ORGANIZATION FOR SOCIAL SCIENCE RESEARCH
IN EASTERN AND SOUTHERN AFRICA
(OSSREA)

Agricultural Land Management for Sustainable Production in Swaziland: A Pilot Study of Gege, Maphilenga and Zombodze Areas

Paul S. Maro

Research Report Series No. 4

ORGANIZATION FOR SOCIAL SCIENCE RESEARCH IN EASTERN AND SOUTHERN AFRICA (OSSREA)

Agricultural Land Management for Sustainable Production in Swaziland: A Pilot Study of Gege, Maphilenga and Zombodze Areas

Paul S. Maro*

(Submitted in December 1991)

Research Report Series No. 4

April 1996

P.O. Box 31971, Addis Ababa, Ethiopia
Tel 119705, Tlx. 21646, Fax 551399

* Technical Advisor, SADCC, Environment and Land Management, Sector Coordination Unit, Maseru, Lesotho.

OSSREA acknowledges the support of Ford Foundation, Swedish International Development Cooperation Agency (Sida), the Norwegian Royal Ministry of Foreign Affairs and Environmental Policy and Society (EPOS).

On OSSREA's Research Report Series

The Organization for Social Science Research in Eastern and Southern Africa (OSSREA) has been running two research competitions - the Social Science and Gender Issues Research Competitions - for a number of years now. winners of these competitions are required to submit their findings in the form of final research reports.

This Research Report Series presents papers selected from these reports and is intended to disseminate the results to a wider audience. The papers are published unedited as submitted by the authors and errors that remain are the sole responsibilities of the authors. Also the views expressed in the papers are th.se of the authors and do not, in any way, reflect those of the Organization.

Table of Content

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to the Organization for Social Science Research in Eastern and Southern Africa (OSSREA) for extending a small research grant to me in 1989 that enabled me to carry out the data collection for this research project. My thanks also go to the four students of the University of Swaziland who assisted in the field data collection. Lastly, I am indebted to a the many Swazi farmers and government officials who spared their valuable time to talk to us, and from whom we have learnt a lot.

1. INTRODUCTION

1.1 The Problem

There are two apparently contradictory trends in Swaziland which if not checked can lead to a major crisis in resource use and sustainable development in agriculture. First, the size of a the country is not only small (17, 360 sq. km) but the land tenure is such that only 52% of the land is available to smallholder farms (Swazi Nation Land - SNL) and this carried 70% of the population in 1986 compared to 47% of the land in large scale individual tenure farms (ITF) with only 8% of the 1986 population. Then the population which has increased rapidly at 2.7% p.a. from 395,136 in 1966 to 520,184 in 1976 and 3.2% p.a. to 676,089 in 1986 has naturally resulted in decreasing farm size from an average of 2 ha of arable land in 1972 to 1.0 ha in 1983 and 0.50 ha in 1986. Second, it is to be expected that under such conditions of increasing land scarcity there would be both official land use planning policy allocating units of land to the use most suited to each, and also deliberate land use management practices by farmers to ensure that land is maintained to maximum production.

Instead, one finds that there is unplanned use of land with some misallocated to wrong uses (Nkambule, 1988); livestock numbers have increased to 680,000 cattle and there is serious overstocking at 1.9 ha per livestock unit instead of 3 ha per livestock unit, thus leading to range degradation, soil erosion, bush encroachment and low animal productivity (USAID, 1980; Roder, 1977); and declining subsistence (maize) production by 36% between 1978 and 1983 necessitating the import of 30,000 tons per annum (Swaziland Government, 1986). These unfavourable trends in land resource use are likely to continue and intensify as population increases. But why these responses? Is it because the land capability has not been assessed and therefore people are not aware of the best use to which the land could be put? Or could it be that the land tenure system militates against long-term investments in land management? Or has the socio-economic setting of family labour led to a "neglect" of agriculture in favour of off-farm and migrant-labour employment which might earn sufficient income for the subsistence of the family?

The Government cannot enforce planned land use without the capability (suitability) of the land being assessed and known. Studies of suitability of land for specific uses and the interaction between population and land resources have

been few and either specialized and limited in scope or too generalized at the national level.

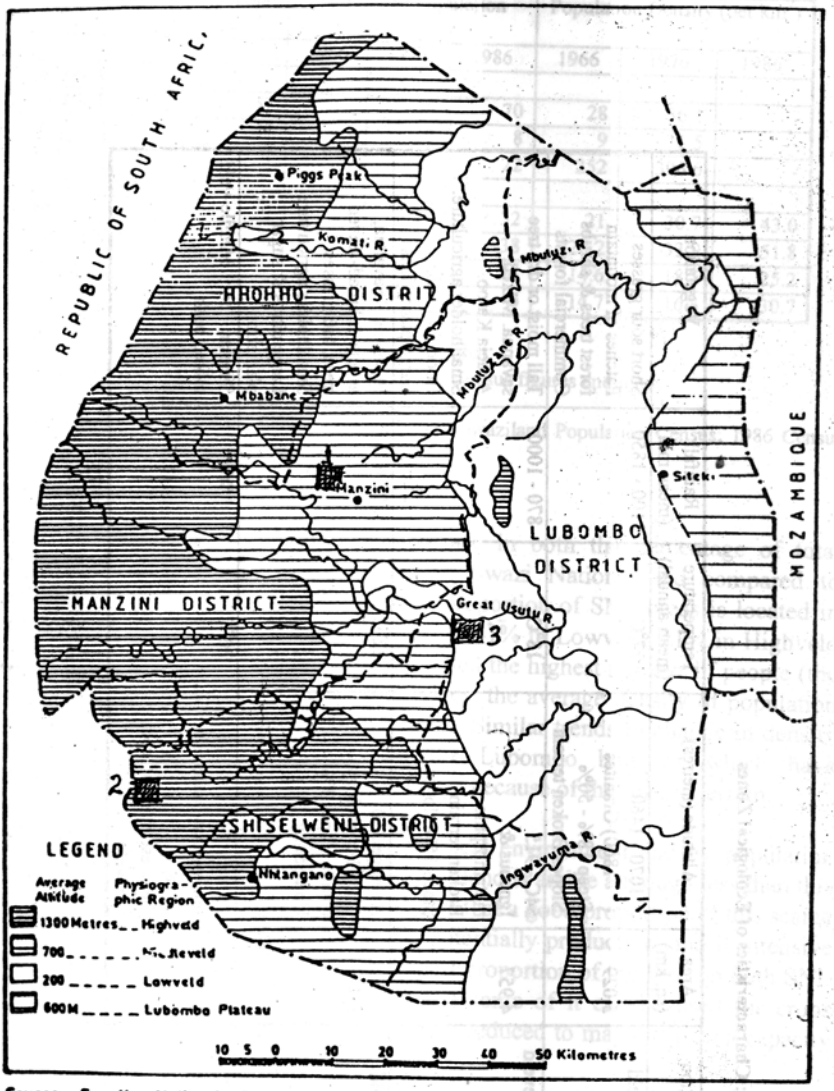
Murdoch's (1968) land capability classification was too generalized but in the absence of any other detailed study still serves as a good starting point, while Bootsman and Schmidt (1983) applied a water budget model to 15 weather stations in Swaziland to conclude that the densely populated upper Middleveld within 0 to 250 mm annual water deficit faced the greatest potential threat of desertification due to excessive pressure on land. Other studies have focused on land allocation and tenure arrangements without explicitly relating these to land capability and management (Hughes, 1972; Fewler, 1980; Russell, 1985). De Vletter (1983) showed the degree of dependency on wage employment even for rural households who grew cash crops and owned cattle.

Useful information can also be obtained from reviews of the Rural Development Areas Programme (RDAP) on problems of agricultural and livestock production, and land use management and conservation (Swaziland, 1983, and 1984).

1.2 General Description of Population and Land Use

The Kingdom of Swaziland lies between latitudes 25° 44' and 27° 19' South and longitudes 30° 47' and 32 07 East. The greatest distance from North to South is 194 km and from east to west 145 km. Its area of 17,360 km is about the size of Wales. Figure 1 and Table 1 describe the major characteristics of the four ecological zones of Swaziland and show how relief, soils and rainfall affect the resource potential of these ecological zones.

Fig. 1 Physiographic Regions



Source: Fourth National Development Plan 1989/84-82/88

Sample areas: 1. Zombodze 2. Gege 3. Maphilenga

Table 1: Characteristics of Ecological Zones

Region	Area (sq. km)	Altitude (metres)	Temperature (mean annual)	Rainfall (mean mm)	Vegetation
Highveld	5,029	1070 - 1460 (1860) Granites Steep 18% - 50% Slopes Broken terrain	17°C	1100 - 1850	Short sour grasses Patches of mountain forest trees & shrubs Commercial forests
Middleveld	4,957	54C - 915 Igneous & metamorphic Broken terrain Steep 15% slopes	18°C	870 - 1000	Tall moist or dry tree savanna. Mixed. Acacia Karoo. Smallholder agriculture. Good for cattle. Large plantations
Lowveld	6,416	Average 350 Complex geology Gentle slopes 3% Undulating	22°C	520 - 675	Bushveld - Savanna, acacia & broad-leaved trees, tall grasses. Smallholder agriculture Large citrus & sugar plantation
Lubombo	1,321	Average 765 Intermediate volcanic lavas Steep escarpment from Lowveld	20°C	869	Similar to Middle-veld mixed bush

Table 2: Population Distribution by Land Tenure and Ecological Zones

Distribution by	% of Total Areas[1]	% of Total Population			Population Density (per km^2)		
		1966	1976	1986	1966	1976	1986[2]
Land Tenure							
Rural (SNL)	52	-	66	70	28	36.1	-
Farm (ITL)	47	-	19	8	9	11.5	-
Urban	1	-	15	22	252	396.6	-
Ecological Zone							
Highveld	29	28	31	32	21	30.7	43.0
Middleveld	26	42	41	38	28.2	33.9	51.8
Lowveld	39	25	24	24	14.6	18.5	25.2
Lobombo	8	5	4	6	14.7	16.3	30.7

Notes: 1. Based on 1976 Census figures for land area.
2. Own calculations based on provisional Census figures and maps.

Source: Central Statistical Office 1966 and 1976 Swaziland Population Census; 1986 Census provisional figures and maps.

Table 2 shows the disproportionate increase in both the percentage of total population and density of population on Swazi Nation Land compared to Individual Tenure Land. Because a large proportion of SNL areas is located in the Middleveld (32% in 1976 as compared to 41% in Lowveld, 21% in Highveld and 7% in Lubombo) which has always carried the highest number of people (the percentage is declining) out of the four zones, the average density of population has nearly doubled between 1966 and 1986. Similar trends in change in density are observed for the Highveld and for Lubombo both of which have comparatively more fragile land resource base because of the rugged terrain.

Land use is greatly influenced by the physical environment and by population density. Only about 15% of the land in Swaziland is arable although less than this is actually planted with crops. Table 3 shows that a good proportion of this scarce cropland is left fallow and this represents potentially productive land if intensive methods of land use are adopted. The largest proportion of the land on both SNL and ITF is however devoted to grazing but some of it can be used for crops especially when livestock numbers have been reduced to match carrying capacity

of land. It is also estimated that 20% of the land under ITF is unused but sometimes loaned to smallholders for agriculture (CSO 1981).

Except for tobacco and cotton, SNL farmers concentrate on the production of food crops such as maize, beans, sorghum, bananas, groundnuts, rice, pineapples, vegetables and fruits (Table 4).

Table 3: Land Use in Swaziland 1980/81 (hectares)

Category	SNL	%	ITF	%	Total
Crop land	81,000	8.4	45,218	5.9	126,218
Crops	81,000	8.4	45,218	5.9	126,218
Fallow	12,354	1.3	3,854	0.5	16,208
Sub-total	93,354	9.7	49,072	6.4	142,426
Grazing Land					
Natural	865,303	89.7	214,489	28.2	1,079,792
Improved	-		61,971	8.2	61,971
Sub-total	865,303		276,440	36.4	1,141,763
Commercial					
Forest	-		101,522	13.4	101,522
Other Land	6,423	0.7	332,926	43.8	339,349
Total	965,808		759,980		1,725,060

Source: CSO, 1981.

Table 4: Total Net Area Under Different Crops on SNL 1981/82 (hectares)

Crop	Highveld	Middleveld	Lowveld	Lubombo	Swaziland	%
Maize	15,608	28,439	10,154	4,735	58,936	70.5
Cotton	-	3,244	8,262	69	11.575	13.8
Sorghum	382	958	750	72	2,162	2.6
Beans a/	623	986	186	222	2,017	2.4
Pumpkins a/	400	1,091	320	201	2,012	2.4
Potatoes	26	115	-	-	141	0.2
Tobacco	255	160	2	-	417	0.5
Other crops	655	3,294	1,953	471	6,373	0.5
Total	17,949	38,287	21,627	5,770	83,633	100.0

a/ Usually intercropped with maize.

Source: Central Statistical Office, 1983.

They rely on family labour and have low level of inputs, hence yields are generally low. Individual tenure farms in contrast are large, use modern inputs and produce for the market. Some small-scale irrigation is practiced on SNL in the Highveld and Middleveld but the main irrigation areas are for sugar-cane in the Lowveld. Under the Swazi nation system farmers can be allocated land for crop production only, and the area allocated varies considerably depending on the ecological zone, population density and size of the household. In 1972 the majority of the farms in all the ecological regions were between one and five hectares. By 1983 the most common size of cropped area on SNL was down to 0.5 to 1.0 ha, but with the Rural Development Areas (resettlement schemes) having a higher proportion of the farms over 3 ha compared to non- RDA areas (Table 5.1).

Table 5.1: Farm Size on SNL 1982/83 (Per cent)

Size of Cropped Area	RDA	Non-RDA	Total
0.5	9.4	17.2	10.4
0.5 - 1.0	19.5	24.2	19.4
1.0 - 1.5	17.2	17.7	17.4
1.5 - 2.0	13.0	12.3	12.9
2.0 - 2.5	12.9	9.0	12.4
2.5 - 3.0	7.6	6.4	7.4
3.0	21.1	12.9	20.1

The increasing imbalance between population and resources is also illustrated by consideration of the average amount of land available per person on SNL. It will be observed from Table 6 that there has been a steady decrease in the amount of arable land available per rural person from an average of 0.5 ha to 1.0 ha in 1960 to 0.10 to 0.20 1986, which are very uneconomic sizes. Because not everyone in the rural areas operates land, actual farm sizes are better than these calculated average figures. The implications of the deteriorating relationship between numbers of people and land resources nonetheless call for urgent action in population control to bring down the rate of natural increase; intensification of agriculture to force the diminishing farm unit to produce more for the increasing population; and diversification of the economy into non-agricultural sectors to

absorb the population and check the influx from rural to urban areas. It is also desirable to reassess the current land tenure system with a view to transferring some more land from ITF to SNL.

Livestock are important on SNL. Over 500,000 cattle are on SNL and only about 100,000 are on ITL, while in 1984 other types of livestock totaled 298,000 goats, 700,000 poultry birds, 30,000 sheep, 15,000 horses, mules and donkeys and 20,000 pigs (FAO, 1985). The cattle average herd size in 1983 was 18.5 but this differed between SNL with 16 head per household and 48 head per farm on ITL. Whereas pastures are improved and grazing is managed on ITL ranches, communal grazing is practiced on poor natural pastures on SNL thus resulting in degradation and serious soil erosion. The average stocking rate in Swaziland, including cattle, sheep, goats and equines is 2.5 ha per livestock unit (LU = 350 kg) with SNL communal grazing areas overgrazed by 50% at 1.9 ha per LU and ITL stocked at 4.5 ha per LU. The stocking rates on SNL differ within the ecological zones with the Highveld with 1.94 ha/LU, Middleveld, 1.33 ha/LU and 2.10 ha/LU in the Lowveld. These stocking rate figures would be much higher if only grazing land on SNL was considered. Estimated carrying capacity per LU is 2.65 for both the Highveld and middleveld, and 4.0 ha for the Lowveld (World Bank, 1977). Besides providing meat, milk, manure, transport and draught power in tilling the soil, cattle are also used as *lobola* (bride-wealth) and are a store of wealth that can provide prestige. They are a form of investment and security for the former and often provide access to credit.

The most significant impact of population pressure on the land resource is degradation and soil erosion. Most of the arable land has slopes of 3-12% with relatively shallow and fragile soils which are subject to severe sheet and gully erosion under the intensive rainfall and farming practices which leaves the soils unprotected for most of the year. But the introduction in the 1950s of mandatory grass contour stripping between fields, contour ploughing, and prohibition of cultivation on or near river banks has greatly reduced erosion on arable land.

Without application of manure or fertilizers however, the soils have become weak and tired with continuos use and this has affected yields adversely. Maize production in Swaziland declined from 110,607 tones in 1978 to 82,760 tones in 1983 due to falling production in SNL small-farms which declined by 36% compared to 48% increase in large scale (ITL) farms in the same period. Maize imports therefore increased from 35,088 to 61,781 tones between 1978 and 1983,

and this represents 43% of the annual national consumption of maize (Ministry of Agriculture, 1984). If the population continues to increase at the present rate, the country will have to import three times the amount of maize presently imported by the year 2000, unless fertilizers and agrochemicals are judiciously applied to increase output without harm to the environment.

One of the more visible impacts of pressure of population on land resources is severe soil erosion due to overstocking on communal grazing in SNL. The stocking density is 1.9 ha/LU which is double the livestock carrying capacity of the land. This has led to pasture depletion, widespread loss of soil due to sheet and gully erosion, bush encroachment, drying up of springs, dam siltation and obviously low animal productivity. The rate of erosion may be as high as 25-35 tons of soil loss per hectare per year as compared to maximum of about three tons per hectare per annum. According to some estimates about 3/8 of the communal grazing land (308,000 ha) has soils with a life expectancy not exceeding 50 years because the stocking rate is less than 2 ha/LU, and the rest of the SNL grazing land has a life expectancy of up to 100 years, that is if the stocking rates and soil erosion are not stopped and reversed (Roder, 1977).

Table 6.1: Pressure of Population and Arable Land in SNL

Ecological	Total A. (ha)	SNL Tt[1] Area(ha)	SNL Arb[1] Area (ha)	SNL 1960	Arb[1] 1971	Lnd 1976	ha/pr 1986[2]
Highveld	502,950	200,362	19,195	0.72	0.27	0.20	0.12
Middleveld	459,750	318,234	45,284	1.11	0.34	0.34	0.21
Lowveld	641,620	352,603	38,085	1.32	0.55	0.41	0.30
Lubombo	132,120	60,295	3,833	0.45	0.24	0.21	0.10
Swaziland	1,736,440	931,494	108,397	1.00	0.36	0.31	0.20

1. Includes cropland, fallow and homestead area on SNL, and considering only rural population.

2. Based own estimates of rural population from 1986 provisional census figures.

2. METHODOLOGY

2.1 The Conceptual Base

The government of Swaziland wants to ensure that there is more rational use of land through a national land use plan project that uses the FAO (1978) agro-ecological zones (AEZ) method to demarcate land units throughout the rural areas and enforce their use according to their assessed suitability (Nkambule, 1988).

The research aimed to use two complementary approaches or models to assess land suitability and the human carrying capacity of land (critical density) which assesses the number of people per given unit of land, and therefore the amount of land required per household to achieve desired objectives. It is not enough to know that a unit of land is suitable for maize production or for grazing. In order to maintain that land in sustainable production it is necessary to know the number of people or households it can support under specific conditions (or assumptions).

i) The agro-ecological zones approach entails the following concepts and variables:

   i) Climatic Resource Inventory including temperature and moisture (rainfall). Potential evaporation and water-balance diagrams can show the length of growing period (LGP) and therefore indicate the types of crops suited to the LGP.

   ii) Soil Resource Inventory for the sample areas was based on the existing 1;125,000 soil map with its local classification of "sets" and "series" which are adequately described to identify the crops suited to such soil units.

   iii) The combination of the climatic and soil information will produce optimal land suitabilities for the identified crops. The FAO-AEZ study has only four classes: very suitable, suitable, marginally suitable, and not suitable for crops, under anticipated crop yields. In the micro application to the sample areas this approach helps to identify land use types that "match" and those that "do not match" the suitabilities identified. It is possible that land tenure arrangements in combination with socio-economic factors of

family labour and prices paid to farmers for crop sales might explain the practice of putting land to uses to which it is not best suited.

b) The second, and complementary approach aims at establishing the maximum number of people a given area can sustain permanently at a given standard of living without deterioration in the land resource.

The concept of critical population density or population carrying capacity of land (Allen, 1965; Brookfield, 1972; Geertz, 1963; Maro, 1975; Newman and Matzke, 1984) is very useful in that not only does it show the "over" or "under-population" when the calculated carrying capacity is compared to the actual population census number of people, but also the required amount of land to meet certain set goals.

This population carrying capacity model uses three sets of variables:

i) Food requirements: the number of calories required per person per annum; the proportion of such requirements contributed by each crop grown; yields per hectare of crops grown; caloric value of crops per unit weight of food prepared for eating. If for example, the caloric requirement per person is fixed at 2000 calories per day and an average family (father, mother and children) has seven persons, the annual food requirement would be 5,110,000 (2000 x 7 x 360) calories per household.

ii) Minimum monetary income per household, derived from yield per hectare, price, and proportion of monetary income each marketed crop contributes.

iii) The area per household for cash crops, food crops and grazing needed to achieve the caloric and monetary requirements set above.

Other assumptions would have to be made concerning how to classify and count areas that practice some form of mixed crop and livestock rearing on the same piece of land. It would be reasonable to count them twice. It is also assumed that the cattle are for meat rather than milk production.

The carrying capacity model can be summarized in the following formula (Maro 1975: 19-21, 43-45):

1. Carrying Capacity $= P_{hh} \dfrac{C_t}{C_{hh} + F_{hh}} + \dfrac{G_t}{G_{1u} \times H_{1 \text{ or } 2}} -$

Where
P_{hh} = number of persons per household
C_t = total area cropped per zone (ha)
C_{hh} = area under cash crops per hh (ha)
F_{hh} = area under food crops per hh (ha)
G_t = total area grazed per zone (ha)
G_{1u} = area for grazing per livestock unit (ha)
H_{1hh} = size of herd for meat production per hh
or H_{2hh} = size of herd for milk production per hh
hh = household (family)

2. $C_{hh} = \sum_{i=1}^{n=4} \dfrac{C_i \times I}{Y_i \times P_i}$

Where
C_{hh} = area under cash crops (per 100 hh)
I = gross annual monetary income per hh
C_i = proportion of income obtained from ith crop
Y_i = yield of ith crop in kg per ha
P_i = price of ith crop per kg

3. $F_{hh} = \sum_{1=1}^{1=3} \dfrac{C_i \times K_t}{Y_i \times K_i}$

Where
F_{hh} = area under food crops (per 100 hh)
C_i = number of calories required
Kt = proportion of requirement met by i-th crop
Y_i = yield of i-th crop in kg per ha
K_i = calories derived form i-th crop

This carrying capacity model is suitable for small area studies for which most of the data is available. But for large areas such as whole big countries massive data and many calculations would be required. The great advantage of the model is that it is dynamic in that it accounts for changes in technology, prices, as well as in yields and introduction of new crops. It can be applied to different time periods for the same area, and can be replicated in any area provided data are available. The only setback with the model is that it depends on the assumptions and constants set, hence these have to be finalized only when some pre-test or cross-checking has been done to ensure that they are realistic to the areas under study.

Both models above describe the ideal conditions, which are rarely obtained in real life. Indeed in the present study it was possible only to work out approximate crop suitability according to the FAO-AEZ method, while scarcity of accurate and reliable data made it impossible to calculate the population carrying capacity of land according to the model outlined above.

However, data obtained from the field interviews gives useful information on both farmer-perceived land suitability for crops and on perceived carrying capacity and land adequacy. This farmer-perception is an important variable in attempts to introduce better land management practices.

2.2 The Sample Areas

Three areas were sampled in different ecological zones namely, Gege in the Southwestern Highveld in Shiselweni district; Zombodze in the Middleveld in Manzini District; and Maphilenga in the Lowveld in Lubombo District (Fig. 1).

Zombodze is situated almost at the centre of Swaziland, a few kilometeres northwest of Manzini city. On the West the area is bordered by the Mdzimba mountain range. Within its area of about 82 km^2, the average altitude is 700 metres above sea level. The area experiences hot wet summers (16 - 26° C) and cool dry winters. Average annual rainfall is 900 mm, which falls in summer between October and March.

The area is generally low-lying and undulating and is drained by several streams, the largest being Mtlane and Usushwana rivers (Fig. 2). Natural vegetation is scattered mainly along the rivers and the rest of the area has man-made and some

exotic vegetation, due to dense human settlement and intensive agricultural land use. The average population density is 200 persons per square kilometre. Most of the people in Zombodze are in-migrants from other parts of the country who have settled permanently or temporarily in the area while the majority of them find employment in Manzini city and Matsapha industrial areas.

Zombodze is under Swazi Nation Land in the Central Rural Development Area which was among the first RDAs to be established in the Kingdom. The RDA has had some impact on agriculture by providing agricultural machinery, extension and advice on agricultural practices, provision of farm inputs and assistance to farmers in selling their agricultural produce.

The area is well provided with health and educational facilities, clean water and good secondary roads, and is increasingly receiving more urban influence.

A variety of crops are grown but maize and vegetables are the dominant crops. Vegetables are sometimes grown under irrigation. Cattle are important but grazing land is becoming increasingly scarce.

Gege area is bordered by the Republic of South Africa in the West, the Mbabane-Nhlangano road in the East and Geogea forest plantation in the South. Seventy per cent of the area is Swazi Nation Land (SNL) and the rest is under private title deed ownership. The total area studied is about 40 square kilometres.

Gege lies between 100 and 1250 metres in altitude in the Highveld region of Swaziland. The climate is humid semi-temperate type with temperatures ranging from -5°C in winter to 23°C in summer. The mean annual rainfall ranges between 1100mm and 2200mm and occurs in the summer especially from October to February. Winters are relatively dry.

Unlike Zombodze which is a receiving area for in-migrants, Gege is characterized by both out-migration particularly of young able-bodied males between 20 and 40 years of age to urban areas, and in-migration from surrounding areas and from South Africa.

Maize is the main subsistence and cash crop grown, but beans, sorghum and potatoes are also grown. Livestock, especially cattle, goats and sheep, are widely raised in the area.

The population density in Gege is high between 150 and 200 per square kilometre, thus natural vegetation is practically non-existent; some of the highland plains are covered with grasses and form part of the communal grazing areas.

The area is provided with schools, health facilities and tap water, and is well connected to the major urban centres in Swaziland.

Maphilenga area lies to the South of Sipophaneni off the main road to BigBend. It is generally a low-lying area less than 500 metres above sea level. It experiences hot summers with mean annual rainfall of 670 mm. Much of the natural vegetation of bushveld sawana, acacia and broad-leaved trees and tall grasses is still found in most of the area.

Smallholder agriculture with cotton and maize as the main crops is expanding as people from other parts of the country continue to settle in the area. Cattle grazing is an important occupation in the area. Unlike Zombodze and Gege areas, Maphilenga area does not seem to suffer from pressure of population as settlements are few and dispersed and there seems to be plenty of unused land.

Social services, schools, health and water facilities are very dispersed and people have to cover greater distances than in the other two sample areas to have access to these services.

In addition to the already noted contrasts in the three sample areas in terms of altitude, rainfall, temperature and settlements, the three areas also differ in terms of soils and agricultural potential. Whereas in Zombodze the soils are generally deep, well developed grey and red sandy and clay loams (regosols, lithosols and ferralitic soil) and generally acidic; in Gege the soils are similar but in some places tend to be shallower than in Zombodze. Slopes also tend to be steeper and degradation and erosion of soil is more evident in Gege than in Zombodze. In Maphilenga the soils tend to be dominated by grey sandy loams which are shallow and only slightly acidic and some rock outcrops are more common than in both Zombodze and Gege.

2.3 Data Collection and Analysis

The main sources of data were from the farmers. A comprehensive questionnaire (see Annex 1) was designed and research assistants were trained on how to administer it after it was pretested on farmers near the University. Using both population and topographic maps, a sampling design was established and then field data collection through questionnaire interviews was conducted from July to mid August 1989 with the assistance of the research assistants in Gege, Maphilenga and Zombodze areas.

It had been planned to interview at least 60 farmers from each of these sample areas and this was almost achieved; 54 farmers were interviewed from Gege area, 58 from Zombodze and 37 from Maphilenga. Compared to the number of households in each of the sampled areas, the number of sampled farmers was adequate.

The size of the sample area for Zombodze covered 1986 population emmeration areas 22131, 22132, 22133, 22134 and 22135 with an estimated 524 households whose total population was 4101 people. For Zombodze the 58 heads of households interviewed represented about 11% of the total number of households. Maphilenga had 123 households within the emmeration areas numbers 43301 and 43141, with a total population of 900 people. The sample size of 37 interviews represented 30% of the households. Gege was covered by emmeration area numbers 31200, 31221, 31222, 31223, 31224 and 31225 with 604 households and a population of 3,700 people. The 54 heads of households interviewed represented 9% of the total number of households within the sample area.

Names of the residents of the sample areas were obtained from their chiefs who were informed and requested in advance to have the farmers available in their homes/farms on the days of interviews.

A simple stratified random sampling procedure was adopted; roads and main paths were selected to provide a reasonable spread within the area (ref. Fig. 2,3 and 4) and generally each other farmer along both sides and inwards from the road/path as far as possible were interviewed. Although farmers were cooperative in answering the questions, some questions, as shown in subsequent sections were not well answered, especially on livestock, income and dietary habits.