

## CHAPTER 5

### CONCLUSION AND RECOMMENDATIONS

The review of literature revealed that the production systems and potential in the marginal and sub-optimal areas in South Africa have not been thoroughly investigated. Consequently, most of the production technologies applied in these areas are directly imported from the high potential areas and are therefore inappropriate. In South Africa most of these areas contribute a lot to agricultural production, especially dryland maize production, and such neglect usually led to mismanagement and ultimately degradation of these important yet fragile ecosystems. In marginal production areas of South Africa, production is not only limited by agro-ecological characteristics of land but the farmer's circumstances also play a major role. The impact of changes in input level or management operations on crop yields becomes more important in land suitability evaluation, especially if production is carried out close to the margins of ecological suitability.

Successful crop production under marginal climatic conditions in the study area also largely depends on soil water characteristics; the way soils take up and store rainwater, the water holding capacity of the solum as well as the underlying layers. The role of underlying layers in impeding drainage beyond crop rooting depth is also of paramount importance. For example soils in the study area with soft plinthic horizons or soft carbonate subsoil have exceptionally good soil climates and normally have high agricultural production potential specifically for rainfed crop production. It has been documented that such soils increase the probability of sustained high maize yields, especially in these dryer areas. There is a need to quantify the contribution of these deeper horizons to meet the water needs of the crops.

The importance of qualitative and economic land evaluation in order to bring about an understanding of the relationships between the conditions of the land and the

manner in which it can be utilized to ensure sustainability can never be over-emphasized. This is especially true if the outputs from such evaluations can be well understood and used as management tools by the land users. Simulation models have been developed and successfully applied in land evaluation. Summary mechanistic models have been documented to be the most realistic and practical tools for land evaluation, especially if such models are properly calibrated and validated to suit the local conditions. A valuable property of crop models is their ability to utilise long-term climate data to provide long-term yield simulations, which can serve to evaluate the interannual yield variability and quantification of risk in the specification of land suitability (De Wit *et al*, 1993). Further, simulation models enable the modification and evaluation of input and management specifications of the production system to ensure appropriate extension and land use recommendations.

The results from the evaluation of the CYSLAMB model for the climatically marginal areas of the Northwest Province showed that the model has reasonably good applicability in the study area as it provided the yield estimates within acceptable levels of accuracy, which is fundamental to agricultural land evaluation. The simulated grain yield showed good agreement with observed values ( $R^2 = 0.95(t)$  and  $=0.85(p)$ ). Due to the erratic nature of rainfall, the extreme seasonal yield fluctuation is the typical situation that the maize producers in the study area are faced with. Lower plant densities as well as low input levels are amongst the management strategies applied by the farmers in the area to ensure efficient moisture use and yet aim to achieve maximum profit. The model seemed to cope reasonably well with these situations. However the simulations based on the individual crop development stages, i.e., yield(p), tended to over-predict the yield during dryer seasons whilst underestimating the yield in wet seasons whilst the yield(t) based on total crop growth period gave results that are much closer to the observed. Amongst the factors in the model causing this situation is that at yield(p) the effect of moisture stress is considered according to the sensitivity of maize at a particular stage of growth. In which case, should the stress occur more during a stage when maize is more sensitive to moisture stress conditions, then the negative impact on yield will



be stronger accordingly. With the yield(t) simulations the impact of moisture stress is spread over the whole period which tends to marginalize the impact that moisture stress would have if it were to occur during the most sensitive stages of crop growth.

Besides the good results obtained during this evaluation, this model can be quite useful in the sense that it operates with commonly available inputs and non-specialists can easily understand its user-defined parameters. However the soil moisture balance sub-routine of the model has not been validated for South African conditions especially in the light of the existence of the unique soil characteristics that contribute a lot to dryland agriculture in climatically marginal areas. It would therefore be desirable if the model could be calibrated to also cater for such exceptions and also include other factors such as the impact of soil moisture carried over from one season to the next in its moisture balance calculations. A soil moisture budget model, which takes account of the carryover of soil moisture from one season to the next, could give reliable yield predictions for different planting dates as well as different soil water holding capacities. The management system employed in crop production is also very important. Choosing the appropriate planting dates for instance revealed a substantial difference in yield potential in the study area. The results showed that planting should be delayed in order to allow flowering to commence after the expected mid-summer drought. However, due to great fluctuation in annual precipitation and distribution, no strict adherence is encouraged to the suggested planting dates in this report. But, should adequate rain occur for planting, it is very important to determine what conditions can be expected later on in the season if the particular precipitation is used for planting. A decision can thus be made on whether planting should occur or be delayed.

Results obtained from the plant population simulations showed that when water was limiting, yield potential peaked at a distinct optimum density of 14000 plants.ha<sup>-1</sup> and declined at higher densities. As water became more abundant during wet seasons, higher yields were simulated at higher plant densities. The production risks associated with dryland maize production in this area can be minimized by choosing the appropriate management systems to ensure that the farmer is able to get a fair

yield during good seasons and also “break-even” during below average seasons. Ideally the most convenient approach if it were possible for the maize farmers in the marginal land is to plan differently for a dry cycle than wet cycle, thereby reconsidering factors such as mentioned in this study, viz: planting dates, plant populations, target yields, associated production practices and possible non-utilization of certain marginal soils as also suggested by Du Pisani (1985).

The importance of tillage systems that contribute to minimizing the soil moisture stress can never be overemphasized. An example of such system is fallowing, by means of which water from a previous rain season is stored in the soil to supplement the rain falling during the cropping season. In a classical 27-year study in an area with only 400mm per annum average rainfall in the USA Smika (1970) compared a wheat-fallow system with continuous wheat. In the continuous wheat system 10 out of the 27 years had complete crop failures, while no crop failures occurred with the wheat-fallow system. Average yields, calculated back to a per year basis was nearly double for the wheat-fallow system than with the continuous wheat. Other highly desirable tillage systems are those that will, amongst other things, enhance water infiltration, suppress subsequent evaporation, reduce run-off rates and eliminate soil layers that restrict root penetration into deeper soil layers where water is stored.