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MINISTRY OF LANDS, RESETTLEMENT AND REHABILITATION

REPORT ON THE BROAD AGRICULTURAL POTENTIAL OF THE GOVERNMENT FARMS "SKOONHEID, ROSENHOF AND RUSPLAAS" OMAHEKE REGION

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SUMMARY

The objective of the survey was to make an inventory of the soils, vegetation, water resources and fencing conditions on the farms in order to assess the broad agricultural potential.

Geomorphologically the farms consist of gently sloping sand plains (major part, approximately 65% of the total area) with depressions and lower lying areas (approximately 35% of the total farm area), which are related to old drainage systems.

The sand plains consist of very deep, (dark) brown to yellowish red sandy soils and are characterized by a dominance of Terminalia sericea trees and shrubs associated with hard unpalatable grasses such as Eragrostis pallens and Aristida stipitata.

The soils in the depressions are moderately deep, greyish to brown sandy loams to (clay) loams underlain by calcrete at a depth within 150 cm. They are characterized by a dense bush savanna with Acacia mellifera as the dominant species associated with palatable grass species such as Eragrostis inundensis, Fingerhuthia africana, Antephora pubescens and others. These depressions offer the most valuable grazing areas and are also the areas where horticultural crop production may be tried (gardens). However the climate poses serious constraints on rainfed crop production (see chapter 1.4).

The soils in the lower lying areas (in between the sand plains and the depressions) are often calcareous, brown to reddish brown loamy sands to sandy loams. The lower lying areas are characterized by Acacia erioloba associated with Ziziphus mucronata, Grewia flava, Tarchonantus camphoratus and Terminalia sericea. The latter indicates sandier conditions in the lower lying area or a transition to the sand plains. Associated grasses are a mixture of hard, unpalatable species, intermediate and desirable species, the latter being the minority.

The major constraint for rainfed crop production is the amount and distribution of the rainfall, both are highly variable in space and time. Under the prevailing climatic conditions the loamy soils in and around the depressions and lower lying areas are at best marginally suitable for rainfed crop production due to the low and unreliable rainfall. In years of above median rainfall and at specific periods during the rainy season water logging can be a problem. Their suitability for irrigated crop production is considerably higher on the condition that irrigation is properly managed since these soils pose a salinization hazard (build up of salts in the root zone). The sandy soils offer no potential for rainfed crop production. Suitability for irrigated crop production is also marginal due to the low water holding capacity (low efficiency of irrigation), low natural fertility and low cation exchange capacity (low retention of fertilizers) of these sandy soils.

Since these soils are generally deeper than the soils in the depressions rainfed or preferably irrigated maize, sorghum and millet production should be implemented on these soils. The fact that the rooting depth is limited in the depressions due to the calcrete will reduce the yield considerably (by as much as 50%).

The general grazing condition of the three farms is still good. This can be attributed to the recent rains in the area (at the end of the rainy season the veld has its peak standing biomass).

The recommended stocking rate of the three farms is 1:15 (i.e. 1 livestock unit (lsu) per every 15 hectares). This stocking rate represents the ecological carrying capacity. Grazing conditions in the lower lying areas and depressions on the more loamy soils are better compared to grazing conditions on the sandy plains.

It is essential that sound grazing management is implemented at the farm. Only through proper and timely management, i.e. rotational grazing with an adequate rest period, depending on the size and composition of the herd as well as the species composition and ground cover of the vegetation, can the present condition of the veld can be maintained.

Due to the climatic limitations and lack of abundant water resources, crop production can not be the major land use for any resettlement programme. Resettlement on these farms will have to be based on extensive grazing with adequate, proper and timely management, with crop production as an additional land use practice on subsistence household level.

It was observed that grazing management was not implemented at the farms. The farm is greatly overstocked. Rotational grazing which is vital for the ecosystem of the farm, is not being practised and fences and water points, although still in a reasonable to good condition, are not being maintained. Lack of a clear policy, lack of specific skills of Government officials employed on the farms and lack of resources seem to be the major factors affecting efficient management.

1. INTRODUCTION

1.1 Background

A reconnaissance survey of the natural resources of the Government farms, Skoonheid, Rusplaas, and Rosenhof in the Gobabis District, Omaheke Region, was carried out from 18 to 21 April 1994. The three farms are located adjacent to each other and cover an area of 14824 hectares (7104, 3434 and 4286 resp.). From 10 to 14 August 1993 a survey of the Skoonheid farm had already been conducted. Unfortunately some essential data went missing after the survey. It was therefore decided to re-survey Skoonheid, combined with a survey of Rosenhof and Rusplaas.

The farms are presently administered by the Directorate of Resettlement within the Ministry of Lands, Resettlement and Rehabilitation.

This farm survey is part of an exercise in which all Government farms are being surveyed in order to make an inventory of the soils, vegetation and grazing conditions, water sources and condition of the fences in order to establish their broad agricultural potential which is essential for the resettlement process.

1.2 General Information

Figure 1 shows the location of Skoonheid, Rosenhof and Rusplaas farms. The farms are situated approximately 110 kilometres North of Gobabis. Gobabis is the main service centre. Small business centres are found in Plessisplaas, 15 kilometres from the farms and Epukiro, 40 kilometres from the farms.

The access roads to the farms are all weather gravel roads which are regularly maintained. The farms are connected to the telephone lines.

There are a roman catholic and a primary school in the vicinity of the farms. A number of primary and secondary schools are located along the main gravel road from Gobabis to Epukiro.

The inhabitants of the area in which the farms are located are Damaras, Hereros and San people. Most people are involved in subsistence farming. Most farmers keep livestock; cattle, goats, sheep, donkeys (used for ploughing) and horses. Surrounding the farm are commercial farmers who are primarily involved in livestock production (cattle, sheep and goats).

Table 1 provides the numbers of livestock on the three farms as well as the total numbers. The figures are based on a livestock count by officials of the Ministry of Lands in June 1993.

FIGURE 1

LOCATION OF "SKOONHEID - ROSENHOF - RUSPLAAS"

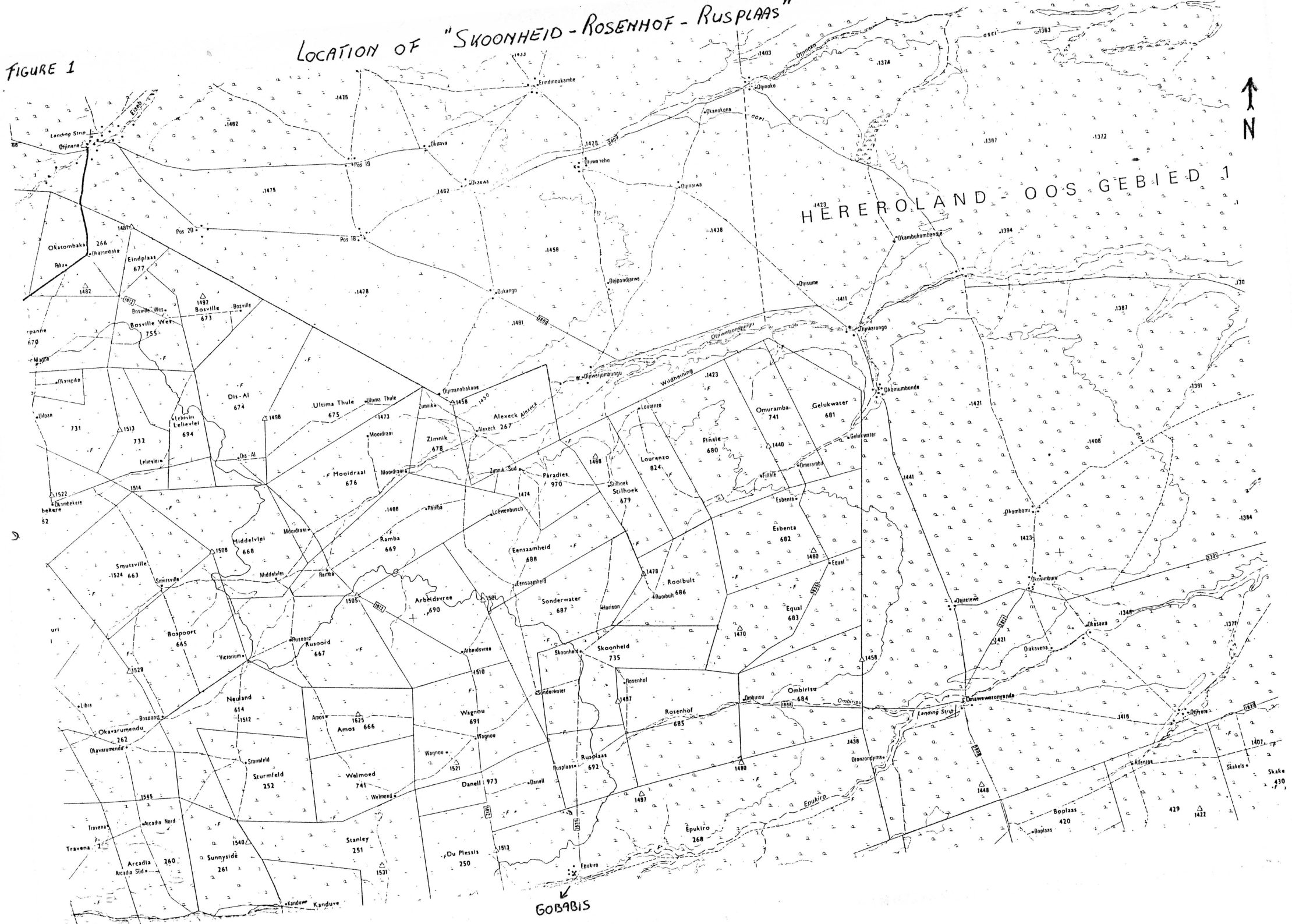


Table 1

Farm	Large stock	Small stock	Total Livestock
Skoonheid	944	586 (98)	1530 (1042)
Rusplaas	847	175 (29)	1022 (876)
Rosenhof	602	21 (4)	623 (606)
Total	2393	782 (130)	3175 (2523)

Source: Ministry of Lands, Resettlement and Rehabilitation, 1993.
Note: Numbers between brackets under "small stock" indicate the equivalent number of large stock units. Under "total livestock" numbers between brackets present the total number of lsu.
1 lsu = 6 ssu.

At the time of the survey a five hectare plot, north of the main house at Skoonheid, had been cleared for horticultural purposes. Approximately 1 hectare had been planted under maize. Under the guidance of the Directorate of Resettlement the people will try to produce vegetables, maize, water melon, pumpkin and tomatoes.

1.3 Geology and Geomorphology

The area is covered by the Kalahari system which consists of unconsolidated sands of aeolian origin, underlain by consolidated calcareous sand and gravel. The thickness of the sand cover varies from 0 to 50 metres.

The kalahari sands are underlain by undifferentiated layers of the Swakop Group (Damara Sequence). They consists of a sequence of Pleistocene and Pliocene sands and gravels. A main water bearing horizon, at a depth of 25 mtrs., consisting of quartz conglomerates, is embedded by sandstones, cemented by calcite and clay.

The three farms are located on the Kalahari Sand Plain, with a flat to almost flat (less than 2%) topography. The area is gently sloping down towards the East. The sand plain incorporates depressions, areas with shallow calcrete which is outcropping in places and lower lying areas, in between the depressions and the sand plain. On Rosenhof farm a drainage channel, the Ombrisu, is draining to the east into the Epukiro dry river valley.

1.4. Climate Information

The climate in the area can be classified as "sub-tropical savanna". The rainy season starts towards the end of October and continues until April. From May to late October or early November it is completely dry. Temperatures rise steadily from its minimum in June/July to its maximum in December/January.

Gobabis and Epukiro are climatic stations which are considered to be representative for the area. Gobabis has a synoptic weather station, number 0787/838, recording period 69 years, providing data on rainfall, temperature (min. and max.), relative humidity, sunshine hours and evaporation. A summary of the Gobabis climate data is provided in appendix 1. Epukiro station is located nearest to the farms but is only recording rainfall data. Table 1 provides the rainfall probabilities (25%, 50% and 75%) for Epukiro station. Other required data is taken from the Gobabis station. Unfortunately, synoptic data are meagre since especially in the communal areas there is need for much additional research and basic data collection.

Table 2.

Rainfall probabilities (25%, 50% and 75%) for Epukiro station.

	Jan	Feb	Mrc	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Season**
75% probability (3 years out of 4)	40	33	29	8	0	0	0	0	0	4	20	22	**318**
50% probability (2 years out of 4)	68	83	49	24	0	0	0	0	0	11	35	49	**380**
25% probability (1 year out of 4)	121	107	89	55	6	0	0	0	2	23	56	81	**462**

Table 2 indicates the rainfall which can be expected 3 years out of 4 (bad rainfall years), 2 years out of 4 (average rainfall years) and 1 year out of 4 (good rainfall years). The table does not indicate the variability of the rainfall within the season.

Rainfall and Evaporation

The amount and distribution of rainfall are undoubtedly the most important constraints for agricultural activities. Mean (average) and median (middle figure in a ranked column) annual rainfall figures only present a rough indication of climatic suitability for agricultural practices. However, the variability, both within and between seasons is of much greater importance for agricultural production. Also the intensity of the rainfall present problems for agriculture.

Table 2 indicates that the rain falls in the months October to April with the wettest months December through to March. The long term median (50% probability) rainfall for Epukiro which is the nearest rainfall station is 380 mm. per year, 3 years out of 4 (75% probability) 317 mm can be expected, while only 1 year out of 4 (25% probability) 462 mm can be expected. In other words every year there is only 25% chance that the rainfall amount will be as high as the minimum amount required for maize production (minimum requirement for maize is 400 mm per year). This does not indicate that the rainfall is poorly distributed. Most rain is received in a few intensive showers, alternated by long dry periods.

Evaporation is influenced by temperature, wind speed, humidity and solar radiation and these in turn can be influenced by the nature of the evaporative surface.

The mean yearly evaporation is high. It ranges from 137 mm in June to 312 mm in December. During the rainy season the evaporation is highest. The mean annual evaporation is 229 mm, see appendix 1 (climatological data from Gobabis). The total annual evaporation is 2,75 metres.

Figure 2 indicates the isohyets over the three farms. The rainfall decreases from the North-West (Skoonheid) to the South East (Rosenhof). The isohyets are based on average climate data from various stations in the area. The isohyets correspond with the 25% rainfall probability figures of Epukiro stations, indicating that Epukiro is "dryer" than can be expected.

Growing period

The growing period is defined as the period during which the precipitation (rainfall = P) exceeds half of the potential evapotranspiration (PET). If the PET and P figures from Gobabis and Epukiro are compared in that way, it appears that even in the "good" rainfall years (25% probability figures) the area does not have a growing period. This means that the rainfall never exceeds half of the evapotranspiration. This indicates that crops will be under severe moisture stress at all times. Therefore climate is the main constraint to any rainfed crop production in the area.

Air Temperature

The mean minimum temperatures vary from 2.5 degrees Celsius in July to 17 degrees Celsius in summer. In the winter period, from April to September, frost can occur incidentally. Generally the risk for growing frost sensitive crops is low. This applies only to crops under irrigation, which can be grown in the dry, winter season. In summer there is no risk for growing frost sensitive crops. The mean maximum temperatures vary from 32 degrees Celsius in December and January to 22 in June/July (see appendix 1).

Relative Humidity and Sunshine hours

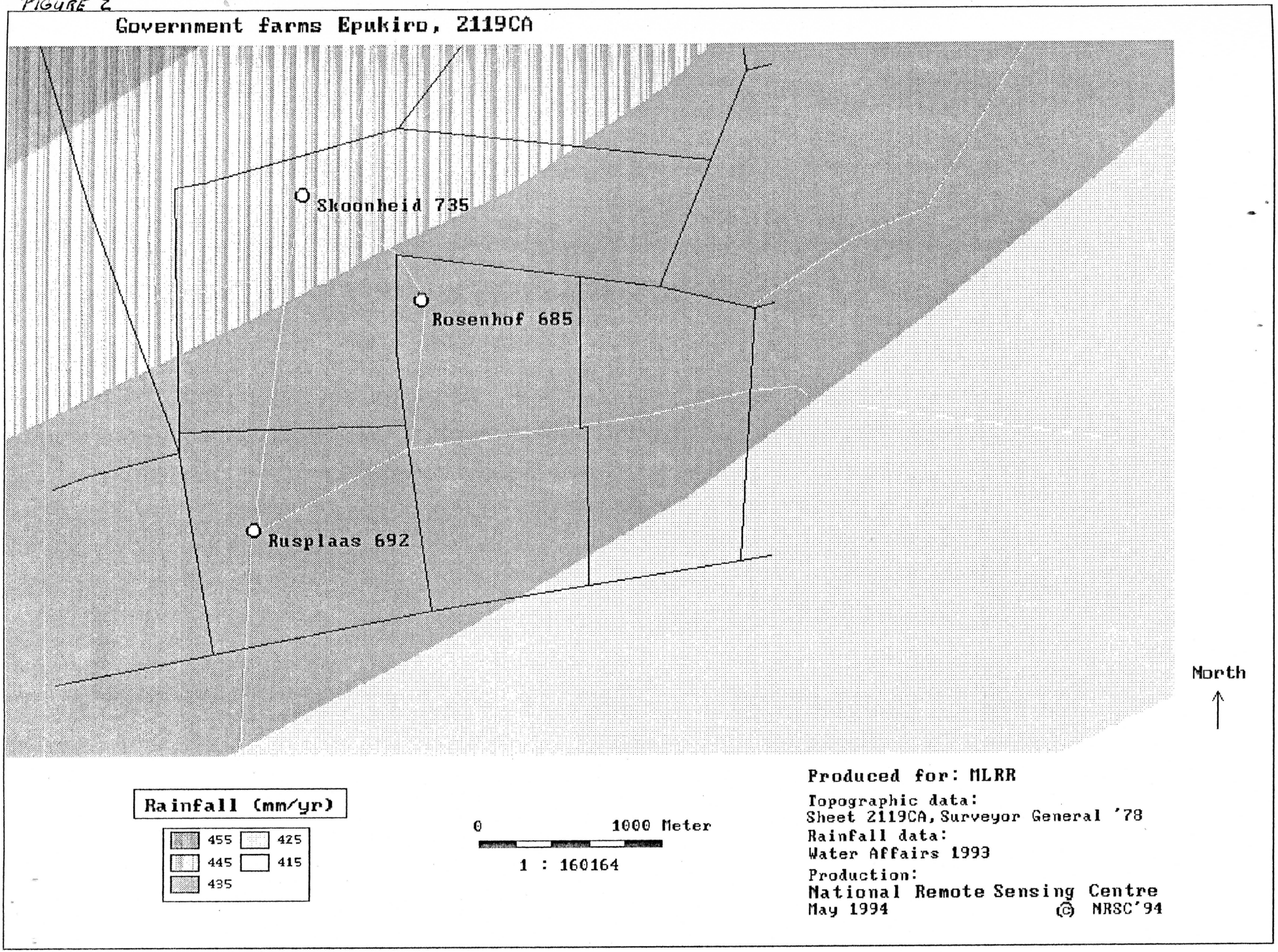
The relative humidity is always low and only exceeds 50% in the months February to April, where it is highest in the year. The humidity reaches its lowest point in September. The overall low values of humidity contribute to the high evaporation figures.

The mean monthly sunshine hours vary from 221 in February to 314 hours in August. The monthly average is 276.5 hours. The high figures of sunshine hours per month and consequently high radiation figures also contribute to the high evaporative demand.

1.5 Water Sources

Apart from the rainfall, the main sources of water are underground wells and boreholes. In total the three farms have 16 boreholes, of which 8 are around the farm houses and 8 in

FIGURE 2


Government farms Epukiro, 2119CA
Skoonheid 735
Rosenhof 685
Rusplaas 692
North
Rainfall (mm/yr)
455
425
445
415
435
0
1000 Meter
1 : 160164
Produced for: MLRR
Topographic data:
Sheet 2119CA, Surveyor General '78
Rainfall data:
Water Affairs 1993
Production:
National Remote Sensing Centre
May 1994
© NRSC'94

Government farms Epukiro 2119CA

Name$	Area& (m2)	Area ha	Peri&
Rosenhof, 685	42778520	4,278	27627.36
Rusplaas, 692	34360940	3,436	23462.62
Skoonheid, 735	70812090	7,081	43050.35
Total	1.5E+08	14,795	290431.4

various camps supplying reservoirs, either directly or through pipelines. The borehole at post A3 on Rusplaas, at the boundary fence with Skoonheid is supplying 5 camps of Skoonheid with water. In total there are 10 windmills, 26 reservoirs, 5 water tanks and 11.2 kilometre pipeline on the farms.

The yield of most of the boreholes on the farms was measured. The lowest yield measured was 1.2 m^3/hr, the highest measured was 1.5 m^3/hr. Some of the boreholes are equipped with diesel pumps, others have windmills. The flow of the pumps driven by windmills is erratic since it depends on the force of the wind. The outflow of windmill driven pumps was measured at times when a strong wind was blowing.

Figure 3 indicates the camps and the boreholes with the measured yield during the field period and the indicated yield when the borehole was installed. Some boreholes could not be measured as they could not be operated, due to lack of an operational pump or reservoir. The original yields given in figure 3 indicate the original potential outflow of the boreholes. The measured outflows are a result of the pump capacity and diameter of the pipe (when operated by a diesel pump).

At the beginning of 1994 Interconsult conducted a pumping test for three boreholes around the Skoonheid farm house. In the vicinity of the house are 6 boreholes of which 2 are currently operational. 1 is supplying Rusplaas and 1 is supplying the main Skoonheid farm house. The other 4 are not in operation. Of these 4 boreholes 1 could not be tested due to insufficient depth of water for pumping. This borehole will have to be deepened if additional water is required. Consequently 3 non-operational boreholes were tested.

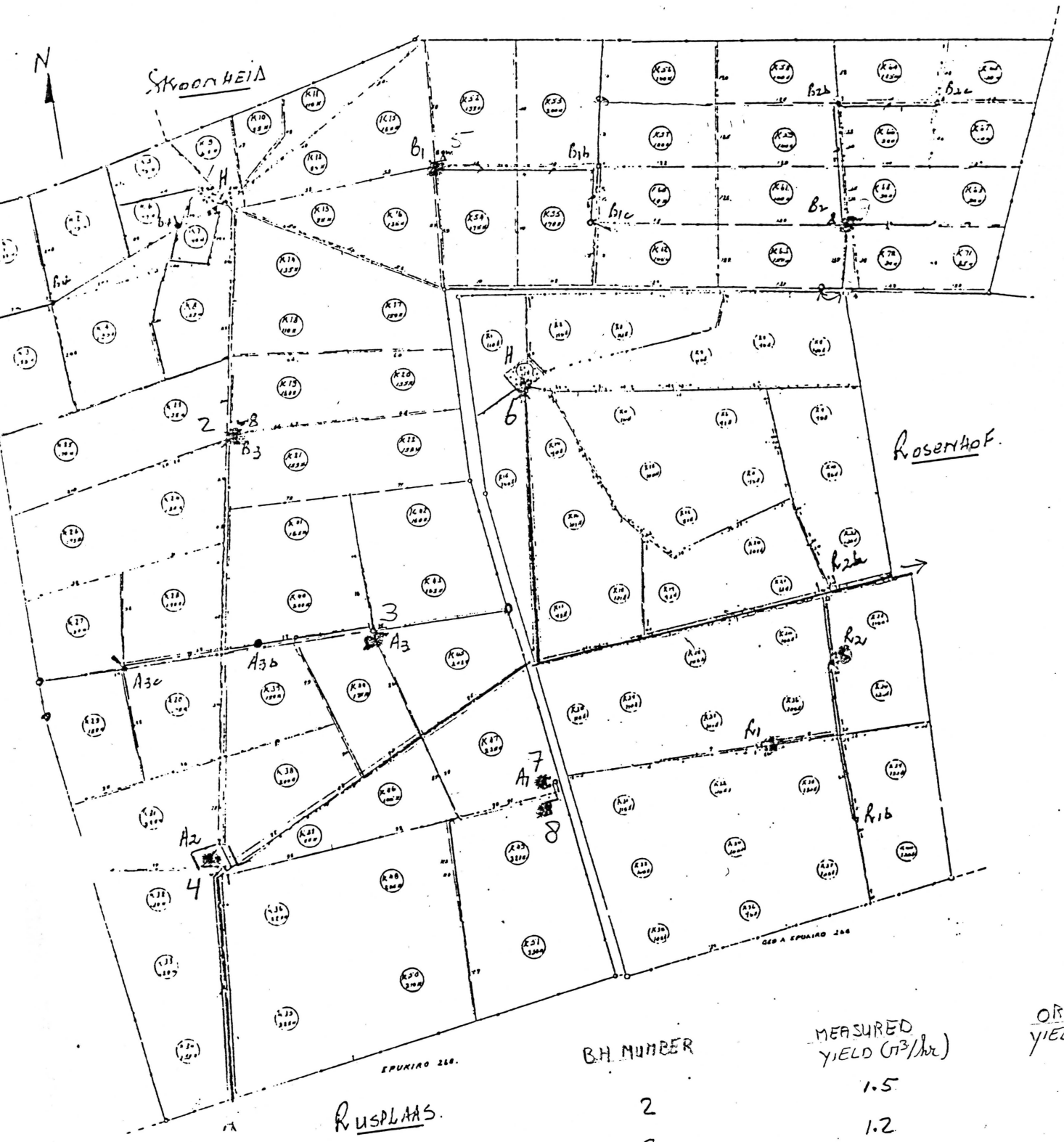
Borehole 1 (see figure 4) was drilled most recently but the rising mains and the electrical submersible pump are removed. During the survey the water table in the borehole was measured as 46 mtrs. deep. Borehole 2 is in a concrete hut, here the diesel engine has been removed. The other two boreholes (nr. 3 and 4) are both driven by a windmill and are not in a working order. Furthermore it was discovered during the test pumping that the discharge pipe in borehole nr. 4 has a rusted hole at 30 mtrs. depth, this results in water loss and rusty water during initial pumping.

The conclusion of the survey was that the 3 boreholes, if taken into operation, should be pumped for maximum 12 hrs per day with recommended pumping rates of resp. 0.8, 1.2 and 1.4 m^3/hr. With the recommended pumping rate and pumping for a 12 hr. period per day the three boreholes are able to additionally deliver around 40m^3 water/day. If pumped at a higher discharge rate the pumping efficiency will decrease dramatically due to an increase in the laminar flow (seepage), resulting in a considerable loss of water (Interconsult, 1994).

Generally the water at the three farm houses is of good quality.

RE 3

LOCATION OF BOREHOLES AND THEIR MEASURED AND ORIGINAL YIELDS



B.H NUMBER	MEASURED YIELD (m^3/hr)	ORIGINAL YIELD (m^3/hr)
2	1.5	2.3
3	1.2	6.8
4	1.2	1.4
5	N.O	–
6	1.1	7.6
7&8 (together)	1.2	3.2

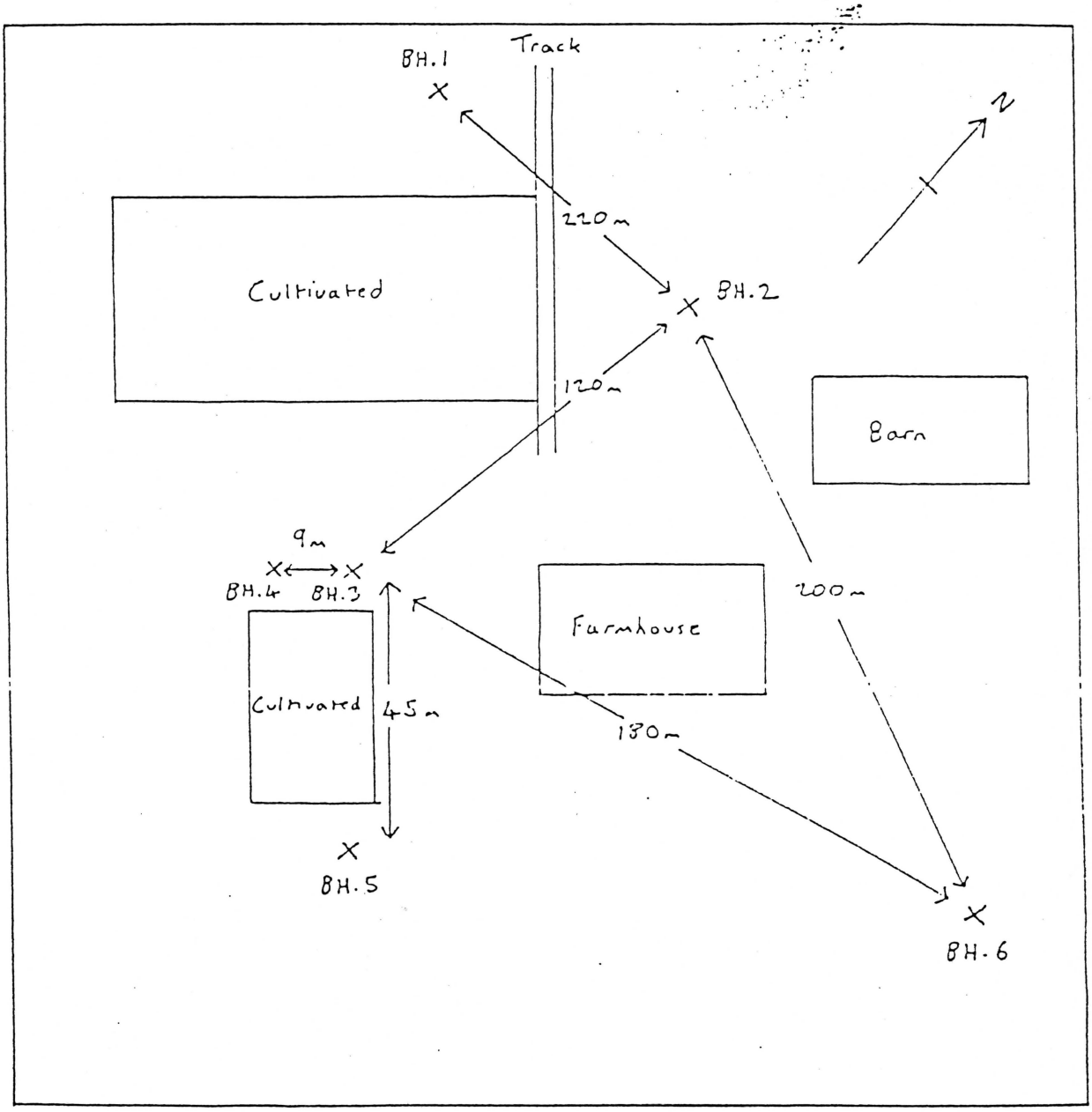


Fig. 4 Sketch of Skoonheid Farm showing location of boreholes (not to scale)

There is one seasonal stream ("Ombrisu") on Rosenhof farm, draining in easterly direction, towards Botswana, into the main Epukiro river, which is also a seasonal river. During the rainy season or shortly after, surface water may be found in these streams and depressions. Livestock on the farm also depends on this source of water during or shortly after the rainy season.

2. SOILS AND VEGETATION

2.1 Survey Methodology

Office Preparations

Information from the Surveyor General's Office (aerial photographs, topographic maps) and the Geological Survey Department (geological maps) in Windhoek, as well as other existing information on the farm was collected and studied prior to the field work. A topographic map, scale 1:50.000, Epukiro 2119 CA, was used as a base map for the farm survey.

The aerial photographs used were panchromatic black and white, dated 1974, scale 1:50.000. The farms are covered by two flight lines (photo numbers 417-421 and 310-313). The central points of the aerial photographs are indicated on the topographic map.

A preliminary photo interpretation of the farms was carried out. Preliminary land units (uniform parcels of land) were identified on the basis of vegetation, drainage pattern. Slope and relief did not play an important role due to the relatively flat nature of the farm. The sampling points were identified on the aerial photographs and a field programme was prepared.

Field Survey

The purpose of the field survey was to check the boundaries of the preliminary land units, as identified in the office and to describe the soil, vegetation and surface characteristics in each unit. This was done by soil augerings and/or digging of soil pits at the pre-determined observation sites. In total six soil pits were dug, described and sampled. The profiles were described according to the FAO Guidelines for Soil Profile Description.

The soil samples were taken to Windhoek for analysis in the soils laboratory of the Ministry of Agriculture, Water and Rural Development. The soil samples were tested for:

- Exchangeable cations (Ca, Mg, Na, K)
- Phosphorus
- pH KCL
- Texture (%sand, %clay, %silt)
- Electrical conductivity.

The soil data as captured in the field is stored in the FAO Soil Data Base (see appendix 2).

A general idea of the vegetation structure, species composition and grazing capacity of the different vegetation types on the farms was obtained by driving extensively around. The agricultural extension officer of Gobabis, Mr. Versveld, visited the farm and provided valuable data on the different vegetation types, their potential for grazing and management aspects for grazing. Detailed vegetation observations, including the structural (physiognomic) vegetation type, the dominant tree, shrub and grass species, as well as the cover of the grass layer were recorded at the sites of the soil profiles.

2.2 Results

2.2.1 Soils

The survey revealed that the main unit on the farms is the sandy plain, covering approximately 65%. The remaining part consists of depressions and lower lying areas (5% and 30%) respectively.

At the time of preparing this report, the chemical analysis results had not been received from the soil laboratory in the Ministry of Agriculture. When data is available it will be added as a supplement. The soil classifications given in appendix 2 are therefore tentative.

Sand Plain
This unit occurs on the almost flat, higher lying areas on the farm. The soils are sandy to loamy sandy and vary in colour from dull brown in the top to orange in the bottom. The structure is weak sub-angular blocky to massive structureless. The soils are very deep and are well drained. The infiltration rate in this unit is very high, water logging, even after heavy showers, will therefore seldom occur. When tested in the field pH values of 5.0-6.0 were measured. The soils in this unit have a low natural fertility and a low available water holding capacity, approximately 60mm/m. The dominant soil type in this unit can provisionally be classified as ferralic Arenosol (FAO, '88) or ustic Quartzipsamment (Soil Taxonomy). Profile SH0006 in appendix 2 is representative for this unit.

This unit is unsuitable for crop production and offers marginal to reasonable grazing. The parent material of the sand plains is the fine grained Kalahari windblown sands. Therefore, this unit is prone to wind and sheet erosion whenever the vegetation cover is thinned or removed (a result of overgrazing). The veld condition and accompanying stocking rates should be closely monitored.

Depressions
The depressions occupy the lowest position in the landscape. The soils in the depressions are moderately deep, (slightly) calcareous, brownish grey to greyish yellow brown sandy loams to sandy clay loams. These soils are underlain by calcrete. The structure is better developed than in the soils on the sand plains and varies from a strong sub-angular blocky structure in

the top to a moderate sub-angular and angular structure in the bottom of the profile. Often calcium carbonates nodules are present on the soil surface and in the profile. Due to the presence of calcium carbonates these soils are alkaline (pH water > 7), occasionally strongly alkaline (pH water > 8.5) In such cases supplying of sulphate fertilizers is recommended to lower the pH.

These soils are moderately well drained and have a tendency of sealing and crusting. Due to the slow infiltration rate of the topsoil, the depressions can be prone to waterlogging after periods of heavy rainfall. The water holding capacity of approximately 200mm/m, is considerably higher than on the sandy soils. The dominant soil type in the depressions can provisionally be classified as: luvic Calcisol (FAO, '88) or petrocalcic Paleustalf (Soil Taxonomy).

These soils offer the best potential for irrigated crop production. Due to climate constraints the potential for rainfed crop production remains marginal. Grazing potential is good, provided that these areas are properly managed. The depressions carry valuable, palatable species but if not given adequate rest periods and/or stocking rates the specific veld conditions will deteriorate rapidly, decreasing the grass layer and posing a serious risk in these erosion prone areas.

The lower lying areas
These areas occupy the intermediate positions in the landscape. The soils are deep to very deep, dark brown to dull yellow orange, non to extremely calcareous loamy sands to sandy loams. The structure is moderately subangular blocky in the top, with the grade decreasing to weak in the subsoil. The pH is slightly alkaline (topsoil pH-7, subsoil pH-8). Calcium carbonate nodules do occur at the bottom of the profile and most probably the soils overly calcrete at a greater depth. The soils are well drained and water logging will not be a major problem. It might occur at localized small depressions of a few metres in diameter. The average water holding capacity of these loamy soils is approximately 140 mm/m. Provisionally these soils can be classified as: calcic Luvisol (FAO '88) or typic Paluestalf (Soil Taxonomy).

These soils offer a good potential for irrigated crop production. Suitability for rainfed crop production remains very marginal because of similar reasons as mentioned above. Grazing in these areas is reasonable but variable, including areas with palatable, desirable grass species and areas with hard, unpalatable species.

2.2.2 Vegetation

The farm is situated in the Acacia erioloba (camelthorn) savanna vegetation type. It is an open savanna with a reasonable grass cover, where the Camelthorn, Acacia erioloba is the dominant tree. Associated shrubs and trees are: Acacia hebeclada, subspecies hebeclada, Ziziphus mucronata, Tarchonantus

camphoratus, Grewia flava, Ozoroa paniculosa, Rhus ciliata and others of less importance.

Patches of Terminalia sericea occur on the sand and form small woodlands. In this vegetation type hard, unpalatable grasses occur such as: Eragrostis pallens and Aristida stipitata. The latter is an indicator of phosphate deficiency. Normally the plant succession in such vegetation type would be a progression from Schmidtia kalahariensis, through Stipagrostis uniplumis and Schmidtia pappaphoroides to climax grasses Antephora pubescens, Brachiaria spp. and Digitaria spp., perennial grasses.

The sand plains are associated with Terminalia sericea, often with hard, unpalatable grass species such as Eragrostis pallens, Aristida stipitata and others.

The lower lying, loamy areas are associated with Acacia erioloba, Acacia mellifera, Grewia flava and other species. Grass species include palatable (Schmidtia kalahariensis, Digitaria sp., Anthephora pubescens etc.) and unpalatable species (Aristida sp., Eragrostis sp. etc). Source: Versfeld, 1994.

The vegetation in the depressions is characterized by a dominance of Acacia mellifera which occasionally forms a dense shrub savanna (monostand). Associated grass species are Eragrostis inundensis, Fingerhuthia africana, Antephora pubescens, Schmidtia kalahariensis and other mainly palatable species. During the survey it was observed that these palatable species are being grazed to the ground. This will result in a decrease of the grass cover and an increase of erosion. This is mainly the result of continuous grazing of these camps. Acacia mellifera also occurs as an encroacher on areas which are overgrazed (around boreholes and other localized areas on the farms).

The vegetation type on the lower lying areas and particularly the depressions is often referred to as "sweet veld" indicating that the grasses tend to keep their nutritional value in the winter period.

It appears that the camps on the three farms coincide well with the different vegetation types. In other words the size and location of the camps corresponds to the structure and species composition of the vegetation.

Carrying capacity

The carrying capacity of a farm depends on the following:

i. veld condition.
ii. veld management during the past seasons and years
iii. rainfall pattern of the area.
iv. livestock management; rotational grazing versus continuous grazing.
v. fodder availability; structural vegetation type on a farm and species composition.
vi. stocking rates.

The carrying capacity can vary between the years and within a year between the seasons, depending on the above mentioned factors.

In general the farm has a good vegetation and grass cover for grazing but is prone to degradation due to overstocking.

The economic carrying capacity is estimated to be 1:10, 1 livestock unit (LSU) in 10 hectares. It is however recommended to keep stocking rates at 1:15, being an ecological carrying capacity in order to maintain the veld condition. The carrying capacity will decrease in winter and in seasons of low rainfall. For carrying capacity calculations it is taken that 1 LSU equals 6 small stock units (SSU).

The three farms can keep 988 lsu (total area of the farms is 14824 hectares), the equivalent number of ssu's or any combination. In figure 1 it is indicated that presently 2523 lsu are grazing on the farms. This is an overstocking of 250% when compared to the ecological carrying capacity of the farm. Aggravating this is the fact that rotational grazing is not practised. Camps are grazed continuously. The combined effects of serious overgrazing and no rotational grazing will result in a rapid deterioration of the veld, signs of which are already visible in several camps. Once started this process is practically irreversible. The veld degradation in turn will lead to a decline of the carrying capacity and subsequent decline in economic value of the farm.

3. LAND EVALUATION

The land evaluation procedure is a way of assessing the suitability of a particular tract of land for a particular use (crop) in a particular climate. The process involves the matching of the land characteristics (soils and climate) and the plant/crop requirements.

The method used is called "Plantgro" (PGRO) which is a computerized land evaluation programme. This programme can provide quick qualitative assessments of plant performance on a certain soil type under certain climatic conditions. Plantgro is based on "the law of the minimum" which states that a plant will grow at a site as well as that site provides the requirements which limit its growth most (often water).

The assessment is given on a scale from 0-9, where 0 represents no limitation and 9 represents sudden death of the plant. Except the assessment of plant performance also the physical constraint which is most limiting is indicated and thereby indicates possible management interventions such as the application of irrigation water, fertilizers etc.

PGRO uses three types of files, i.e. plant-, soil-, and climate files. Plant files indicate the crop requirements. The soil- and

climate files are created using relevant data from surveys and climatic stations in the area. The prediction of the plant performance is based on matching the three mentioned files.

PGRO should be used intelligently and the results should not be accepted at face value. The models used in the programme are always simplified and they cannot reflect the complete situation in an area. The system should be used as a tool and not as an oracle.

In appendix 3 the soil file from a soil type in a depression is given. The chemical data for this file were extrapolated from another survey by Spencer et all in 1993. The climate file is compiled using data from the Gobabis synoptic station and Epukiro rainfall figures.

An evaluation was run for maize and millet under rainfed conditions. The soil limiting factor for maize and millet production is the pH. Maize is more affected (limitation rating 4) then millet (limitation rating 3). The overall limiting factor is, as expected, the rainfall. In winter the minimum temperatures will affect production for both, indicating that the crops can not be grown the year round under irrigation.

The best overall performance rating for maize is rated as 7 indicating zero potential. Interpreting this information means that maize can not form the secure basis for a production system on which a resettlement scheme can be based. Maize might be produced incidentally in good years of rainfall amount and distribution.

The best overall performance rating for millet is 3 (moderate) in February and 5 (low) in January and March. Interpreting this information indicates that millet performs better under the present conditions and can give a yield almost every year. The crop should be planted at the beginning of the year (January) planting in March is too late in the season. This crop also can only perform moderately under the given circumstances. Millet production can provide the household with grains on a subsistence level.

Both crops can be grown under irrigation during the summer period, provided there is adequate water and under proper management.

It is realized that this information provides nothing new. It however, does indicate that farmer settlers should actively be encouraged to produce millet since the climate is not suitable for a reliable maize crop. Maize crop failures will occur at least 2-3 years out of 4.

4. EXISTING CAMPS AT SKOONHEID, RUSPLAAS AND ROSENHOF

Skoonheid has 38 camps and one field. One fence in the southern part of the farm, bordering Rusplaas does exist but is not indicated on the original farmplan (see appendix 3). The 5 camps of Skoonheid which border Rusplaas are depending on water from borehole no. A3, which is situated in Rusplaas. This will have to be taken in consideration in the event Rusplaas is going to be sold.

Rusplaas has 11 camps and 2 fields. One fence which is indicated on the farm plan does not exist.

Rosenhof has 12 camps and 1 field. One fence in the western part of the farm does exist but is not indicated, while on fence in the southern part is indicated on the farm plan but does not exist.

The fences and gates on the three farms are still in reasonable to good condition. Maintenance is needed at certain fences around boreholes, where gates are being used daily. It was observed however that farmers who are occupying the farm are not replacing droppers which are broken. Terminalia sericea which occurs abundantly on the farms can provide the poles for the droppers.

The total length of the fences on the farms are as follows:

- Outer border fences, with neighbouring commercial farms 53,5 km
- Inner border fences 14,76 km
- Internal camp fences 185,40 km

The average life span of a fence is approximately 20 years. Several fences are approaching that age. Maintenance will have to be undertaken in order to prevent the replacement of parts of or the entire fence. To replace a fence will cost approximately N$1300.- per kilometre on materials only.

The tracks along the outer fences at the border with the neighbouring commercial farms are not being maintained. In many cases they are overgrown with grasses and scrub. It is important that these tracks are cleared and maintained since they act as important fire breaks with neighbouring farms.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Vegetation

The present condition of the veld is reasonable although signs of overgrazing are present. The economic carrying capacity of the three farms can be estimated as 1:10. That is if there are liabilities on the farm and expenses will have to be paid from the farm produce. The ecological carrying capacity of the farms is approximately 1 lsu:15 ha. At this stocking rate and with

proper management the present condition of the veld can be maintained. The latter means that 988 lsu can graze on the three farms in a rotational grazing system.

At the time of survey it appeared that the farms are overstocked by 250%. In order to avoid serious range degradation livestock numbers on the farms will have to be controlled and rotational grazing will have to be implemented as a matter of priority.

Soils and Water

Climate in general and rainfall in particular is the most severe limitation to crop production under rainfed conditions which can consequently not be recommended as the major land use for the farms.

The area does not have a growing period (time that the rainfall exceeds half of the evapotranspiration) at any time of the year. Consequently crops planted under rainfed conditions will always be under severe stress and will at best yield a fraction of their potential maximum yield.

Small gardens under irrigation are possible on the loamy soils of the lower lying areas and the depressions.

The resettlement process on the farms will have to be based on extensive grazing with irrigated crop production as an additional land use on subsistence level.

5.2 Recommendations

General

1. It is recommended as a matter of urgency that a qualified manager, who is knowledgeable in range management in semi-arid areas will be appointed and placed on the farms to monitor and control grazing.

2. It is recommended that Government officials of the Directorate of Resettlement, who are responsible for the various Government farms, are being trained in management of extensive grazing systems, including ecological assessments and monitoring. (This recommendation can be seen in connection with no.1.).

3. It is recommended that clear policies for resettlement are being defined as a matter of urgency. These policies should include envisaged sustainable land use on the respective farms (including the economics), allocation of responsibilities for labour, maintenance etc., description of resources available and their control. In this regard reference is made to chapter 6.2 from the report "site assessment for irrigated crop production at Mara, Tulpvlei and Halifax Farms, Hardap Region.

4. Related to recommendation no.3, a directive has to be issued that fences be maintained by the farmers themselves. Droppers and poles can be obtained from Terminalia sericea trees. The droppers and poles should be debarked after cutting and preferable be lightly burned to lengthen the lifespan.

5. Rain gauges should be provided, installed and maintained on all Government farms. Responsibility for data collection will have to be allocated (e.g. car taker of the farms).

6. It is recommended that the future development of the farms be based on the careful monitoring of the underground water reserves in order to ensure sustainable use of the farms.

7. It is recommended that the farmers and their farming practices, who will be resettled on the farms be assessed after a period of two years in order to determine the viability/potential of both the farmer and his management practices as well as the farm.

8. All the boreholes at the three farms should be cleaned and checked and pump test should be executed to determine the optimal sustainable yield and compare the figures with the original figures at the time of installing the boreholes.

9. It is recommended that the tracks along the border fences are being cleared as a matter of urgency so that they can act as fire break in the event of a veldfire.

Grazing

1. It is recommended that Government takes urgent action to bring cattle numbers to the level which can be sustained by the veld on the farms (i.e. approximately 1000 lsu). The stock numbers will have to be strictly controlled.

2. For the three farms a stocking rate of 1 LSU : 15 Ha is recommended. This means that the three farms can carry 988 LSU or an equivalent number of small stock, 6 SSU = 1 LSU or any combination within the recommended limits.

3. It is recommended that adequate range management including rotational grazing and appropriate rest periods will have to be implemented as a matter of urgency.

Crop production

1. Large scale, rainfed crop production *can not* be recommended as the major land use for the resettlement schemes.

2. It is recommended that small, irrigated gardens be established, preferably in the depressions next to or in the vicinity of the homesteads of the farmers for home

consumption. Assistance will have to be provided in site selection for the garden and the lay-out of the irrigation scheme.

3. It is recommended for irrigated production of maize, sorghum and millet that fields be established on the deep loamy soils indicated by Acacia erioloba.

4. It is recommended that Lucerne (alfalfa) under irrigation is tried on the farms, in the depressional and lower lying areas. If promising, this crop can provide supplementary feed for the livestock during the winter season. The possible surplus can be marketed to the commercial farmers in the surrounding area.

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APPENDICES

1. Climatic data from Gobabis synoptic weather station.
2. Soil Profile Descriptions.
3. Land Evaluation Results.
4. Layout of the existing camps at Rosenhof, Skoonheid and Rusplaas.

Appendix 1

Climatological Data for Gobabis, Station number 0787/838
Recording period: 69 years.

Month	Mean Max. Temp. °C	Mean Min Temp °C	Mean Sunshine hrs/month	Mean Monthly Evap. (mm)	Mean Rainfall mm.	Highest Temp °C	Lowest Temp °C	Rel. Hum. %
January	31.8	17.4	254.5	298.5	94.8	40.5	4.5	45
February	30.3	16.6	220.9	240.6	84.6	38.5	5.5	51
March	29.0	15.1	252.8	225.3	60.0	38.0	4.5	54
April	27.2	11.6	236.3	170.3	34.9	35.2	-0.5	53
May	24.6	6.3	300.0	160.1	6.9	32.0	-6.5	45
June	21.9	3.1	282.2	137.3	1.5	32.6	-9.2	44
July	22.2	2.5	301.4	152.6	0.1	31.0	-9.9	40
August	25.0	4.6	313.8	193.7	0.5	33.2	-8.6	31
September	28.8	8.8	296.0	269.8	3.1	36.6	-5.6	27
October	31.1	12.9	297.0	300.8	14.3	39.3	0.0	29
November	31.6	15.2	266.1	292.0	42.8	38.7	3.1	34
December	32.4	17.0	296.6	312.2	57.7	39.9	6.4	37
Annual				2753.2	401.2	39.9	-9.9	41

APPENDIX 2

SOIL PROFILE DESCRIPTIONS

SOIL PROFILE DESCRIPTION Profile: SH0005 Unit: Status: 2

Sheet/Grid : 2119CA/ Coord : S 21-32-10 E 19 -09-28
Location : 200 mtr from Skoonheid farm house.
Survey Area: Omaheke region Elevation: 1500 m
Author(s) : Jan Huesken Date : 18/04/94

Classification FAO: Calcic Luvisol(1988)
ST : Typic Paleustalf, coarse loamy,
Soil Climate: USTIC
Topography : Flat; 0-0.5% Land Form: plain
Element/Pos.: lower part Slope : 0.3 - 0.7% straight
Micro Top: even
Land Use : extensive grazing Human Infl: clearing
Vegetation : savanna Grasscover: 0-15%
Species : Acacia erioloba Ziziphus mucronata Acacia mellifera

Parent Material: aeolian deposits over in situ weathered
Eff. Soil Depth: > 150cm
Rock Outcrops : nil -
Surface Stones : nil
Erosion : slight wind erosion/deposition and slight sheet erosion Sealing/Crusting: slight sealing

Drainage : well; permeability: moderate ; external drainage: moderate
Watertable: not observed
Flooding : nil
Moist Cond: dry 0 - 90 , slightly moist 90 - 110cm
Remarks: Profile is representative for lower lying areas. Soil pit at the edge of recently cleared area for extension of existingfield. Old field under maize. Leaves of maize plants have yellow spots,either deficiency of micro-nutrients r water problem.

Samples:

A1 0 - 15 cm 7.5YR 3/2 (dry) and 7.5YR 2/2 (moist); loamy sand (5% clay); moderate fine to coarse subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores , many very fine and few medium roots; non calcareous; field pH: 7.0, clear wavy boundary.

? 15 - 30 cm 7.5YR 3/4 (dry) and 7.5YR 2/3 (moist); loamy sand (5% clay); moderate fine to coarse subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , many very fine and common medium roots; non calcareous; field pH: 6.5, gradual wavy boundary.

BT1 30 - 60 cm 7.5YR 4/4 (dry) and 7.5YR 3/2 (moist); loamy sand (7% clay); moderate fine and medium subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), common very fine pores and common fine pores , few clay on pedfaces; few fine irregular hard calcareous white nodules; many very fine and common medium roots; non calcareous; field pH: 6.5, gradual wavy boundary.

BT2 60 - 90 cm 7.5YR 4.5/4 (dry) and 7.5YR 3/3.5 (moist); sandy loam (15% clay); weak fine and medium subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), common very fine pores , few clay on pedfaces; few fine irregular hard calcareous white nodules; common very fine and few medium roots; slightly calcareous; field pH: 7.5, clear wavy boundary.

Bck 90 - 120 cm 10YR 6.5/3 (dry) and 10YR 5.5/3 (moist); sandy loam (20% clay); weak fine and medium subangular and angu structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), common very fine pores , few clay on pedfaces; dominant fine irregular hard calcareous white nodules and common coarse irregular hard calcareous white nodules; common very fine and few medium roots; extremely calcareous; field pH: 8.5,

Print Date: 28/05/94

SOIL PROFILE DESCRIPTION Profile: SH0006 Unit: Status: 2

Sheet/Grid : 2119CA/ Coord : S 21-32-10 E 19 -09-28
Location : 3,25 km due west from Skoonheid house.
Survey Area: Omaheke region Elevation: 1493 m
Author(s) : Jan Huesken Date : 19/04/94

Classification FAO: Ferralic Arenosol(1988)
ST : Ustic Quartzipsamment, sandy,
Soil Climate: USTIC
Topography : Flat; 0-0.5% Land Form: plain
Element/Pos.: intermediate part Slope : 0.7 - 2% straight
Micro Top: uneven
Land Use : extensive grazing Human Infl: no influence
Vegetation : tree savanna Grasscover: 0-15%
Species : Terminalia sericea Ziziphus mucronata Grewia flava Acacia erioloba

Parent Material: aeolian sand
Eff. Soil Depth: > 150cm
Rock Outcrops : nil -
urface Stones : nil
Erosion : slight wind erosion/deposition and slight sheet erosion Sealing/Crusting: slight sealing

Drainage : somewhat excessively; permeability: high ; external drainage: rapid
Watertable: not observed
Flooding : nil
Moist Cond: dry 0 - 130cm
Remarks: Profile is representative for the sandy plains, being the major unit onthe three farms. Grass species are: Eragrostis pallens and Stipagrostisuniplumis.

Samples:

A 0 - 25 cm 7.5YR 5/4 (dry) and 7.5YR 4/4 (moist); sand; weak to moderate medium and coarse subangular and angular b structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , many very fine and many fine roots; non calcareous; field pH: 5.5, gradual wavy boundary.

B1 25 - 60 cm 7.5YR 5/4 (dry) and 7.5YR 4/4 (moist); sand; weak to moderate medium and coarse subangular and angular b structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , many very fine and few roots; non calcareous; field pH: 5.5, gradual wavy boundary.

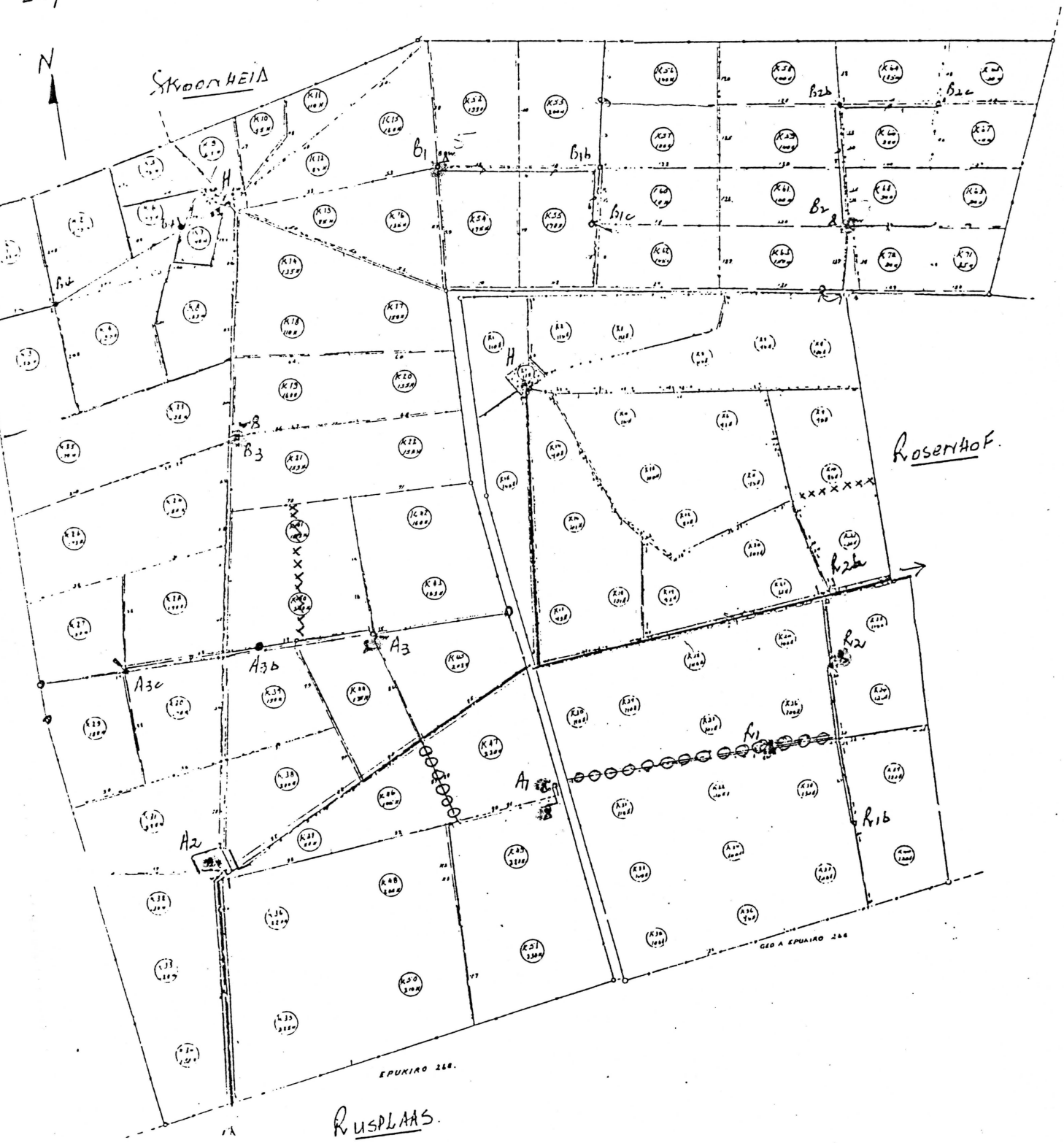
B2 60 - 100 cm 7.5YR 5/6 (dry) and 7.5YR 3/4 (moist); sand; weak medium and coarse subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , common very fine and common fine roots; non calcareous; field pH: 5.0, gradual wavy boundary.

C 100 - 130 cm 7.5YR 6/8 (dry) and 7.5YR 5/8 (moist); few fine diffuse mottles; sand; weak medium and coarse subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , common very fine and common fine roots; non calcareous; field pH: 5.0,

Print Date: 28/05/94

FIGURE

LAYOUT OF CAMPS AT SKOONHEID, RUSPLAAS AND ROSENHOF



×××× EXISTING FENCE, NOT INDICATED ON FARM PLAN

oooo FENCE INDICATED ON FARM PLAN BUT NON-EXISTEND

SOIL PROFILE DESCRIPTION Profile: RP0001 Unit: Status: 2

Sheet/Grid : 2119CA/ Coord : S 21-37-05 E 19 -06-43
Location : 200 mtr from Rusplaas farm house.
Survey Area: Omaheke region Elevation: 1505 m
Author(s) : Jan Huesken Date : 20/04/94

Classification FAO: Luvic Calcisol(1988)
ST : Petrocalcic Paleustalf, fine loamy,
Soil Climate: USTIC
Topography : Flat; 0-0.5% Land Form: plain
Element/Pos.: depression- intermediate part Slope : 0.3 - 0.7% straight
Micro Top: uneven
Land Use : extensive grazing Human Infl: no influence
Vegetation : savanna Grasscover: 0-15%
Species : Acacia mellifera Acacia erioloba Grewia flava Acacia hebeclada

Parent Material: fluvial deposits over in situ weathered
Eff. Soil Depth: 50-100cm
Rock Outcrops : nil -
urface Stones : nil
Erosion : slight sheet erosion Sealing/Crusting: slight sealing

Drainage : moderately well; permeability: moderate ; external drainage: moderate
Watertable: not observed
Flooding : annually ; 1-15 days
Moist Cond: dry 0 - 60 , slightly moist 60 - 100cm
Remarks: Soil profile is representative for the depressional areas on the farms.The depressions used to be cultivated by th-
e previous owners.

Samples:

A 0 - 10 cm 10YR 4/1.5 (dry) and 10YR 2/1 (moist); loamy sand (14% clay); strong fine and medium subangular and angu structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , many very fine and many fine roots; non calcareous; field pH: 6.5, clear wavy boundary.

Bt 10 - 40 cm 10YR 3.5/2 (dry) and 10YR 2/1.5 (moist); sandy loam (17% clay); moderate fine and medium subangular and angular blocky structure; slightly hard (dry), friable (moist), non sticky (wet), non plastic (wet), many very fine pores and many fine pores , few clay on pedfaces; many very fine and few medium roots; non calcareous; field pH: 6.5, gradual wavy boundary.

Btk1 40 - 70 cm 10YR 4/2 (dry) and 10YR 3.5/1 (moist); sandy clayloam (25% clay); moderate fine and medium subangular and angular blocky structure; slightly hard (dry), friable (moist), slightly sticky (wet), slightly plastic (wet), common very fine pores and common fine pores , few clay on pedfaces; common fine irregular soft calcareous white nodules; common very fine roots; slightly calcareous; field pH: 7.0, gradual wavy boundary.

Btk2 70 - 100 cm 10YR 5/2 (dry) and 10YR 4/2 (moist); sandy clayloam (27% clay); moderate fine to coarse subangular and angular blocky structure; slightly hard (dry), friable (moist), slightly sticky (wet), slightly plastic (wet), common very fine pores and common fine pores , few clay on pedfaces; common fine irregular soft calcareous white nodules; common very fine roots; slightly calcareous; field pH: 8.0,

Print Date: 25/05/94

APPENDIX 3

LAND EVALUATION RESULTS

PROGRAM: GRO

This was run on 31-05-1994 at 11:26:02
by Huesken

THE PLANT (identification) Data-file: MAIZE110.PGN

1. Plant name: Maize (110 d - 25 deg - DN)
2. Scientific name: Zea mays L.
3. Family: Poaceae
4. Product(s) considered: grain
5. File author(s): C. Hackett
6. Date created: 1189; modified by J.H. Venema 11/93
7. Quantity of world information on species (0-9): 9
8. Coverage of world information by data-set (0-9): 7
9. Main reference(s) used: Doorenbos and Kassam (1979)
10. Perennial (1,0): 0
11. Growth phase considered: growth and flowering (not ripening)
12. Photoperiodic response attributed: DN
13. Remarks:
14. Remarks:
15. Remarks: Relations weighted towards main growth and fl'g
16. Remarks:

KEY DATA

Dimensions: height (m) - 2 potential rooting depth (cm) - 200

non-limiting rooting depth (NLD, cm) - 75 critical drained depth (CRDRDEP, cm) - 75

Temperatures (deg. C):

Thresholds: brief cold - 1 extended cold - 6 heat damage - 44

Cardinal temps for devel.: TA = 8 TB = 25 TC = 26 TD = 36

Development units (DUs):

optimum per week (OPTDU) = 52

SUMDU (total DUs for growth season) = 780

THE SOIL (time-constant factors) Data-file: SKOONCOR.SL-

SOIL site: Skoonheid Notes

Vertical depths (cm): DA = 40 DB = 60 DI = 100 Root penetrable depth = 100 Drainable depth = 200

Texture A = 4 Texture B = 3 (classes 1-8, v. fine to v. coarse)
Avail. water capacity A (%) = 14 AWCB% = 20
Drain. water capacity A (%) = 0 DRWCB% = 0 DRWCI% = 0

Factor	Site value	LR (0-9)	
Fact 1. Aeration (class)	6	0	(classes 1-6, stagnant to good)
Fact 2. Base sat'n (% CEC)	75	0	
Fact 3. CEC (meq/100g)	25	0	
Fact 4. Depth (% NLD)	133	0	(as % non-limiting rooting depth)
Fact 5. Nitrogen (%)	4	0	
Fact 6. pH	8	4	
Fact 7. Phosphorus (avail. P)	6	4	
Fact 8. Potassium (meq/100g)	.3	0	
Fact 9. Salinity (mS/cm)	5	3	
Fact10. Slope (deg.)	0	0	
act11. Texture (class)	4 , 3	1 (overall)	(classes 1-8, v. fine to v. coarse)

SOILGLR (Soil Greatest Limitation Rating) 4 (carried forward to p.3)

THE CLIMATE (time-varying factors)

CLIMATE site: Gobabis Data-file: GOBABIS.CMV

Calendar of CLIMATE inputs for LR calculation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DAYLENGTH (hrs)	14	14	13	12	12	12	12	12	13	13	14	14
DLFACTOR (0.0-1.0)-pc	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DLFACTOR (0.0-1.0)-man.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SOLAR (MJ/m^2/day)	23	21	19	17	16	15	14	16	19	21	22	22
TMAX (deg. C)	32	30	29	27	25	22	22	25	29	31	32	32
TN (deg. C)	17	17	15	12	6	3	3	5	9	13	15	17
TLOWEST (deg. C)	5	6	5	-1	-7	-9	-10	-9	-6	0	3	6
THERMAL UNITS opt= 222	220	234	217	184	126	84	84	120	159	202	212	220
DEVEL. UNITS opt= 222	220	234	217	184	126	84	84	120	159	202	212	220
RAIN (mm)	68	83	49	24	0	0	0	0	0	11	35	49
EVAP'N (mm)	299	241	225	170	160	137	153	194	270	301	292	312
IRRIG'N (mm)	0	0	0	0	0	0	0	0	0	0	0	0
WATER STORE - day 1 (mm)	0	0	0	0	0	0	0	0	0	0	0	0
DEFICIT - last day (mm)	201	134	154	129	144	123	138	175	243	260	228	232
PWATERAVAIL (%)	25	38	24	16	0	0	0	0	0	4	13	17
SURPLUS (mm)	0	0	0	0	0	0	0	0	0	0	0	0
DRAINED DEPTH (cm)	200	200	200	200	200	200	200	200	200	200	200	200
RUNOFF (mm)	0	0	0	0	0	0	0	0	0	0	0	0
FLOODING (1,0)	0	0	0	0	0	0	0	0	0	0	0	0
PETCF	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
WIND - extreme (km/hr)	9	9	9	9	9	9	9	9	9	9	9	9

Max soil water store (mm) = 176 Surplus divider = 30 /7 No quality relationship used

THE PREDICTION

PLANT file: F-MILLET.PGN SOIL file: SKOONCOR.SL- CLIMATE file: GOBABIS.CMV

Calendar of limitation ratings (LRs 0-9, . = 0)

(Relation of LRs to performance: 0 - 2 = high 3 - 4 = mod. 5 - 6 = low 7 - 8 = nil 9 = rapid death)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fact12. Dayl.plnt clock	2	2	1	.	.	.	.	.	1	1	2	3
Fact18. Thermal units	2	2	1	1	3	5	5	4	1	.	1	2
SOILGLR	3	3	3	3	3	3	3	3	3	3	3	3
Fact14. Solar radiation	.	.	.	1	2	2	2	2	.	.	.	.
Fact15. Brief cold	1	.	1	9	9	9	9	9	9	9	7	.
Fact16. Extended cold	.	.	.	.	9	9	9	9	4	.	.	.
t17. Heat damage	.	.	.	.	.	.	.	.	.	.	.	.
Fact24. Devel. units	1	.	.	1	3	5	5	4	2	1	1	2
Fact19. Water avail.	5	3	5	6	8	8	8	8	8	7	6	6
Fact20. Seas. w'logging	.	.	.	.	.	.	.	.	.	.	.	.
Fact21. Flooding	.	.	.	.	.	.	.	.	.	.	.	.
Fact22. Wind damage	.	.	.	.	.	.	.	.	.	.	.	.
Fact13. Dayl.mngmt.view	.	.	.	.	.	.	.	.	.	.	.	.
Quality bypassed	.	.	.	.	.	.	.	.	.	.	.	.

Calendar of Greatest Limitation Ratings (GLRs) by time period (SOILGLR down to Wind)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GLRs	5	3	5	9	9	9	9	9	9	9	7	6

Length of Growing Season (LGS) for each starting period and OVerall LR for each season (OVLR)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LGS (no. of periods)	99	99	99	99	99	99	99	99	99	99	99	99
OVLR	9	9	9	9	9	9	9	9	9	9	9	9

For LGSs: 88+ = ran out of time-periods 99 = death before reaching SUMDU

Warning ! Dummy relationships were used for the following:

No dummy relationships used

PROGRAM: GRO

This was run on 31-05-1994 at 11:27:57
by Huesken

THE PLANT (identification) Data-file: F-MILLET.PGN

1. Plant name: Finger millet (rapoko)
2. Scientific name: Eleusine coracana
3. Family: Gramineae
4. Product(s) considered: grain
5. File author(s): J.H. Venema
6. Date created: 0793
7. Quantity of world information on species (0-9):
8. Coverage of world information by data-set (0-9):
9. Main reference(s) used: Purseglove; MLW/85/011
10. Growth phase considered: general
11. Length of growth phase (weeks): 21
12. Photoperiodic response attributed: Weak short-day
13. Remarks: can be stored for long periods
14. Remarks: little bird damage
15. Remarks:

KEY DATA

Dimensions: height (m) - .3 potential rooting depth (cm) - 80

non-limiting rooting depth (NLD, cm) - 40 critical drained depth (CRDRDEP, cm) - 30

Temperatures (deg. C):

Thresholds: brief cold - 1 extended cold - 6 heat damage - 44

Cardinal temps for devel.: TA = 10 TB = 22 TC = 30 TD = 38

Development units (DUs):

optimum per week (OPTDU) = 52

SUMDU (total DUs for growth season) = 1092

THE SOIL (time-constant factors) Data-file: SKOONCOR.SL-

SOIL site: Skoonheid Notes

Vertical depths (cm): DA = 40 DB = 60 DI = 100 Root penetrable depth = 100 Drainable depth = 200

Texture A = 4 Texture B = 3 (classes 1-8, v. fine to v. coarse)
Avail. water capacity A (%) = 14 AWCB% = 20
Drain. water capacity A (%) = 0 DRWCB% = 0 DRWCI% = 0

Factor	Site value	LR (0-9)	
Fact 1. Aeration (class)	6	0	(classes 1-6, stagnant to good)
Fact 2. Base sat'n (% CEC)	75	0	
Fact 3. CEC (meq/100g)	25	0	
Fact 4. Depth (% NLD)	250	0	(as % non-limiting rooting depth)
Fact 5. Nitrogen (%)	4	0	
Fact 6. pH	8	3	
Fact 7. Phosphorus (avail. P)	6	2	
Fact 8. Potassium (meq/100g)	.3	0	
Fact 9. Salinity (mS/cm)	5	1	
Fact10. Slope (deg.)	0	0	
Fact11. Texture (class)	4 , 3	1 (overall)	(classes 1-8, v. fine to v. coarse)
SOILGLR (Soil Greatest Limitation Rating)		3	(carried forward to p.3)

THE CLIMATE (time-varying factors)

CLIMATE site: Gobabis Data-file: GOBABIS.CMV

Calendar of CLIMATE inputs for LR calculation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DAYLENGTH (hrs)	14	14	13	12	12	12	12	12	13	13	14	14
DLFACTOR (0.0-1.0)-pc	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.7
DLFACTOR (0.0-1.0)-man.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
SOLAR (MJ/m^2/day)	23	21	19	17	16	15	14	16	19	21	22	22
TMAX (deg. C)	32	30	29	27	25	22	22	25	29	31	32	32
TMIN (deg. C)	17	17	15	12	6	3	3	5	9	13	15	17
TLOWEST (deg. C)	5	6	5	-1	-7	-9	-10	-9	-6	0	3	6
THERMAL UNITS opt= 222	265	268	244	206	129	85	85	121	185	223	243	265
DEVEL. UNITS opt= 222	206	209	217	206	129	85	85	121	164	199	189	176
RAIN (mm)	68	83	49	24	0	0	0	0	0	11	35	49
EVAP'N (mm)	299	241	225	170	160	137	153	194	270	301	292	312
IRRIG'N (mm)	0	0	0	0	0	0	0	0	0	0	0	0
WATER STORE - day 1 (mm)	0	0	0	0	0	0	0	0	0	0	0	0
DEFICIT - last day (mm)	171	110	131	112	128	110	122	155	216	230	199	201
PWATERAVAIL (%)	28	43	27	18	0	0	0	0	0	5	15	20
SURPLUS (mm)	0	0	0	0	0	0	0	0	0	0	0	0
DRAINED DEPTH (cm)	200	200	200	200	200	200	200	200	200	200	200	200
RUNOFF (mm)	0	0	0	0	0	0	0	0	0	0	0	0
FLOODING (1,0)	0	0	0	0	0	0	0	0	0	0	0	0
PETCF	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8
WIND - extreme (km/hr)	9	9	9	9	9	9	9	9	9	9	9	9

Max soil water store (mm) = 136 Surplus divider = 30 /7 No quality relationship used

THE PREDICTION

PLANT file: MAIZE110.PGN SOIL file: SKOONCOR.SL- CLIMATE file: GOBABIS.CMV

Calendar of limitation ratings (LRs 0-9, . = 0)

(Relation of LRs to performance: 0 - 2 = high 3 - 4 = mod. 5 - 6 = low 7 - 8 = nil 9 = rapid death)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fact12. Dayl.plnt clock	.	.	.	.	.	.	.	.	.	.	.	.
Fact18. Thermal units	.	1	.	1	3	5	5	4	2	1	.	.
SOILGLR	4	4	4	4	4	4	4	4	4	4	4	4
Fact14. Solar radiation	1	1	2	2	2	2	2	2	2	1	1	1
Fact15. Brief cold	.	.	.	9	9	9	9	9	9	6	.	.
Fact16. Extended cold	.	.	.	.	3	9	9	6	.	.	.	.
Fact17. Heat damage	.	.	.	.	.	.	.	.	.	.	.	.
Fact24. Devel. units	.	1	.	1	3	5	5	4	2	1	.	.
Fact19. Water avail.	7	6	7	7	8	8	8	8	8	8	7	7
Fact20. Seas. w'logging	.	.	.	.	.	.	.	.	.	.	.	.
Fact21. Flooding	.	.	.	.	.	.	.	.	.	.	.	.
Fact22. Wind damage	.	.	.	.	.	.	.	.	.	.	.	.
Fact13. Dayl.mngmt.view	.	.	.	.	.	.	.	.	.	.	.	.
Quality bypassed	.	.	.	.	.	.	.	.	.	.	.	.

Calendar of Greatest Limitation Ratings (GLRs) by time period (SOILGLR down to Wind)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GLRs	7	6	7	9	9	9	9	9	9	8	7	7

Length of Growing Season (LGS) for each starting period and OVerall LR for each season (OVLR)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LGS (no. of periods)	99	99	99	99	99	99	99	99	99	3+	3+	3+
OVLR	9	9	9	9	9	9	9	9	9	7	7	7

For LGSs: 88+ = ran out of time-periods 99 = death before reaching SUMDU

Warning ! Dummy relationships were used for the following:

No dummy relationships used

APPENDIX 4

LAYOUT OF EXISTING CAMPS AT ROSENHOF, SKOONHEID AND RUSPLAAS