was to generate sufficient income to:

- a) meet the cost of production including personel compensation,
- b) meet the cost of maintaining the infrastructure necessary to provide the commercial farmers and food plot holders with a comprehensive range of services,
- c) to generate income required for other community development projects.

A fourth production system, namely 0,1 ha allotments, was introduced when the scheme was extended to incorporate the state owned farm Committuys in order to provide land for the resettled community of Glenmore. The objectives of the allotments are the same as those of the food plots. The difference in size between food plots and allotments (0,25 ha versus 0,1 ha) is said to reflect the status of the holders in terms of land rights, i.e. food plot holders had land rights whereas holders of allotments did not.

The relative high levels of production on the food plots and the free market and the privatization philosophy, which influenced government thinking during the late eighties and early nineties, lead to the gradual dismantling of the tribal estate farms, which are in the process of being converted into food plots of 0,2 ha. At the end of this process, only three systems of production will remain in place, namely allotments, food plots and commercial mini farms.

Services to the various farming communities continues to be provided by the scheme management and its infrastructure. Over the years, the scheme management has changed hands several times and at present it forms part of the Ciskei Agricultural Cooperation (CAC).

The services provided by scheme management include land preparation, inputs (excluding fertilizers), the purchase of planting material, the delivery of water to field edge, advisory assistance and the marketing of the produce. The supply of fertilizers is a service that has been privatised, but the way in which fertilizer

purchases by farmers are financed is similar and forms part of the financing arrangement between the providers (scheme management) and the clients (farmers and growers).

The clients pay a market related price for land preparation, planting material and fertilizer, but do not pay for water and advisory services. For each client the scheme management runs an account into which payable services are debited and sales of produce are credited.

The food plots and allotments are arranged in long strips of land. Most often, holders of plots within such a strip of land will plant the same selection of crops. Typically, an entire part of the strip will be prepared and planted by the different holders to cabbage, another part to potatoes and a third part to maize. By preparing a section of the entire strip, cumbersome manoeuvring of the tractor, required in case of preparing plots individually, is avoided. The individual holders are responsible for tending and irrigating the crop. If a holder is not interested in planting, his plot is skipped. At any one time, the proportion of holders participating in a particular planting is approximately 80%.

On the food plots and allotments irrigation is by means of a drag-line sprinkler. This consists of a flexible hose pipe which is attached to one of many regularly spaced risers off the main water line. At the other end of the hose pipe is a single sprinkler positioned on a tripod. This is a simple but appropriate system, which is well suited to the small plot size and the high number of growers involved in the scheme. The way in which irrigation is scheduled is not very sophisticated. The recommendations by the scheme are directed at supplying 36 mm of water per week. The amount of water applied is estimated by multiplying the duration of irrigation with the delivery rate of the sprinklers (time x mm water delivered per time unit). Growers and scheme management are in agreement that the quality of the produce is satisfactory to, on occasions, very good.

The production system on the mini farms is very similar to that on the food plots, but there appears to be a wider variety in crops grown. Here, fields are irrigated using a line of sprinklers which enables the farmer to irrigate larger areas at any one time.

The Tyefu irrigation scheme uses a mixture of runoff water from adjacent ephemeral tributaries and Fish river water, which is stored in dams and gravitated to the scheme. Whenever possible, water from the Fish river is pumped during times of flood, when the salt content of the water is at a minimum (but still saline). Direct use of Fish river water is discouraged. Once used to water seedlings, the saline Fish river water burnt and destroyed the entire batch.

With regard to production, both farmers and scheme management agree that the food plots and allotments are a success. The rate of success on the mini farms is variable and depends on factors such as soil quality (the 1974 sand deposits are poor quality soils) and the enthusiasm, age and management skills of the farmer. There is however a severe problem with regard to the marketing of produce.

Tyefu is far removed from the main fresh produce markets and the cost of transport to these markets (mainly East London) affects the economic viability of the project. At present, the problems related to marketing are exacerbated by ineffective tele-communication. Phone and fax have not been working for months on end. This has an adverse effect on the ability of the marketing department of the scheme to cash in on market opportunities.

These are some of the problems identified by the scheme's management:

- The food plots are doing perfectly well but production by commercial farmers varies amongst individuals. Some are doing well but others are not. Old age appears to be a problem. Another setback that affects progress at the scheme is a scarcity of markets. Our main fresh produce market is in East London, which is about 150 km from the scheme. The products (those produced by the holders) are generally of a good quality, but often the grade of the products has been reduced by the time they reach the market. Ninety percent of our vegetables is sold on fresh produce markets. Transport costs affect profitability. In 1993 we (scheme management) spent R70 000 on transport.
- Initially, a lack of finance limited the ability of the plot holders to become involved in crop production. People required loans to pay for land preparation and other input costs. Ciskei Agricultural Bank (CAB) gave the people loans and they (the people) agreed to pay 10% of the loan till they are through with the account. Financially, the repaying of loans is often very painful for the growers.
- The selection of crops to be planted is based on market expectations. We are intending to enter negotiations with Land Harvest, a large vegetable processing plant in Port Elizabeth. The vegetable production from plot holders and commercial farmers could be sold directly to that firm. In this way marketing and transport problems would be avoided. Before planting we would agree with Land Harvest on the prices of the products.
- Crops other than vegetables have been considered. At one stage, the people wanted to plant lucerne in their plots but that was discouraged by scheme management, because the tractors are too small for lucerne and the necessary implements are not available.
- The management of the scheme foresees a success with citrus production. They believe that citrus would do well in this area. They indicated that there is a farmer in the region whose oranges are doing well.
- Scheme management is positive about the future of the scheme. The scheme used to use Fish river water when the river was in flood but now they will be getting water from the Orange river. The problem with water from the Fish river is that the salt content of the water is high.

The discrepancy between the price of vegetables on the retail market and the actual credits to the farmers for produce sold, which appear to be related mainly to geographic factors and related marketing problems, is affecting the attitude of the growers. Growers are getting too little return on time and labour invested. Our interview with a large number of growers at Ndlambe, the most experienced and successful of all plot holder communities, indicated that there is a growing feeling of frustration and despondency amongst them. The target of their frustration is the scheme management, being the link between them and the market and being responsible for the management of their finances. Some of the perceptions expressed by the meeting are presented here without editing. Note that the obvious errors with regard to the size of the lands (and some others) are not typographical. Of the essence here are the ideas and perceptions expressed by the growers.

The meeting involved 63 participants (29 women and 34 men), all involved in production on food plots at Ndlambe.

#### On production

- At Ndlambe there are 403 people who have food plots.
- Anybody in Ndlambe has the right to have a food plot.
- We grow mainly maize, cabbage, potatoes, carrots, peas and onions.
- The maize we grow is for our own consumption.
- We also get some cabbage for our own homes.
- The officers look for markets to sell the other crops.
- We are prohibited from bringing or selling crops to other people known to us.

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#### On the different kinds of enterprises

- Some have 2 ha plots, some have 8 ha.
- Those who have 8 ha are commercial farmers. They were elected by a village committee.
- People were asked to volunteer to plough 8 ha, so those who felt confident in ploughing 8 ha were given the land, but only 13 people could get land. Many more applied.
- We (plot holders) don't agree that our plots are 2 ha, they are much smaller than 2 ha.

#### On service provision

- We hire a tractor for ploughing and pay for it. The money (to pay the tractor) is deducted from the money we make on crops sold.
- Money for the preparation of maize fields is drawn from money made on cabbages, because maize is for our own consumption.
- Our plots are not ploughed unless we pay.
- We have the experience to plough and farm on our own, but we don't have money to stand on our own.
- People are allowed to use draught animals to plough, however, they (officers) don't take into account the fact that some people used animals,

they just deduct money from everybody.

- Some of us had their own seedlings, but were not allowed to plant them because we have to buy them from the scheme.

#### On accounting procedures followed by scheme management

- We are given statements of the number of bags we have made but none that shows the sale price and the deductions made.
- We are given receipts that show the number of the bags sold but not the price. So we can't calculate the money that is due to us.
- We are not told how much money has been deducted from our account.
- We are not informed about the sale price of our produce.
- Some do not get any money and they don't know how much has been deducted for services.
- We want to be given a list of money we have made, so as to know how much money to expect.
- The buyers who come to the scheme pay the money there and then, but the managers would always say that the crops are taken to the market. One man said he witnessed buyers issuing a cheque for crops bought, but afterwards the management said the money has not been paid yet.

#### On marketing by scheme management

- The main problem is the sale of crops, the officers use a wrong method. A bag of cabbage is sold for 82c.
- Our crops are sold for about 22c a bag.
- We were told that the lorry in the scheme would deliver our crops to the markets, but we were never told that money would be deducted from our account to pay for transport.
- We feel that somebody who is a food plot holder should go with the lorry to the markets in order to ensure of what has been sold and for how much.
- We don't understand why the transport costs of the buyers is deducted from us because, if one goes to a shop in K.W.T. that shop does not pay us back the money we used to get to K.W.T. So why do we have to pay somebody who comes to our shop (scheme).
- A few weeks ago, a buyer came to the scheme for some cabbages, this man did not go to the office but came straight to the plots. Some food plot owners sold him bags of cabbage for R7 each. When the management heard about this, they wanted that money saying it has to go to the bank, the people refused; then the management said the buyer has complained that the bags, were too expensive.
- If we could have our own transport, we would sell our crops in suitable places (the growers claim to know those places).

#### Attitude towards scheme management

- The officers decide on their own, they don't consult the people. We (the people) have formed a committee, but the management does not consult with that committee.
- We are never told things, we just see them happen.

- We are being cheated by the management [they were very angry when they said this].
- The plot holders stressed that they are cheated. They claim there is a lot of corruption within the management.
- We want a new start, a change of management, at one stage some of us attacked one of the managers physically. Afterwards we were given some money.
- We feel that some of our members (food plot owners) should be trained so that they together can become part of the management.

#### Attitude towards researchers

- People have come and gone, asking about the scheme but nothing happens thereafter.

#### General evaluation of their livelihood

- At the end of the day we don't see any progress in terms of the money we make.
- We feel that we are working for nothing, we don't gain a thing.
- Basically, we only get crops for our own consumption, but we do not make a living.
- We feel that we are slaves, working for nothing. For example, a woman's organisation formed a pig production club, but when it was time to sell, it was said that their pigs were too old. They were given R125 (after deductions) for 6 pigs, (which were in very good condition).
- We have grown quite bitter, in fact, we are beginning to have negative thoughts.
- Some have already abandoned their plots because they are fed up, others are likely to follow.

From these reactions it is apparent that low net returns on labour, capital and time invested by the growers has a demoralizing effect, to the extent that it threatens the future of the scheme.

The immediate cause of contention amongst the growers could be addressed by increasing the level of transparency with respect to financial aspects of the operations. It is suggested that accounting procedures should be made more "grower-friendly". The introduction of a detailed account system indicating and explaining both credit and debit aspects to the individual growers should go along way at removing suspicions of corruption.

It is also suggested that a selection of growers (identified by the growers themselves) gets exposed to and possibly involved in the marketing of produce. The marketing by growers themselves should be encouraged whenever practical, especially if this could lead to increases in the returns from production.

All these suggestions are aimed at addressing the immediate grievances of the growers (see reactions and perceptions by growers). Implementation of these suggestions may assist in improving the attitude of the growers towards their work

and towards scheme management.

However, a number of factors contribute to the demise of the growers, namely

- a) the gross margins on crops grown by the scheme at present tend to be low (see also Table 5 p 36)
- b) distance to the market causes transport to become a major cost, reducing margins even further;
- c) poor tele-communication services prevent scheme management from exploiting market opportunities optimally; and
- d) the size of the production units is very small, in fact too small to realize a significant income for the holders, irrespective of the crops grown.

In the long term, therefore, solutions other than improving working relations between growers and scheme management must be found.

From Table 5 it is evident that the gross margins of the major crops grown at Tyefu (cabbage, potatoes, maize) are generally low. The gross margins of citrus compares very favourably with those of crops grown at present in the area (e.g. potatoes, cabbage and maize).

- 6.2.2 Production systems on the western side of the river (white commercial farmers):** On the west side of the Fish river, where the land is in the hands of white commercial farmers, some 350 ha is under irrigation at present. Most of the white farmers, who are involved with irrigated crop production, specialize in the production of one crop, namely lucerne, which is for sale. The lucerne market thrives during periods of drought (up to R12 or R14 per bale) and a slump is experienced when the season is favourable (as little as R3,50 per bale). Other crops grown are maize (small areas) and vegetables (small areas). One farmer is producing chicory on a large scale. Attempts at large scale vegetable production appear not to have been successful, distance to the markets being the main limiting factor.

Over-head irrigation is by far the most commonly used way of applying irrigation water. Water is pumped directly from the Fish river and applied by means of a line of sprinklers. Some surface (flood) irrigation is still practised by a few farmers. As was the case in Tyefu irrigation scheme, irrigation scheduling is not based on the actual water requirements of the crop. Usually farmers try to supply a predetermined and fixed quantity of water to the crop on a weekly basis.

### **6.3 HAZARDS ASSOCIATED WITH IRRIGATED CROP PRODUCTION SYSTEMS WITH RESPECT TO RESOURCE DEGRADATION**

Over time, irrigation may lead to resource degradation. The main hazards in this regard are:

**Salinization**, which refers to the accumulation of soluble salts in the soil profile;  
**Sodification**, which refers to a change in the composition of the cations present on the soils exchange complex in favour of sodium;

**Alkalinization**, which refers to the accumulation of carbonates in the soil, resulting in an alkaline soil reaction (increase in pH)

**Waterlogging**, which refers to poor soil aeration as a result of the accumulation of excess water in the profile which fails to drain away over relatively short periods of time (weeks), thereby creating a perched water table or causing a rise in the existing water table;

**Soil erosion (by water)**, which refers to losses of soil solids caused by runoff.

Water logging is caused mainly by factors related to soil and landform. In the case of the irrigable soils in the Fish river area, soil drainage is adequate in most cases and, as far as could be established, no problems regarding waterlogging have occurred on the lands under irrigation at present.

Soil erosion is closely related to runoff. A variety of factors may be responsible for runoff to occur, including soil factors (mainly infiltration rate and soil depth), land form (mainly slope gradient) and application rates of irrigation (when the rate of application exceeds that of infiltration, runoff will occur on sloping land). It is our perception that on the irrigated lands soil erosion is not a major problem.

Salinization, sodification and alkalinization are mainly the result of water quality and irrigation practices. Irrigation water containing salts will result in the accumulation of salts in the soil profile unless irrigation practices are directed at applying more irrigation water than is required to meet the water demands of the crop. Water applied in excess of that which is taken up by the crop, percolates through the profile. On its way down the profile, the water dissolves salts accumulated in the soil profile and leaches these salts to lower layers and ideally out of the rooting zone. Simple models, enabling the estimation of the leaching fraction, exist. The leaching fraction is the proportion of the irrigation water applied that has to leach through the rooting zone in order to remove the salts introduced as solids dissolved in the irrigation water. Rainfall, being virtually salt-free, also plays an important part in the process of removing salts from the rooting zone. Simple models, which enable the estimation of the leaching fraction and which take into the account the effect of rainfall, are also available. Suitable references in this regard are Dregne (1976) and Harry (1988). Modern developments in the field of solute movement have reached a stage where computer packages modelling movement and activity of different ion species are commercially available.

The quality of an irrigation water is determined by total salt concentration and by the chemical composition of the salts.

Loxton, Venn & Associates (1987) presented the results of an analysis of the Fish river water conducted over a period of 60 months, (1977 to 1983 with some missing months). In order to present an overall picture of the water quality of the Fish river a summary of these data is presented here in the form of mean values in Table 4.

**Table 4.** Results of the chemical analysis of Fish river water sampled at Tyefu irrigation scheme during the period 1977-1983 by Loxton, Venn & Associates (1987). The data presented in the Table are the means of 60 entries.

pH	EC (mS m <sup>-1</sup> )	TDS (mg l <sup>-1</sup> )	cations (me l <sup>-1</sup> )				Anions (me l <sup>-1</sup> )				SAR
			Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	
7,8	200	1320	13,87	0,15	1,91	4,25	11,63	0,25	5,20	3,71	7,9

EC = Electrical conductivity in milli-Siemens per metre

TDS = Total dissolved salts

SAR = Sodium adsorption ratio

Using the USDA classification of irrigation water (Richards, 1954) and the analytical results presented in Table 4, the Fish river water is classified as a high-salinity medium sodium water. The average salt concentration of the water is so high, that the irrigation of a perennial crop such as lucerne with undiluted Fish river water (as is the case on the RSA side of the river) introduces to the soil nearly 20 tons of salts every year (calculation is based on the application of 1500 mm irrigation water per annum).

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According to Richards (1954), high salinity water cannot be used on soils with restricted drainage and even when soils are adequately drained special management for salinity control (leaching of salts) may be required and crops with good salt tolerance should be selected.

Medium-sodium water presents an appreciable sodium hazard in fine textured soils with a high cation exchange capacity, especially under low leaching conditions, unless gypsum is present in the soil (or is introduced into the soil as a soil ameliorant). The sodium hazard of such water is low when the water is used in the irrigation of coarse textured soils (Richards, 1954 and Harry, 1988).

Returning to the way in which irrigation is practised in the Fish river valley, it was explained that the scheduling of irrigation (when to irrigate and how much) at present is bound to cause some degree of water stress during most parts of the year (except perhaps in the case of a very wet season). From the information at hand, it appears that the amount of water that is being applied is insufficient to meet both crop and leaching requirement. Note that this appears to be the case on both sides of the river!

The valuable and scarce natural resource, namely irrigable land, is, therefore, expected to be threatened by two processes of resource degradation, namely salinization and sodification. The sodification is expected to be accompanied by alkalization since some of the sodium is introduced in the form of carbonate and bicarbonate.

All available evidence (Nell, 1989; Modi, 1991; Loxton, Venn & Associates, 1987 and Dempsey, 1994 pers. com.) suggest that on both sides of the river, the problem of salinization has not yet resulted in a significant degradation of the resource. It appears that the leaching action of rain water brought about by the occasional wet spell has been sufficient to remove most of the salts introduced with the irrigation water.

The degradation of the resource as a result of sodification and alkalization is, however, apparent on both sides of the river. Studying the irrigated soils on the western side of the river, Nell (1989) found that, during the period 1950 to 1989, the soil pH had increased by approximately 0,7 of a unit (median soil pH increased from 8,1 to 8,9) and most soils are now considered to be strongly alkaline. He also found that irrigation had increased the exchangeable sodium percentage (ESP) of the soil by about 70% in the surface horizon (from 7,2 to 12,4) and by about 40% in the subsoil (from 14,8 to 20,7). In fact, at present, the ESP values of the irrigated soils is now so high that the soils can be referred to as being sodic (lower ESP-limit for sodicity is 15%) and of course as being strongly alkaline. Loxton, Venn and Associates (1987) found all the irrigated soils at Tyefu to have a pH in excess of 7,3 (most being higher than 8) and an ESP in excess of 10. However, problems with respect to sodicity and alkalinity are less severe on the eastern side of the river. This is most probably due to the dilution of the Fish river water with runoff water, which occurs in the storage dams.

Sodicity causes a deterioration in soil structure because of its deflocculating (dispersing) effect on clay particles. The deterioration of soil structure leads to a reduction in the permeability of the soil. At the surface, sodicity and deflocculation are known to cause or promote crusting, which is the formation of a dense, massive layer at the surface of the soil. Surface crusting causes a dramatic reduction in infiltration rate, which, in turn, may lead to runoff and erosion. In the subsoil, the reduction in permeability caused by sodicity reduces the drainage rate of the soil, interfering with the removal of excess water and salts which, over time, may cause salinization and waterlogging.

Agronomic problems associated with alkalinity include reduced availability of some nutrients such as phosphorus and iron and an increase in the incidence of certain plant diseases such as potato scab.

It is very important to realize that the effects of sodicity are likely to become more apparent after the introduction of water from the Orange river scheme, which has a low salt content. The dispersing effect of sodium is enhanced by a reduction in the solute concentration of the soil solution. In other words, the effect of salinity (here caused by the use of saline Fish river water) counteracts some of the effects of sodicity. It is, therefore, important that as soon as better quality irrigation water is available, gypsum is applied to the soils as a matter of

course. Guidelines enabling the estimation of the quantity of gypsum required for the various lands are available (Dohse, 1980).

#### 6.4 OPTIONS FOR THE FUTURE

With regard to the Tyefu irrigation scheme, Loxton, Venn & Associates (1987) suggest a change in crop from vegetables to citrus. They base their recommendations on an assessment of the suitability of the land for citrus production and on the superior monetary returns offered by this enterprise (see also Table 5). At present, 500 ha is under irrigation at Tyefu. Potentially, another 1200 ha of land is irrigable, resulting in a total of approximately 1700 ha of irrigable land on the east side of the river (Loxton, Venn and Associates (1987)). Citrus could be introduced on new land, avoiding interference with current production systems. In other words, the production on the food plots is continued whereby emphasis is placed on the supply of food to the households of plot holders. Over time, citrus established on new land would gradually replace the function of vegetables as a source of income.

Growers expressing an interest in citrus production could be sent (employed) to farms along the Kat river. Here they would spend time working in the industry and receive formal training in order to enhance the learning process. Alternatively, a small citrus estate could be established on part of the land still available at the scheme. This estate would then have to address the needs for education, training and research, production playing a subordinate role. The initial phase of learning appears to be very important in determining the success of the process by which new (foreign) technology is being adopted by growers. The food plot holders at Ndlambe are considered to be the most successful group of vegetable growers. Before producing vegetables on food plots, many worked as farm labourers on the tribal farm. During this period, they had the opportunity to get familiar with the various aspects of vegetable production, which they transferred successfully to their food plots. Similar experience was gained at Fort Hare, where labourers on the experimental farm transferred technology, of which they gained knowledge during their formal duties, to their home gardens. The farm workers are now producing better maize and vegetables in their gardens than they do on the farm.

Indications are that white commercial irrigation farmers are extremely keen to convert from lucerne to citrus. One farmer has already established a small orchard in order to test the potential of this crop in the area. Generally, white farmers identify the absence of suitable infrastructure, such as a packing shed, as a major factor preventing the conversion to citrus. Following the implementation of the Glen Melville scheme, applications for an additional  $\pm$  500 ha to be put under irrigation have been filed. Studies indicate that the total net area of potentially irrigable soils in the Ecca river valley (also called the Brak river) and the western side of the Fish river valley is 1921 ha (Nell, 1989). Of these 1921 ha, slightly more than a third is rated as class 1 or 2 land (generally well suited) and slightly more than half is rated as class 5 land (marginally suited) (Nell, 1989). Recent developments in the field of citrus production make it possible to produce good yields on very marginal land, opening opportunities to expand production to land presently rated as marginal or even unsuitable for citrus.

**Table 5. Summary of gross margins of some important crops grown on both sides of the Fish river and those of some citrus enterprises (after Loxton, Venn and Associates (1987) and The Directorate Agricultural Economics (1991)).**

Enterprise	Gross margin in R/ha (1987)*	Gross margin in R/ha (July 1991)**	Remarks
<b>FIELD CROPS</b>	all gross margins include transport and labour		
Lucerne	506	2 118	Predicted mean over a 6 year period
Maize	619	930	
Potatoes	-50	5 638	
Sweetcorn	116	1 265	
<b>VEGETABLES</b>			
Cabbage	-860	2 370 <sup>1</sup> 2 824 <sup>2</sup>	<sup>1</sup> Sundays river valley <sup>2</sup> Gamtoos river valley
Cauliflower	1 444	4 162	
baby carrot	1 242	5 977	
green pea	490	1 484	
Broccoli	1 008	8 218	
<b>FRUIT</b>			
Minneolas	20 683	16 547	Predicted mean over a 25 year period
Lemons	-	18 331	
Navel oranges	2 006	11 043	
Valencia oranges	1 648	8 665	

\* transport cost based on markets to which Tyefu supplied in 1987. Several of these markets, especially markets for vegetables, have subsequently been discontinued (e.g. Zwelitsha, Mdantsane) resulting in a further increase in the distance to the markets and a associated increase in transport costs

\*\* transport costs as calculated by the Directorate Agricultural Economics (1991) which, in some cases, may be a lot less than is the case for Tyefu.

It appears, therefore, that conditions are favourable to consider the introduction and support of a citrus industry in the lower Fish river valley. Land is available to initiate production on both sides of the valley. With time, such an initiative may lead to close cooperation between white and black farmers, through the sharing of extension services and infrastructure and a common interest. The monetary returns from citrus are highly dependent on the quality of the fruit produced. Quality can be maintained only when production is managed properly. If a citrus industry is to be established in this area, there will be a tremendous need for farm systems research and extension.

## 7. OVERVIEW OF THE TYPES AND NUMBERS OF LIVESTOCK IN THE STUDY AREA

### 7.1 LIVESTOCK HOLDINGS AND BENEFITS DERIVED FROM OWNERSHIP

The commercial sector takes it for granted that the objective of farming is to generate income through the marketing of produce. This is not true of the communal sector. An ARDRI study of the KwaZulu cattle industry during 1982/83 clearly illustrates that cattle are not kept as a production enterprise per se, but rather for local consumption. In response to the question: "If you have cattle, why do you keep them?" domestic uses (milk, ceremonial, draught, meat consumption) were cited eight times as often as "for cash sales" (Tapson & Rose, 1984). The domestic uses benefit not only the owner, but the community as a whole. For this reason any intervention planned must take cognisance of the impact of the intervention on the total community, including non-owners of livestock. May and T'Jonck (op cit) found that of the animals slaughtered in Bophuthatswana in 1989, 68% of the cattle, 84% of the sheep and 66% of the goats were used for social needs.

According to the respondents in the current study, livestock are not kept as a way of generating immediate cash income, but as investment and insurance and for restoring dignity and boosting the social status of the owner. Due to their limited numbers, cattle are neither used as draught animals nor for paying lobola. In fact, for lobola, it is cheaper to pay hard cash than to pay in the form of livestock, informants said.

Reasons for keeping livestock were given as:

- 1) as investment and insurance
- 2) for milk
- 3) for meat
- 4) as draught animals
- 5) for sale

The main benefit from owning cattle is milk. However, regular milking has been difficult in the past few years due to drought.

The livestock holdings in the study area are summarized in Table 6.

**Table 6. Summary of livestock holdings**

	Percentage Household Owning*			Average Holdings		
	Cattle	Goats	Sheep	Cattle	Goats	Sheep
Ndwayana	46	55	0	8	24	0
Qamnyana	-	-	-	9	10	23
Sheshegu	35	67	34	8	21	24
Commercial	59	71	41	66	863	168

\*Data for Sheshegu from Williams, 1987

#### White commercial farmers

Angora goats dominate the commercial livestock industry. Goats make up 79% of livestock holdings and 93% of these are Angoras. The rest are Boer goats. The cattle are almost exclusively Bonsmara, and the sheep are of the Dorper type. There is no dairy farming in the area.



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#### Cattle in the communal sector

In the communal sector a non-descript type of cattle, called indigenous by the farmers, is the most common, mainly because it is hardy and readily available. Judging by their appearance Nkone and Africander must have made significant contributions to the gene pool. However, about 21% of cattle owners also keep breeds such as Guernsey for milk production, as well as a mixture of a modern and an indigenous breed. They call such mixed breed 'Baster'. If it was possible, more than 70% of livestock owners would keep modern breeds for milk production, while the rest would look for breeds that produce mainly meat. Friesland are more popular than all other dairy breeds, mainly due to its large size and because it is popular amongst white commercial farmers.

#### Ndwayana

For the whole village of Ndwayana there are 3 bulls of the indigenous type free-ranging on communal land. Services of these bulls are not paid for. Surprisingly, the sex composition of the herd is planned, with female animals appearing in larger numbers than males (ratio is 3:2). Oxen, being regarded as 'useless unproductive animals that cannot produce milk' and risky to keep, are sold as soon as they are ready for the market or exchanged for heifers at an early age.

## Qamnyana

All respondents who attended the PRA sessions in Qamnyana keep indigenous and indigenous-cross cattle. None of them keep modern breeds, because they are expensive to purchase. 30% of the respondents claim to have a mixture of the modern and the indigenous type.

## Sheshegu

In Sheshegu land is used for livestock production only. The Sheshegu community does not have an irrigation scheme. The people also no longer cultivate their arable lands. It is almost 10 years since they last ploughed. The grazing veld of Sheshegu is not mountainous like that of Ndwayana and Qamnyana. 'Indigenous' cattle are the most common. A 'Baster' cross of modern and indigenous breeds is also kept. Livestock inspectors and the community have agreed to concentrate on the Bonsmara breed. Respondents said they choose this breed because they were told of its good qualities. A selected number of the residents were taken to Hewu and shown Bonsmara cattle. All the respondents said they want to keep cattle for dairy and meat production. They prefer to have fewer cattle that grow large in size rather than many small mixed animals. There are 4 bulls of indigenous type free-ranging on the communal land. The services of these bulls are not paid for.

## Black commercial farmers



Two commercial farms were visited near Alice. Their areas are 850ha and 900ha. 102 and 32 cattle of the mixed Bonsmara, Simentaler and indigenous breeds are kept on these two Ulimocor owned farms. At the beginning of this year the farmers leasing the farms were told not to pay rent for the farms, because Ciskei was in a phase of political transition. Researchers were told that, all the other farms in the area are run on a part-time basis with one exception only.

The farmer on the 850 ha farm sells milk directly to Sheshegu village. He owns 7 indigenous milking cows. In March this year he harvested 107 and 17 bags of maize and sorghum from 20 acres using 8 indigenous oxen. He also sold green mealies to the village. The other farmer, who owns a butchery in Alice, appears not to be very interested in farming, and uses the farm mainly to keep cattle and sheep bought on stock sales until they are slaughtered.

## Former farm workers

Eight families (former farm labourers) were visited on the Petriens Farm owned by an Alice butcher. These families make a living solely from farming. They keep between 17 and 24 cattle each. About 3 cattle, particularly oxen, are sold by each family annually. Milk production is enough for domestic consumption for each family. The families are allowed to keep on the Petriens Farm not more than 4 milking cows. The rest of their livestock is kept on another farm owned by a Ciskei Agriculture Officer working in Alice. Apparently this officer compensates them in this way for looking after his livestock.

### Goats in the communal sector

Goats are the main species that communal communities benefit from economically. Goat milk is used in coffee. For the Tyefu villages, the people in Glenmore offer a good market for goats because not many Glenmore residents keep goats. Goats bought are used mainly for slaughtering in traditional ceremonies. They also slaughter them for Christmas, Easter, to celebrate the success of pupils of school or when they have an important visitor (e.g. a niece). The main problem with this informal market is that sellers may have to wait for a considerable time before finding a buyer. During the waiting time there may be losses through death or theft, or animals may simply lose condition. However, given a choice, owners would still prefer the present informal marketing system than to sell to white farmers on the other side of the river, because these farmers tend to dictate the price.

### Tyefu

In Tyefu indigenous and combination indigenous-Boer goats are kept. Angoras are not kept because they are considered to be 'weak goats', and owners would rather remain with the type of breeds that they have at the present moment. For the whole village of Ndwayana there are 5 bucks, the services of which are not paid for. Before 1990 the village was lent 2 Boer goats by the Ciskei Department of Agriculture. The rams were later rejected by the villagers after the does experienced kidding difficulties due to the large size of the kids. Female goats dominate males in numbers, but not to the same degree as cattle. Stock stales for goats do not exist. Goat castrates are mainly used in traditional ceremonies. In Qamnyana there is a strong preference for white indigenous goats. These are used for traditional purposes and there is a good market for them. On average, 2 - 3 goats were slaughtered last year (1993) for home consumption. One owner, belonging to the group owning a small number of goats (<50), claimed to have slaughtered 6 last year for this purpose.

### Sheshegu

In Sheshegu indigenous and a combination of indigenous and Boer goats are kept. The way in which goats are managed is similar to that in Tyefu. The Sheshegu community was also lent 2 Boer goats by the Ciskei Department of Agriculture but these were rejected after the does experienced kidding difficulty due to the large size of the kids. The number of female goats is higher than that of males.

### Sheep in the communal sector

#### Sheshegu

Sixty percent of the community in Sheshegu keep sheep, with indigenous sheep being the most common. Cross indigenous-modern sheep are also kept. Sheep are mainly kept for meat and wool. The livestock inspectors used to collect the

wool to be sold in the market. However, the price for the wool has dropped because the sheep are no longer up to standard due to drought. Unlike the other two villages, there is a shearing shed in Sheshegu. The respondents have stopped shearing sheep because of contamination of wool with wild seed and sheep scab.

### **Tyefu**

The villages in Tyefu Location do not keep many sheep. Reasons given for this is heartwater disease and hilly veld. Respondents reported that all the sheep are purely indigenous. They are not shorn because of the drop in the price of wool. Contamination of wool with wild seed and sheep scab are the other reasons for not shearing. If the price of wool increased, more than 62% of the respondents would be interested in merinos, while 38% would still keep the indigenous sheep because they survive drought well. Milk from sheep is used mainly in coffee.

### **Donkeys in the communal sector**

#### **Ndwayana**

About 13 people in Ndwayana own donkeys and the highest number per owner is 13. Some of the senior residents denied ownership of donkeys because they are regarded as 'poor man's animals'. Instead they attributed ownership to their sons. Donkeys are mainly used for transportation. Although they are used as draught animals, they are not used for ploughing at the village's food plots. They are used for:

- collecting firewood
- fetching water from the river or water taps
- taking the sick to the clinic, thus substituting for an ambulance
- taking young pupils to the creche in the mornings
- fetching bought maize or vegetables from Ndlambe Irrigation Scheme
- taking maize to Ndlambe Irrigation Scheme for milling, which costs R4 per 50 kg bag

#### **Qamnyana**

Donkeys are not kept in Qamnyana because they are easy to steal. Stealing of donkeys is said to be done by residents of the villages that have an irrigation scheme, namely, Pikoli, Ndlambe, Glenmore and Ndwayana.

## **7.2 SUITABILITY OF THE BREEDS CURRENTLY USED**

Stock losses due to drought (which is prevalent in the region) and the inadequate winter supplementation (which is rare in the communal system) are exacerbated by the use of unadapted breeds. One of the tragedies of livestock production in South Africa is the near extermination of indigenous cattle through crossbreeding programmes to "improve" the native cattle of the region. Farmers were told by government officials to "upgrade" their cattle with European breeds. Up until 1972 it was government policy to introduce the use of Brown Swiss bulls in the former

Ciskei area. These cattle are very poorly adapted to the climate and the grazing of the region. Since the early eighties the recommendations changed to Bonsmara, Simmentaal, Brahman, Nkone, Angora, Boer Goat, and Dohne Merinos.

In the arid and semi-arid regions indigenous breeds should be the cornerstone of livestock production in both the commercial and the communal sectors. Their supposedly inferior production was a misconception due to a very narrow definition of production. If production is simply measured as growth rate or milk production per animal, then the European breeds outperform indigenous breeds. But if maintenance costs, reproduction and mortality are considered, then indigenous breeds often outperform the so-called "improved" breeds (Rege, 1993; Moyo, 1990; Scholtz, 1988).

At a management level higher than that practiced by commercial farmers at present, the use of synthetics warrants consideration. Synthetics have proved to be a success story in the South African livestock industry (Bonsmara, Dorper, Dohne Merino, Dormer, Afrino), because they combine adaptation to local conditions with a relatively high productivity. In the study area the commercial farmers clearly prefer the Bonsmara and the Dorper.

At a sophisticated level of management, any beef production system producing large offspring from small cows will generally be more efficient than a system producing small offspring from small cows, or large offspring from large cows. This is due to the gain in feed efficiency caused by the lower maintenance requirements of the small cow breed and the high growth rate induced in the calf by the use of a large bull breed. Indigenous breeds are ideally suited for the role of dam line. Clearly, there is a great market potential for even the small farmer to sell either female breeding stock to commercial farmers or to cross his indigenous cows with large bulls and then "feedlot" the offspring himself with the aid of the protein-roughage-additives-mineral (PRAM) system (Van Niekerk, 1989).

In the communal sector there are a number of contradictions in the perceptions of farmers. More than 85% of respondents appear to rank animal reproductivity as being more important than body size. The remaining 15% of the respondents suggest that reproductivity is as important as body size. And yet, to the statement that indigenous animals were the most reproductive breed despite their small body size, the same 85% disagreed. Although they mainly keep the indigenous type cattle because they are hardy and readily available, given a chance they would switch to a modern breed, because quality (in terms of body size) is more important than quantity (in terms of livestock numbers). Then again, an indigenous animal of the same bodyweight as an exotic animal fetches a better price in the stock sale, they said.

The Xhosa word for 'indigenous animal' which is 'umgqutsuba' has a meaning which is associated with backwardness and illiteracy. The word thus has an image problem, the image appearing to be more powerful than the facts. Perhaps in future as part of capacity building, this community needs to be encouraged to accept their real climatic conditions, but most of all, to accept the kind of animals that can best thrive under these climatic conditions. Ironically in the case of

goats, preference is given to the indigenous type over both Angoras and Boer goats.

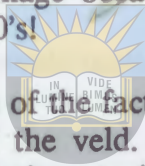
### 7.3 THE LACK OF EQUITY OF THE COMMUNAL LIVESTOCK SYSTEM

The lack of equity in access to agricultural resources exists at two levels: the obvious disparity between black and white, and the less obvious disparity between households sharing the same communal resources. Amongst communal livestock owners the disparity is large. Herd sizes vary from a single animal to more than a hundred. In Sheshegu (Williams 1987) 28% of households had no agricultural resources, 29% had 20 or more small stock units, whilst 43% had between 1 and 19 small stock. The unequal distribution of herd size in Ndwayana is illustrated in figures 5 and 6.

#### Tyefu

All the villages in Tyefu area share the same grazing. There are no fences to either subdivide veld types, or demarcate boundaries for the various communities. There is no control over animal numbers. Basically everybody has the right to use the veld, including close or distant relatives, who no longer stay in the village. One of the ARDRI researchers on this project was told that he had the right to keep livestock on the commonage because his mother was born there, even though she had left in the 1950's!

The community appears aware of the fact that livestock numbers should equate to the area and condition of the veld. However, they still give priority to accommodating livestock of relatives staying outside the village over the capacity of the grazing land itself.



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#### Sheshegu

Not every member of the Sheshegu community has the right to use the veld. As a rule residents of Sheshegu who are regarded as "squatters" are not allowed to keep livestock. Squatters are those who are not first born males in their families and therefore did not inherit their fathers wealth. The title holders have arable land and are also permitted to keep livestock, while the squatters do not have fields and are not supposed to keep livestock. The squatters who do keep livestock have to register it under a title holder's name. This rule was passed by the ex-Ciskei government. Most of the squatters were born in Sheshegu but did not inherit land rights from their fathers. Widows are also refused the right to arable land and the right to own livestock.

The squatters said that they did not feel comfortable with registering their livestock under another person's name, because in the long run that person might claim the livestock as his. They believe that a solution could be found if the whole village would protest against this rule. Before the researchers left the village they facilitated an initiative towards solving the problem of the landless. A committee comprising of both squatters and title holders was to be formed to look into this problem. Both groups appeared very keen to get the problem of landlessness solved.

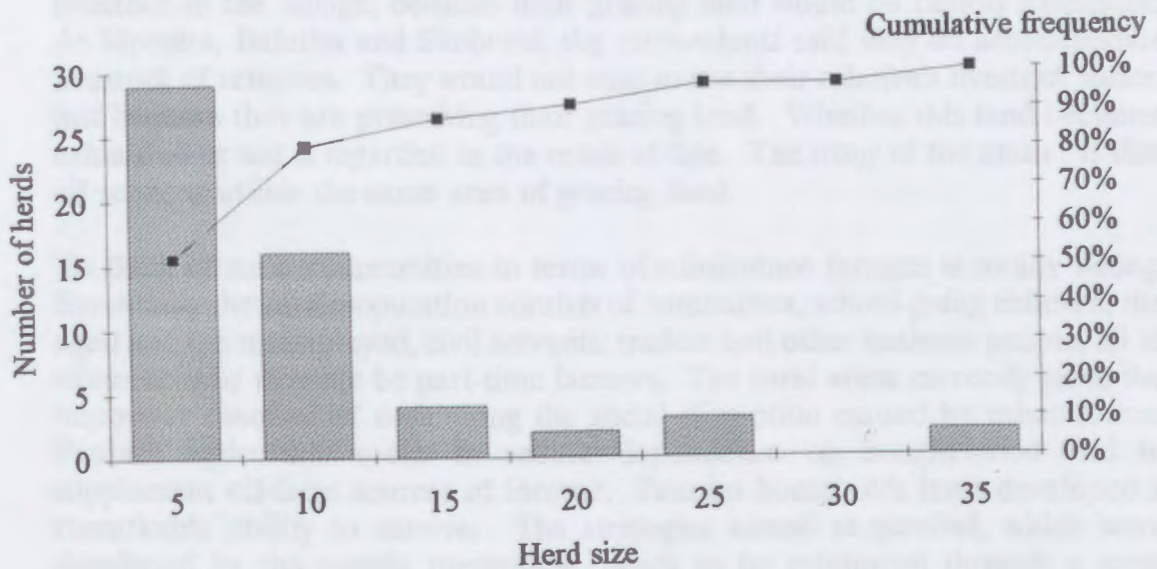


Figure 5. Herd size: upper intervals (cattle).



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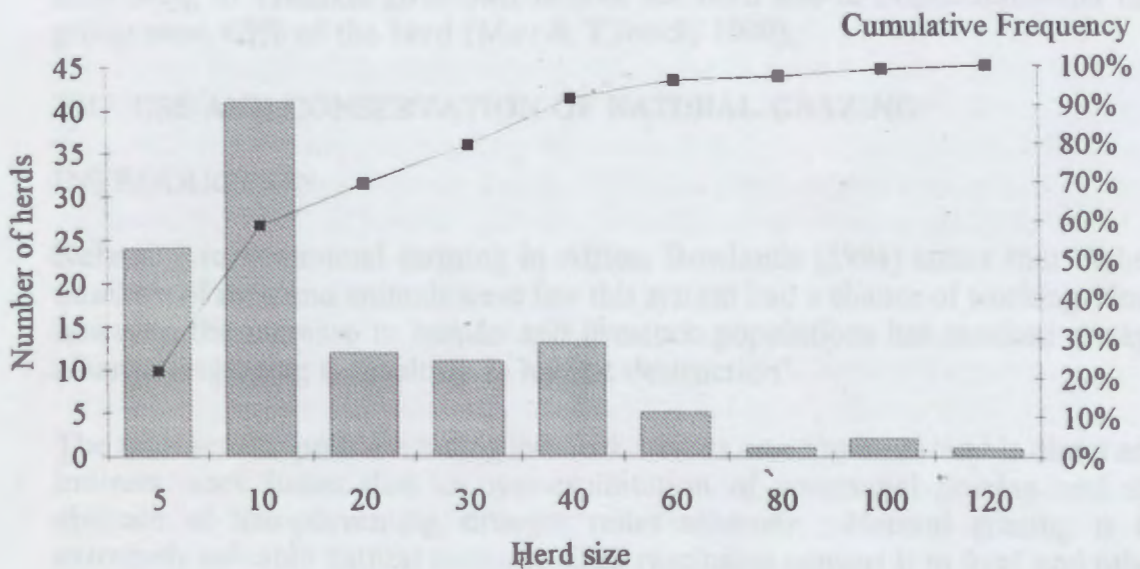


Figure 6. Herd size: upper intervals (goats).

In Sheshegu the rules governing access to grazing differed amongst the different sections of the settlement. Sheshegu is divided into 5 sections, namely Lower Sheshegu, Mpozisa, Skolweni, Lalini and Balurha. The respondents in Lower Sheshegu and Lalini said they do not allow a relative from another area to keep livestock in the village, because their grazing land would be rapidly exhausted. At Mpozisa, Balurha and Skolweni, the respondents said they do accommodate livestock of relatives. They would not wish to see their relative's livestock suffer, just because they are preserving their grazing land. Whether this land becomes exhausted or not is regarded as the result of fate. The irony of the matter is that all sections utilise the same area of grazing land.

To think of rural communities in terms of subsistence farmers is totally wrong. Essentially the rural population consists of commuters, school-going children, the aged and the unemployed, civil servants, traders and other business people, all of whom may or may not be part-time farmers. The rural areas currently serve the important function of cushioning the social disruption caused by urbanisation. Peasant agriculture seeks to reduce dependence on bought food and to supplement off-farm sources of income. Peasant households have developed a remarkable ability to survive. The strategies aimed at survival, which were developed by the people themselves, need to be reinforced through a rural support programme. For support programmes to be effective, these strategies need to be understood more intimately, both in a qualitative and quantitative way.

ARDRI data on four tribal authority areas in the former Ciskei showed that a "true" farmer class existed. This class raised nearly all the cattle, 50% of the sheep and produced one-third of the summer crops. They comprised 22% of households. Surprisingly, it was found that the number of species owned (not number of animals) was a good indicator of who the members of this group were (Williams et al., 1989). In KwaZulu 20% of the livestock owners own 70% of the total herd; in Transkei 20% own 78% of the herd and in Bophuthatswana this group owns 68% of the herd (May & T'Jonck, 1990).

## 8. THE USE AND CONSERVATION OF NATURAL GRAZING

### 8.1 INTRODUCTION

Referring to communal farming in Africa, Rowlands (1994) states that "When numbers of men and animals were few this system had a chance of working. Now, however, the increase in human and livestock populations has reached a stage where overgrazing is resulting in habitat destruction".

The most serious problem facing livestock owners on communal land is direct and indirect stock losses due to over-exploitation of communal grazing and the absence of loss-preventing drought relief schemes. Natural grazing is an extremely valuable natural resource since ruminants convert it to food and other products for human consumption. Sustainable use of this valuable resource is absolutely essential for the wellbeing of the rural population. The major cause of livestock losses on communal grazing is the lack of clearly defined rights and obligations for users. This leads to over-exploitation of the resource base (often by non-residents living in urban centres) and inadequate maintenance of the

infrastructure (such as windmills and fences). As a result, low reproduction rates and high mortality rates have become characteristic of communal livestock systems.

Overstocking leads to poor animal condition at critical times in the reproduction cycle. Poor condition at mating time results in very low conception rates. Poor condition during lactation or at weaning results in high mortality rates amongst the offspring. The end result is that fewer animals are born and more die than would normally be the case on a commercial farm. The owner cannot benefit from an animal that was not born or did not survive. According to the workshop participants in Ndwayana out of every four cattle, three are expected to die of hunger related diseases, while one will survive for long enough for it to reach the market. In reality, according to Brown et al (In: Laker 1975), the average off-take (turn-over rate) in the Peddie district was only 4,1% compared to about 20% in commercial farming.

Past efforts to promote sustainable use by emphasizing soil conservation and overstocking have had very little appeal in the communal areas. The needs of livestock to be able to conceive, lactate and survive and the benefits to the total community, both livestock owners and non-owners, should be the overriding consideration when the use of communal grazing is planned. The use of terminology like "stock reduction" and "user charges" will not motivate conservation management. Prinsloo (DBSA, personal communication) has suggested that these terms undermine the notion of "ownership" of the resource; and that the concept of "ownership" (not to be confused with freehold title) should be the directing force behind any intervention. Linked to this concept is the recognition that access control is far more important than rotational grazing. But access control can only function if the individuals sharing common ownership are identified, the rights of these individuals are clearly defined and a legal framework and institutional structures are in place to enforce the rules.

It is often thought that overstocking can be addressed by marketing "surplus" animals. It may be true that the total herd on the commonage is too large, but, in reality, by far the majority of individual owners have no surplus to sell. When surplus animals are available for marketing, access to markets is a very real problem for the small farmer. Also, most sales are to meet specific cash needs and sellers are therefore "price takers" (Tapson & Rose, 1984).

In an effort to improve the sustainable use of veld in Ciskei, veld management schemes were initiated in 1959. Grazing areas were subdivided into camps and animal numbers reduced by means of culling schemes. These culling schemes were introduced in terms of the Ciskeian Agricultural Development act of 1973. According to Trollope and Coetzee (In: Laker 1975) implementation of grazing systems "has caused a significant improvement in the condition of the veld in Ciskei, particularly in the mixed and sourveld regions. Unfortunately, the sweetveld areas have not shown the same response. This is not unexpected considering the severe erosion, low and erratic rainfall, and poor quality soils of these areas. Severe overstocking, however, is the basic stumbling block with regard to veld rehabilitation in the sweetveld areas."

The same authors state that by 1974 altogether 78,7% of Ciskei had been demarcated into residential, cultivated, and grazing areas, and that 86,5 % of the planned area was under some system of veld management. Tyefu location was proclaimed a betterment area in 1963, but fences were never erected. Without any camps, continuous grazing is the only option at Tyefu.

## 8.2 VELD MANAGEMENT BY WHITE COMMERCIAL FARMERS

The recommended carrying capacity of the commercial farms in the Albany district is 5 to 10ha/LSU. The average current stocking rate on a sample of twelve commercial farms in the area was approximately 11ha/LSU.

The commercial farmers all practice some form of rotational grazing, although no rigid system is adhered to. Camp rotation is based on observation and experience. The following variations were mentioned:

- Each camp receives a rest period of about 7 months.
- Acock's six camp system did not work and was replaced by a wagonwheel system.
- Heavy grazing for a short period followed by a long resting period. The farm is divided into 40ha camps and the veld has improved enormously according to the farmer.

The condition of the veld is described by Palmer (1994) as generally satisfactory, with the exception of a few localised spots.



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## 8.3 VELD MANAGEMENT ON THE COMMONAGES

### Sheshegu

In Sheshegu, the grazing area stretches from the residential area through the ploughing fields and to the communal veld. There is a fence that surrounds the whole veld but it does not divide the veld into camps. Sheshegu community was given 4 camps previously belonging to white farmers. However, Tyali community also uses those camps and claim the land as being theirs. Continuous grazing is practised throughout the year, and there is no ranger looking after the management of the veld.

### Tyefu

There are no fences that delineate separate grazing land for Qamnyana or Ndwayana. The veld is shared by all the villages in the Tyefu and Mahla Tribal Authority areas. The veld is not divided into grazing camps. Respondents reported that it is impossible to divide the veld into grazing camps, because most of the land is full of shrubs and very mountainous, hence only a few portions of the land are covered with grass.

The eroded condition of the Tyefu commonage is a recurrent theme of all reports on the area. Brown (1969) states that "Tyefu Location..... is eroded quite badly over 40 to 50 percent of its surface area." Loxton et al.(1977) uses phrases such as "catastrophic erosion" and "widespread and severe veld degradation".

The carrying capacity of the commonage of Tyefu was 10 hectare per livestock unit (LSU) according to de Beer (1986) and 20 to 35ha/LSU according to Palmer (1994). The 1984 census for the Tyefu Location as a whole lists 4836 LSU at a stocking rate of 5,0ha/LSU. Livestock numbers change dramatically over short periods of time. According to a 1988 survey there were 948 LSU's in Ndlambe and Ndwayana. Currently there are 1573 LSU's. These figures clearly illustrate the urgent need for a legal framework with clear rules defining access to and use of common resources.

Qamnyana farmers measure carrying capacity visually on the basis of height of grass and density of bushes. Against these criteria, they suggest that their grazing land is not as fertile as that owned by white farmers and that of the Double Drift Game Reserve. Furthermore, bare patches of land and large quantities of bushes undesirable to livestock are indicative of the poor condition of their veld. In Sheshegu poor soils are said to be the main cause of the poor carrying capacity.

Some ideas were put to Qamnyana farmers to ascertain their opinions on matters regarding access to and control of grazing. Some of the responses were:

- livestock have been stolen because of lack of boundaries. People want to have fences that would identify their velds, but would like to decide on that as Tyefu section. Their chief (Tyefu) would decide on that.
- we are not prepared to let only a few members of the community farm (like in white society), because each person has his own needs concerning livestock. It is felt that people cannot afford to be without livestock.
- people do not want to be limited in the number of livestock they keep, be it on the present commonage, or on new land allocated to them.
- on the establishment of a legal framework of ownership rights and obligations, they agree to the concept of ownership rights but not to associated obligations.

Amongst the Qamnyana residents there is a belief that a decade from now they will still be farming despite high stock mortality. It is for this future interest that stockowners would never rent out their commonage to anybody. In fact, they would rather see the grazing commonage become a residential area for their sons than to be somebody else's private farm. They still intend to keep cattle in future, despite the fact that they are more susceptible to drought than goats. Their traditional way of life dismisses the possibility of 'doing away with cattle'. Hopes are high that livestock and grazing land related problems will be solved by the new government. These hopes are increased by the presence of researchers in the village. Of the three villages researched, Qamnyana is by far the poorest. Some people, particularly elderly villagers, have given up hope. Generally, the

youth do not wish to stay in the village, even if the settlement can become more developed.

#### 8.4 THE NEED FOR DROUGHT MANAGEMENT

South Africa is a drought prone country. Drought relief programmes for the communal areas did not put much effort into saving livestock, whereas drought relief for the white farmer is primarily directed at reducing stock losses. Assistance to the commercial farmer include rebates on the transport of stock feeds, contributions to feed costs for the maintenance of nucleus herds, subsidies for finishing of stock in feedlots, and the provision of emergency stock water supplies. District drought committees under the chairmanship of the magistrate considers all applications for the proclamation or deproclamation of disaster drought areas according to specific guidelines. These guidelines are based on rainfall and temperature over a period not less than 22 months, veld condition, water availability, stock deaths and fodder requirements and availability. Since 1990 farmers have to register as conservation farmers and comply with prescribed stocking rates and stock reduction schemes to be eligible for drought assistance. There is an increasing realisation that drought is normal in South Africa and should be managed properly. The ANC policy document on agriculture contains a chapter on drought management and the Management Committee for Co-ordinated Drought Action, composed of heads of the relevant government departments, appointed a task team on 10 November 1992 to develop a national drought management strategy. This task team produced a comprehensive document, which will provide valuable information for future policy in this regard.

In the small farmer community, policy makers seem to have had the attitude in the past that drought is nature's way of dealing with the problem of overstocking on communal land. The immorality of such an approach to drought relief becomes more evident when the function of livestock as a "savings bank" is taken into consideration. When a household owning five head of cattle loses two animals because of drought, a very large part of the household assets are wiped out. It is estimated that during the 1992 drought more than 243 000 large stock units and 107 000 small stock units died in the communal sector (unpublished data, Department of Agriculture, RSA). It must be stressed that a major constraint to effective drought relief has been the cumbersome administrative networks that had to be penetrated to get relief to grassroots level, and the lack of appropriate community structures through which drought relief could be channeled.

The changes in livestock numbers in Sheshegu over the last few years, as shown in figure 7, illustrates the effect of drought on stock numbers. Note that stock losses were much higher in the case of cattle and sheep than in the case of goats.

Although it is difficult to determine the exact number of animals that have died during the 1990 - 1993 drought period, Ndwayana farmers estimate that in 1993 they have lost 60% of their cattle and 20% of their goats. Cattle in very poor condition would normally die after falling in dongas and small rivers around the village while searching for water and food. Lucerne sold at a subsidized rate of R7/bale was the only drought relief offered by the then Ciskei Department of

Agriculture. Nevertheless, only 1% of livestock owners could afford to hire taxis to buy lucerne in Peddie town, which is 32km from the village. Less than 1% of livestock owners buy lucerne from white owned farms.

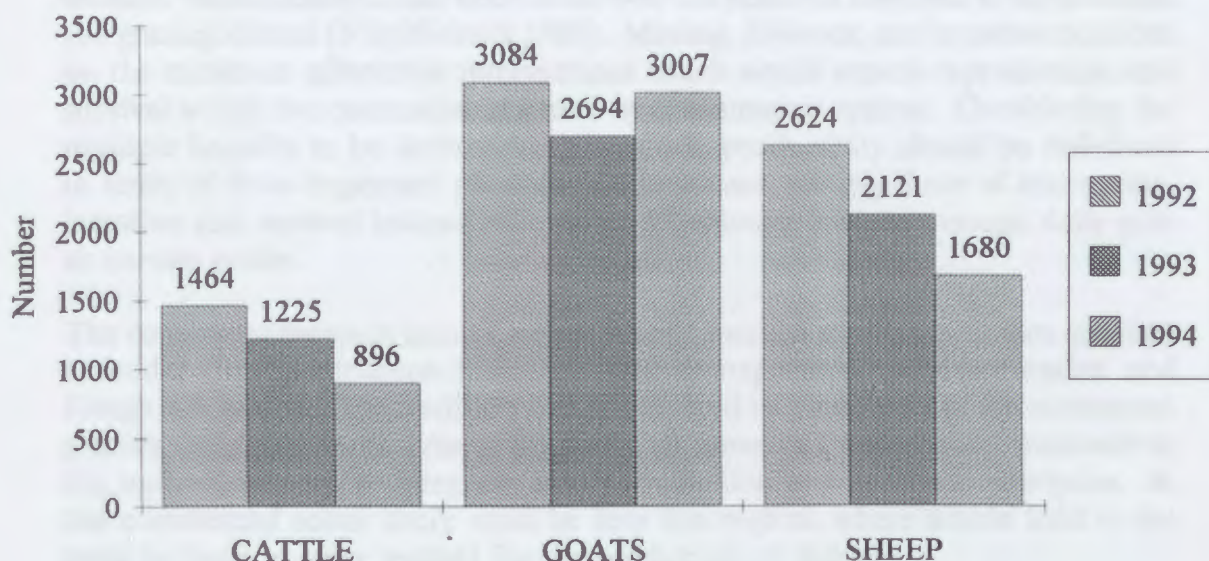


Figure 7. Changes in livestock numbers in Sheshegu location over the period 1992 - 1994

Qamnyana respondents claim that 80% of cattle and 40% of goats and sheep died during the recent drought. The mortality rate for sheep was also increased by sheep scab. When asked what precautions they would take to decrease mortality rates during future droughts, they said they want to keep livestock which is adapted to drought such as the indigenous breed. They also believe that if they can be given more land, the mortality rate would decrease.

According to Ndwayana farmers about 50% of the livestock mortalities are hunger-related, while 20% are caused by gallsickness. Redwater and Black Quarter each cause 10% of the deaths, while the remaining 10% are caused by paratyphoid and other diseases. Except for Black Quarter, all these diseases can be cured and/or prevented using medicinal plants. Only two people from the whole village vaccinate against Black Quarter. They buy the remedies from Grahamstown. The main reasons why many people do not use the commercial veterinary remedies are the high cost and limited availability (only available at places such as Grahamstown and King Williams' Town). They do not look at cost-effectiveness of remedies and they don't buy remedies collectively, in order to obtain discount.

It seems that stock mortality is accepted as normal. It is seen as natural, and there appears to be a feeling that nature should be allowed to take its course. According to the community, the high mortality can only be limited by expanding their grazing land into the Double Drift Game Reserve and white owned farms. This will allow them to rest some camps in case of drought, they said.

## 8.5 THE NEED FOR FODDER FLOW PLANNING

Supplementation of grazing animals is critical to successful livestock production under South African conditions. Cattle gain weight for 4 to 6 months of the summer and lose 20-30% of their maximum summer weight during the dry winter months. Much research has been done over the years on how best to supplement the grazing animal (Van Niekerk 1989). Missing, however, are recommendations on the minimum affordable interventions which would ensure reproduction and survival within the constraints imposed by a communal system. Considering the multiple benefits to be derived from livestock, productivity should be redefined in terms of three important physiological processes, namely those of conception, lactation and survival instead of in terms of concepts such as average daily gain or carcass grade.

The communal livestock farmer, unlike his commercial counterpart, does not plan a fodder flow programme based on veld management, supplementation and forage production. The tradition that arable land becomes part of the communal grazing during winter is a major problem. It presents a formidable constraint to the individual trying to integrate arable production and livestock enterprise. In the commercial sector there must be very few regions where arable land is not used (at least to some extent) for the production of fodder.

### TYEFU

#### Ndwanyana



At Ndwanyana maize residue from the irrigation schemes is used as supplementary feed, mainly for lactating and sick animals. However, only people who have donkeys can afford to fetch this supplementary feed from the irrigation scheme, while those who do not have this transport facility burn the maize remains. Concentrates, stover or mineral licks are not used. Eleven percent of livestock owners use salt in winter as a supplementary mineral.

#### Qamnyana

In Qamnyana all arable fields are now part of the grazing land, because there are no fences surrounding the fields. Drought makes the growing of crops such as maize a waste of time and money. Fields are heavily eroded, tractors are expensive to hire and there are few draught animals. Since the fields were used over a long period of time, soil fertility is now exhausted.

### SHESHEGU

In Sheshegu drought is seen as the main cause that led to the abandonment of dryland cropping. Although during the last ten years very little land has been cultivated, some individuals did try to grow some maize, but lack of fencing leaves the fields open to livestock. Animals are deliberately driven into the fields at night by people who are jealous of those who have planted their fields. All sections of Sheshegu mentioned this problem. They said that their crops are not only affected by drought but also by animals. The respondents admitted that

there used to be a fence around the arable lands but it was destroyed by the residents themselves. They said that when everybody had stopped planting, some people removed the fence and used it at their own homes.

Residents suggested some of the suggestions that individual fields should be fenced. Another suggestion was that all people who have fields should plough and plant at the same time, so that nobody would feel jealous of another person's field. A third suggestion was that squatters should also be given fields. This suggestion mainly came from those who are landless.

## 8.6 LAND HUNGER

The major constraint preventing overstocking lies in the perception amongst communal farmers that the only solution to the problem of scarce nutrition for their animals is more land.

### TYEFU

#### Ndwayana

In Ndwayana the basic need for more land is mainly for grazing. Additional land for extending the irrigation scheme was also mentioned. The respondents complained that their grazing land is mountainous and full of bushes and shrubs. They could not keep sheep in such an environment. The land is full of bare patches and is highly eroded. They are also sharing this land with Ndlambe, Glenmore and Qamnyana.

The respondents strongly demanded that they should be given the land occupied by the Doubledrift Game Reserve. They say that the Reserve has deprived them of their land. Another area claimed is the white owned farming land on the other side of the Fish river. The argument is that in the 1930s that land used to belong to their forefathers.

The people residing at Mzantsi Ndwayana section had started to move to other sections in order to vacate the land for an irrigation scheme. However, they still would like to get the white owned farms for more foodplots.

#### Qamnyana

The Qamnyana community mainly claims the Double Drift Game reserve. They claim not only a certain portion of the reserve, but believe that the whole reserve should be given back to them, and to Ndwayana, Glenmore and Ndlambe. They feel that they have more right over the land than these other villages, because their settlement is closest to the reserve. Qamnyana intends to use this land as an extension to their grazing land and also wishes to have an irrigation scheme on that land. The respondents believe that although drought killed most of their livestock, the mortality rate would have not been so high if they would have had sufficient grazing land.

Houses in Qamnyana are widely spaced, and installation of electricity or water taps would be quite costly. The respondents said that their houses are spaced widely in order to accommodate their livestock and to accommodate their sons who wish to build their houses in the same kraal. The researchers pointed out to the respondents that as the village is so widespread some of the land, which is now occupied by buildings, kraals and big yards, could be used for grazing. People were then asked if they would agree that their village be restructured, or consolidated requiring some people to move to another section of the village. The response was that this suggestion would place them under "trust" and they don't want to be under trust. They said that "trust" status would not take into consideration their need to keep livestock. However, the people did acknowledge the benefits of consolidating the settlement such as easy construction of roads and installation of water taps. They insisted that those who would lose their houses required compensation.

### SHESHEGU

The Sheshegu community wants more land for grazing. The respondents complained that their grazing land is too small. Drought has exhausted their grazing land. The respondents claim that after the white farmers vacated some farms on the other side of the road from Peddie to Alice, Sheshegu was rightfully given 4 farms. However, Tyali community also grazes their livestock there and claims these farms to be theirs.

The other land demanded by the Sheshegu residents are the farms on the other side of the main road which are now occupied by African farmers. They claim that the land used to be theirs until the white farmers moved in and now instead of it being given back to them, African farmers moved in. Doubledrift Game Reserve was the third area being claimed. They would like the Reserve to be vacated, because jackals are killing their livestock.

Although the community had stopped planting their arable lands, they identified some land which they would like to use as irrigated land. Residents feel that their present fields would not be suitable for an irrigation scheme, because their dam would quickly be exhausted. Hence, they claim the African-owned farms because there is enough water on those farms.

### WHITE COMMERCIAL FARMERS

The white commercial farmers are not opposed to land reform, provided it is market-driven and not destructive to the resource, such as has happened in Tyefu.

## 8.7 ATTITUDE TOWARDS CONSERVATION

### Tyefu

Respondents seem to realize that their management system has damaged veld and arable fields, they do not openly accept the blame. The few who do so are strongly criticized by other people.

In 1989 and 1993 attempts were made by the Ciskei Department of Agriculture to claim back the eroded fields at Tyefu location by employing villagers to build stone walls and plant American aloes in areas affected by gully erosion. People perceived these endeavours more as a means of getting extra income, than as a way of conserving the environment. Some of the stones that were collected were later used as building foundations.

According to them people said that the size of the grazing area also rules out rotational grazing, it would be senseless to rest some camps while animals are starving. In fact, before Ciskei became independent, agencies employed by government used to keep animals in one camp for too long a time before moving them to the next camp. The long stay in one camp would then destroy vegetation and cause a loss in animal condition. It is because of these experiences of the past that resting of camps and credibility of Agricultural Officers or agencies employed by government are being questioned by the people. Furthermore, people feel that the reason why white farmers rest some of their camps is because they have enough land to do so.

#### SHESHEGU

The people of Sheshegu were found prepared to practise rotational grazing, but only under the condition that more land is made available to them. Their animals are already starving on the present veld so they cannot rest any camps. They believe that rotational grazing can only be practised during rainy seasons, when the veld is full of grass. They would not like to have a ranger who manages the rotation of the camps, insisting that that decision would have to be made by them.

Nearly all respondents clearly stated that if more grazing land would be made available to them, they would increase their number of livestock. They do not want limitations to be put on the numbers of livestock. Lack of authority over grazing land is not viewed as a primary problem leading to overgrazing and excessive harvesting of firewood, which, in turn, lead to soil erosion, breaking and stealing of fences and high stock mortality.

Perceptions about the importance of their environment and about the impact of agricultural systems practised differ widely amongst individuals within the villages. Noticeably, this difference is related to the individual's background, present state and future interest. More than 65% of the Ndwayana residents who attended the PRA workshops, particularly men, associate the importance of preserving the natural environment with the control of livestock numbers. This perception emanates from the previous experiences:

- after 1918 they lost land to white farmers on the other side of the Fish River. In the late 1980's, they lost land to Double Drift Game Reserve. They believe that the two lands were repossessed because of their superior agricultural potential.
- in the 1960's, Agricultural Officers managed the control of livestock numbers by dosing and vaccinating animals at advanced stages of pregnancy thus causing abortion.

- under a system of rotational grazing, animals would be kept for too long a time in any given grazing camp, starving them until they lost condition.
- in the late 1970's bucks of the modern Boer goat breed were introduced in the village and this caused difficulties at birth.

Looking at the present state of the village, the high frequency of droughts and high livestock mortality have left many people feeling dejected. The entire village believes that there is nothing one can do to minimize livestock mortality, as rain is controlled by God. When talking about management of the natural environment, people tend to focus on the condition of livestock, largely ignoring that of the vegetation.

People at Qamnyana said they over-utilised the veld, because when white people were in control, the community was simply told what to do. Now that the people themselves are in control, they would not treat the Double Drift land in the same way if allowed to move there, because foreigners no longer impose laws on them.

## 9. A HERITAGE OF CONFLICT

For more than a century and a half the Great Fish River has been the boundary between "Settler Country" and "Xhosa Country". Sir Benjamin D'Urban and Sir Harry Smith instigated conflict between the Xhosa and the Mfengu, and settled the latter around Peddie and in the Alice region (including Sheshegu). As with many border areas, the study area has been characterised by friction between neighbouring communities and between communities and the authorities. Some of the indicators of this legacy are:

- Loxton et al.(1977) state: "In the 1950's there was much friction between the people of the region and the authorities, the community adopting an unco-operative and recalcitrant attitude. One result of this uncomfortable relationship was that the Tyefu area lagged behind other parts of Ciskei in rural planning and development. With the passage of time and as a consequence of constitutional development and the perseverance and patience on the part of officials and political leaders there has been a change in local attitudes and the people are now keen to see their area getting planned and developed."
- Qamnyana residents have strong feelings about the game reserves. They feel that wild animals in the Game Reserve are seen as more important than the people of the village. The perception is there because domestic livestock are confined to a small area of land of low potential, whilst ample grazing on good quality land is available to wild animals.
- The Qamnyana community mentioned that a social factor affecting possible development of the village was the political dispute that has divided the village into two groups. Under no circumstances do these two groups attend the same meetings. Each group runs its own affairs. The respondents suggested that before any development could take place, the community would have to be reunited. They requested external help to

end the conflict, because they themselves have failed to do so.

- More fodder would have been available at Tyefu were it not for the chemical eradication of prickly pear plants, which were sprayed by means of helicopters during the 1970's. The eradication of prickly pear came in the wake of livestock mortalities due to the consumption of spiny prickly pear. However, people believe that the incident was designed to starve the animals and humans who consumed prickly pears.
- Ndwayana villagers complain that impounding of stock has a negative effect on relationships between black and white farmers. They claim that their animals are attracted by the smell of lucerne on the other side of the river. This makes them go across and enter the lands of white farmers, which is not fenced off. Thereafter they get impounded. One man in the village claimed that the Tyefu fence was cut down by the residents of Ndwayana, but this claim was rebuked by 119 of the 120 workshop participants. Residents also claim that stock is impounded because white farmers get extra income from impounding. One particular white farmer was said to lure stock onto his land by leaving the gate, leading to his farm, open, thus letting stray animals in. One resident claimed that the impounded animal is then starved until it loses its condition and dies. Pupils attending the farm school are not asked to inform their parents of the presence of impounded stock on the farm.
- When animals belonging to white farmers cross the river, they are not impounded, but are chased back. White farmers feel that they have good relations with their black neighbours. It appears as if they do not realise the severity of the problem of impounding of stock.
- The two black commercial farmers in the Sheshegu area complained about the gathering of firewood by women from Sheshegu, and the occupation of their farms by former labourers of white farmers. The former labourers would resist eviction because they are aware that the farms are not rented by the owners (the commercial farmers do not pay rent). Some of the former labourers own more animals than the farm owners. For example, 67 of the 107 cattle living on the 850 ha farm belong to the former farm workers. Although rotational grazing is exercised, there is usually a dispute about which camp to graze and which to rest.
- Frequent changing of ownership of the farm Petriens poses a problem to the farm labourers' families. Between 1986 and 1994 the farm has had eight owners. The families would not like to be incorporated into Sheshegu or any other village, but would prefer to remain on the farm as that is where they were born. Eviction of the former farm labourers will damage their social and economic well-being, they said. In the past, families evicted from other farms resettled in a squatter village called Zizeni. This is the first village on the gravel road from Alice to Peddie. Those evicted people lost almost all their cattle mainly through theft and starvation. It is for this reason that the families at Petriens Farm resist the idea of eviction. The farm labourer's families have a keen knowledge of

the area. During the recent drought only four cattle were lost. This surprisingly low level of mortality was in part caused by unorthodox survival strategies such as illegally grazing livestock on other people's farm. This was done successfully because most of the farms in this area are managed on a part-time basis.

- According to the white farmers their relationship with black farmers across the river is generally good. Their farm labourers use the clinic facilities and senior schools on the Ciskei side whilst some children living on the Ciskei side attend the farm schools. There were exceptions. One farmer complained about invading livestock and the lack of a proper authority to resolve disputes. Another farmer mentioned theft as a problem. Generally, the removal of the border between Ciskei and South Africa is seen as positive development.

## 10. KEY ISSUES ARISING FROM THIS STUDY

### 10.1 CROP PRODUCTION

- Rainfed cropping is not feasible because of (i) the aridity of the local climate, (ii) the generally poor quality of the soils in most of the area and (iii) cropping systems which are poorly adapted to dry conditions.
- The concentration of more than 3000 ha of potentially irrigable land within the Fish and Ecca river valleys, the supply of Orange river water to Fish river irrigators and the presence of other modest sources of good quality irrigation water along the river valley (runoff dams at Tyefu) favour the development of irrigated farming in the valley on both sides of the river.
- The management system of the Tyefu Irrigation Scheme needs to be fundamentally re-organised. Mistrust, hostility towards the managing agent, unrealistic expectations are the fruit of (i) several changes in managing agent (ii) confounding with regard to the respective responsibilities of Ciskei Agricultural Corporation, the Department of Agriculture, and Ciskei Agricultural Bank (iii) paternalism on the part of management, and (iv) poor communication. A completely new management system needs to be developed. The farmers must play the decisive role in the restructuring process.
- Economic realities suggest that a change in emphasis from vegetables (Tyefu) and lucerne (white commercial farmers) to citrus may result in an increase in the income of both black and white farmers. Introducing citrus on both sides of the river may lead to unprecedented cooperation between the two farming communities, but such a venture would require an extensive effort on the part of farming systems research and extension.
- The all important natural resource, namely irrigable land, is being threatened by sodification and alkalinization. At present, the western side of the valley is more severely affected than the eastern side. The use of gypsum, organic matter and acidifying fertilizers could go a long way in

ameliorating these problems.

## 10.2 LIVESTOCK

- Devising a legal framework and a clear set of rules governing the use of common resources is a necessary precondition before any intervention, aimed at equitable, efficient and sustainable use of the commonage, can have a positive effect on the state of the natural resource.
- The benefits of matching stocking rates with carrying capacity, and using the appropriate species mix and breed types for a specific environment are poorly understood by local African communities. The supply of relevant and appropriate strategic information and a participatory approach to extending this information are necessary in order to improve the level of understanding amongst these communities.

## 10.3 EXTENSION

On the one hand extension is often seen as a critical success factor for agricultural development. On the other hand, just about all the studies and reports on the extension services in Africa indicate the following commonalities: low status among farmers, lack of understanding of their role by both farmers and themselves, poor subject knowledge, poor management by seniors, too wide a ratio between farmers and officers. The same statements are used in reports on Tyefu. Clearly the extension paradigm in the past has not satisfied basic human needs. Perhaps an "extension as facilitation" paradigm with its concomitant principles of participation and responsiveness, should replace the "extension as education" paradigm which sees extension as a conduit for the flow of information from research to farmer.

## 10.4 ACCESS TO INFORMATION

Commercial agriculture is served by a very extensive information network with many components, eg the agricultural press, radio, television, conferences, field days, agricultural development centres, cooperatives, commodity organisations, farmer organisations, local study groups, etc. This information network, which is taken for granted in the commercial sector, is a crucial element for successful decision making in farming and for successful lobbying of the authorities on issues concerning the welfare of the farming community. By comparison the small farmer is exposed to extremely rudimentary information services and networks only. In fact, many of the problems raised by the participants in the Tyefu Irrigation Scheme are a direct result of poor information flow. This is clearly evidenced by existing misconceptions regarding cause and effect of poor performance in the livestock sector, the supposed superiority of the natural resources in the game parks and white-owned farms and by the lack of knowledge of the drought relief scheme operating in the commercial sector.

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## REFERENCES

- ANTROBUS, G.G., FRASER, G.C.G., LEVIN, M., & LLOYD, H.R., 1993. The agricultural economy of Region D: Interim Report. Unit for statistical analysis, Report No 7.
- ANTROBUS, G.G., FRASER, G.C.G., LEVIN, M., & LLOYD, H.R., 1994. An overview of the agricultural economy of Region D: Final Report. Unit for statistical analysis, Report No 14.
- AUSTIN, M.N., 1989a. Using CIRADA: Ciskei rainfall database. ARDRI Bulletin 3/89. University of Fort Hare, Alice, South Africa.
- AUSTIN, M.N., 1989b. Monthly and annual rainfall probability analysis for Ciskei: II Maps. ARDRI Report 1/89. University of Fort Hare, Alice, South Africa.
- BRUTSCH, M.O., 1993. Climate and assessment of horticultural potential of East London and Scenery Park. In: The agricultural potential of Scenery Park, East London. 30-61. ARDRI, University of Fort Hare, Alice, South Africa.
- CISKEI WILDLIFE RESOURCES BOARD, 1989. Double Drift Game Reserve: Conservation Management Plan.
- DANIEL, J.B.McI., 1981. Agricultural development in the Ciskei: Review and assessment. S.Afr.Geogr.J.63,1 p3-23.
- DE LANGE, A.O., 1991. Peasant farming and the rural economy of the East Cape. *Agrekon* 30: 172.
- DENT, M.C., LYNCH, S.D. & SCHULTZE R.E., 1987. Mapping mean annual and other rainfall statistics over Southern Africa. WRC report 109/1/89, Dept. Agric. Engineering Science, University of Natal.
- DIRECTORATE AGRICULTURAL ECONOMICS, 1991. Combud enterprise budgets: Eastern Cape Region, July 1991. Department of Agricultural Development, Pretoria.
- DOHSE, T.E., 1980. Die evaluasie van grond vir besproeiings-doelendes. NIGB verslag Nr 1003/308/82, Pretoria.
- DOORENBOS, J., & PRUIT, W.O., 1977. Guidelines for predicting crop water requirements. FAO Irrigation and Drainage Paper 24, Rome.
- DREGNE, H.E. (ed.), 1976. Managing saline water for irrigation. Proceedings of the International Salinity Conference. Texas Tech. University, Lubbock, Texas, 16-20 August.
- ELS, W.C., 1970. The physical character of the Ciskei and some notes on its potential. In: The Ciskei - A Bantu Homeland: A general survey. p1-50, University of Fort Hare, Alice, South Africa.



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HARRY, R.B.A., 1988. Water quality and drainage. 40pp. Department of Agronomy, University of Fort Hare.

HILL, KAPLAN, SCOTT & PARTNERS, 1977. Keiskamma river basin: natural resources survey: Maps. Hill, Kaplan & Scott, South Africa.

LAKER, M.C., 1975. The agricultural potential of Ciskei. Preliminary report by the Faculty of Agriculture, Fort Hare University.

LOXTON, R.F., HUNTING & ASSOCIATES, 1977. Tyefu irrigation scheme pilot project. Report TS/124/76, Johannesburg.

LOXTON, R.F., HUNTING, & ASSOCIATES, 1979. Fish and Kat river basins study: Maps. Loxton, Hunting & Associates, South Africa.

LOXTON, R.F., VENN, & ASSOCIATES, 1987. Lower Fish river irrigation project, Ciskei development project: Resource base study and agricultural potential Vol 2, Loxton, Venn & Associates (Ciskei) (Pty) Ltd. Ciskei.

MAY, J. and T'JONCK, K., 1990. Livestock Ranching and the Restructuring of Agriculture in South Africa's 'Homelands'. *Proceedings of the Inter-conference Symposium of the International Association of Agricultural Economists*, Swakopmund, Namibia, 24-27 July 1990.

MODI, A.T., 1991. A study of the water holding capacity and other properties influencing irrigation management on three soils in the Tyefu irrigation scheme. Project Report, Dept of Agron., University of Fort Hare.



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MOYO, S., 1990. Evaluation of the productivity of indigenous cattle and some exotic beef breeds and their crosses in Zimbabwe. International Livestock Centre for Africa (ILCA) Research Fellowship Report, ILCA, Addis Ababa, Ethiopia.

NELL, J.P., 1987. Detail grondopname van die Eccarivier as deel van die laer Visrivier staatswaterskema (RSA oewer). NIGB verslagnommer GB/A/87/25, Pretoria.

NELL, J.P., 1989. Samevatting van verskillende grondonderzoeke in die laer Visrivier staatswaterskema. NIGB verslagnommer GB/B/89/11, Pretoria.

REGE, J.E.O., 1993. Indigenous livestock as the backbone of African animal agriculture: the importance of adaptive attributes and potential for their exploitation. *SASAP Developing Areas conference*, 11-14 October 1993, Overvaal Eiland, Northern Transvaal.

RICHARDS, L.A.(ed), 1954. The diagnosis and improvement of saline and alkaline soils, US Dept. Agric. Handb. no 60.

ROWLAND, J.W., 1994. The conservation ideal: The third decade. Southern African Regional Commission for the Conservation and Utilisation of the Soil.

SCHOLTZ, M.M., 1988. Selection possibilities of hardy beef breeds in Africa: the Nguni example. *Proceedings of the 3rd World Congress on sheep and beef cattle breeding*, Vol.2, Paris 1988.

SETPLAN, 1988. Lower Fish River Socio-economic Survey. Directorate of planning, Bisho, Ciskei.

SOIL CLASSIFICATION WORKING GROUP, 1991. Soil classification: A taxonomic system for South Africa. *Memoirs of the agricultural Natural Resources of South Africa No 15*, Soils and Irrigation Institute (now Institute for Soil, Climate and Water) Pretoria, South Africa.

TAPSON, D.R. & ROSE, C.J., 1984. An investigation into the KwaZulu cattle industry. ARDRI report 2/84, December 1984.

VAN AVERBEKE, W., 1991. The effect of planting density on the water use efficiency by maize. D Sc. Agric. dissertation, University of Fort Hare.

VAN NIEKERK, B.D.H., 1989. Modern Developments in the Feeding of Ruminants. *SASAP Developing Areas Branch Annual Symposium, Medunsa*, 18-20 October 1989.

WILLIAMS, W., ROSE, C.J., ECKERT, J.B. & TAPSON, D.R., 1989. Stratification of rural populations: human, economic and material characteristics as an aid in identifying recommendation domains. *In: Development: the human challenge*. Development Society of Southern Africa.

WILLIAMS, W. 1987. Voorlopige verslag oor sosio-ekonomiese en bewuste-behoeftes opnames in die Gaga, Sheshegu en Mgwalana stamgebiede. ARDRI verslag.

