

## CHAPTER 1

### INTRODUCTION

#### 1.1 GENERAL

The present systems of land use, land ownership and land management are controversial issues that pose serious challenges to policy making in South Africa. On the other hand the quality of land itself determines both its present and its potential use under improved crop, soil and water management. These determine to a large extent the sustainability of the production potential of land in order to sustain the increasing population in this country. South Africa is poorly endowed with agricultural resources, having only 13% arable land, most of which is very marginal for cropping (Laker, 1993). It is estimated that only 3 percent of the land in South Africa can be considered high potential agricultural land (Schoeman and Scotney, 1987). The arable potential in South Africa is low by world standards and in comparison to some other countries in Southern Africa (Mackenzie, 1994). Most of the soils in this country are very unstable and extremely sensitive to mismanagement, and hence have a big danger of irreversible loss in crop production capacity. This, together with the presence of tremendous spatial variation of these resources complicates even further the development of appropriate land use.

In South Africa aridity is the main factor that determines whether a region is suitable for intensive farming practices or not. About 65 percent of South Africa has an average annual rainfall of less than 500 mm, which is generally considered to be the minimum required for reliable rainfed cropping. Schoeman and Scotney (1987) commented on the marked seasonal fluctuations in the production trends of major crops such as maize, which according to these authors is attributed to the erratic rainfall patterns and poor selection of soil resources. It is estimated that in the Eastern Transvaal (Mpumalanga) some 40 000 ha of high potential land are being utilized for coal mining (CSIR Environmental Services, 1992). Although these areas will eventually be partly reclaimed, potential hazards that are associated with this type of coal mining are large.

On the other hand the growing demand for food requires that the country should assess its production potential. The heart of the challenge is to ensure optimum utilization of available land resources, without causing degradation. According to Hensley, Anderson, Botha, Van Staden, Singels, Prinsloo and Du Toit (2000), land currently cultivated in South Africa can be divided into three categories:

- (i) Good arable land: Sustainable long-term productivity easily possible with a relatively wide range of production techniques.
- (ii) Marginal arable land: Sustainable long-term productivity only possible with specific production techniques efficiently employed.
- (iii) Poor arable land: An acceptable level of sustainable long-term productivity is not possible for a variety of reasons. For example, rainfall too low and /or erratic; water storage capacity of soils too low in relation to rainfall amount and distribution; soils too frequently waterlogged.

Smith (1998) has generated extensive information on the definition and demarcation of high potential land (which falls within the first category), for rainfed annual crop production in South Africa. More than 50% of the Northwest Province, comprising its western and central parts, is on climatic grounds regarded to be marginal for crop production, mainly due to erratic and very unpredictable rainfall. Crops suffer from moisture deficits and drought even during seasons of normal rainfall. Yet, it produces 35 percent of South Africa's maize output, despite the climatic constraints and will continue to produce a large portion of the country's food grain, especially white maize, to feed the expanding population in the years ahead. The natural resource base in this region is highly fragile compared to the sub-humid parts in the eastern side of the province. Farm prices are typically low relative to production costs, and they fluctuate widely depending on the size of the harvest, which in turn is a function of rainfall.

Agriculture generally competes with other economic sectors in the Northwest Province, e.g. mining and quarrying, army bases, tourism (game and wildlife reserves), human settlements and other industrialization structures for land. Given that the demand for food will increase by roughly 3 percent per annum, this will create greater pressure on land resources.

## 1.2 DESCRIPTION OF THE STUDY AREA

The Northwest Province of South Africa is a semi-arid agricultural region with a harsh climate falling into three distinct physiographic zones: Bushveld or Northern Transvaal, north of a line roughly coinciding with the 29<sup>th</sup> Latitude, Highveld south of that line and Southern Steppe to the west of the 26<sup>th</sup> Longitude. The entire province is said to be falling within the most acute desertification risk (Land and Agriculture Policy Centre, 1995). The average annual precipitation ranges from about 250 mm in the west to 700 mm in the east. The rain season lasts from October to March, with the peak of the rain season being February or March in the Southern steppe climatic region and January in the remainder of the province. Rainfall normally occurs in the form of showers and thunderstorms. Hail is sometimes associated with the thunderstorms and can cause severe damage to crops.

Sunshine hours vary from 70% of the potential maximum in the west to 85% in the east. In January the average daily maximum temperature varies from 33°C in the west to 27°C in the east and 32°C in the northeastern part. The daily minimum temperatures in the areas in January vary from 15 to 13 and 18°C respectively. The daily maximum temperatures during July vary from 17°C in the southern part of the province to 22°C in the northern Transvaal climatic region. The daily minimum temperatures vary from 0°C to 4°C in July. The greater part of the province is frost free, except for only six districts with the following recorded average number of frost days per annum: Christiana 47, Delareyville 60, Lichtenburg 58, Marico 33, Potchefstroom 48, Ventersdorp 54 days. The period within which frost can be expected lasts for about 100 days (June to August) in the west and 120 days (May to September) in the east. In the northern Transvaal region, frost occurs from June to August. Winds are usually northwesterly, attaining their maximum speed in the

afternoon. During thunderstorms strong winds and dusty southwesterly winds of short duration are a common feature. In the northern Transvaal climatic region however, winds are mainly light to moderate and blow from the northeast except for short periods during thunderstorms (Land and Agriculture Policy Centre, 1995). The larger part of the province has even and flat topography. Soil loss is mainly by wind erosion. Water erosion is limited to areas with steep slopes. About 53% (805,000 ha) of the ploughed fields in the province are susceptible to surface soil erosion, mainly wind erosion. Only a small proportion of potential arable lands are suitable for cash cropping, while the rest is suitable for pastures only. The largest part of the province is suitable for extensive grazing only.

## 1.2 MOTIVATION AND STUDY OBJECTIVES

### 1.3 CROP PRODUCTION SYSTEMS IN THE NORTHWEST PROVINCE

This study focuses on the “non-ideal”, low rainfall region of the Northwest Province. The most difficult situation facing farmers is the fact that there is a relatively small difference between yield and production costs especially during “bad” seasons. Farmers in this region who aim at a low to medium risk scenario will manage their crop such that during a “bad” (below average rainfall) season they can at least reach the point where they can recover the input costs or “break even”. In a good (above average rainfall) season the yield obtained can exceed 3 tons per ha. This explains why this region would rather be regarded as “non-ideal” rather than unsuitable for crop production, especially with adapted crops and cultivars. The lower limit of these “non-ideal”, moderate potential regions would be at an annual rainfall of approximately 450 mm, with high potential soils and appropriate management strategies.

Most of the farmers in the region of the Northwest Province receiving less than 500 mm mean annual rainfall (MAR) contend that, considering their low input level and low planting densities, a maximum economic yield of 1.5 tons of maize per ha is an appropriate target for a bad season. In a good rain season they normally get more than 3 ton per ha even with low inputs and planting densities. It can go up to over 4 tons per ha in a good year with higher inputs, but then it has a high risk. Therefore one would come to a conclusion that marginal land for maize production in this context is

that which can maintain economic yield (1.5 tons per ha) at least 70% of the time, under specified climatic conditions as well as management practices. The latter include low plant density, appropriate planting dates and fertiliser application, improved cultivation techniques and other technological inputs such as adapted cultivars, weed and pest control. It follows suit that land that cannot maintain economic production as described here would be regarded as unsuitable for maize production. The following chapters explore a quantitative method to assess the crop production potential of marginal land in this region. As mentioned earlier, this is vital for risk management in fragile ecosystems.

#### 1.4 MOTIVATION AND STUDY OBJECTIVES

The typical production situation in dryland areas, of low inputs, outputs and marketing channels as described by Day, Butcher and Hughes (1990) is true for the Northwest Province. The unpredictable rainfall is the most serious difficulty facing the farmers. Farmers cannot be certain when the first rains will occur or when there will be sufficient moisture in the soil for land preparation, planting and seed germination. They cannot be sure of the amount of rain they will receive for the season nor its distribution throughout the season. Coping with the rainfall situation is a fundamental concern to these farmers. Hence the objective of this study was to find ways to help the farmers have a technique to assist them in their decision-making. Failure of crops due to drought may be expected in one out of seven years for the country as a whole (Cooper (1990), cited by Land and Agriculture Policy Centre (1995)). The probability of drought occurring in marginal areas is said to be higher than 40% (Land and Agriculture Policy Centre, 1995). The use of different methodologies aimed at quantifying the risks that the farmers in these fragile ecosystems are faced with could be a major breakthrough. The development of more accurate estimates of the impact of improved resource management, e.g. by better integration of soils, climate, agronomic and economic information, will also lead to improved economic livelihood of farmers in the sub-optimal regions.

Of the total area of 11 904 351 ha of the Northwest Province, 23.7 percent is arable (Mackenzie, 1994). Considering the fact that arable land is a scarce factor of

production in this part of the country, the sustainable use of such land is of prime importance. This will ensure sustainable food security for the population at large and most importantly, income security for those on the land. The scope for improving crop production is determined by the physical constraints of soils, climate and by the resources available to the farmers and their ability to utilize them effectively. Land evaluation techniques can be used to assess actual and potential land performance for arable farming (Bekker, Kristensen and Radcliffe, 1994). Under marginal conditions, such as due to interannual variability of rainfall, a conventional method of land evaluation resulting in qualitative land suitability classes is of limited value. Therefore a quantitative method, which uses actual rainfall data for individual years, is required (Bekker *et al.*, 1994).

Owing to the fact that the Northwest Province produces 35 percent of the country's maize, there is a need to quantify the risks associated with maize production in this climatically marginal region. This would therefore serve as the basis for sustainable land management alternatives for arable land use. Further, such quantification would lead to proper definition of what is meant by moderately suitable, marginally suitable and unsuitable land for maize production. Ideally, the question of sustainability and economic viability of maize production systems applicable in such areas would be the central issues of concern.

The main objectives of the study were as follows:

- Evaluation and use of the Crop Yield Simulation And Land Assessment Model for Botswana (CYSLAMB) model to quantify maize production potential in the Northwest Province.
- To describe and /or develop a procedure to determine the maize yield production potential of the climatically marginal land of the Northwest Province.
- To give a contextual definition of marginal land.