EXECUTIVE SUMMARY

Natural resources should be managed in a responsible way to ensure sustainable production of food, feed and other crops. In South Africa, before 1988, little was known on the water requirements of planted pastures. Applicable norms for irrigation scheduling were not in place and this resulted in ineffective use of irrigation water. To obtain a better idea of planted pasture water use, a project was started in 1988 with temperate fodder crops followed by tropical and subtropical fodder crops in 1993. This study was made possible with financial aid from the Water Research Commission.

The objectives of this project were to compare different pastures to determine if a single set of irrigation guidelines could be used for all pastures; to determine the water production functions as a tool to determine the economic optimum irrigation level for the different crops and to identify alternative crops, best suited for dryland and irrigation conditions.

The water use of five annual subtropical crops was determined in two consecutive seasons in a trial conducted under a rain-shelter on the Hatfield Experimental Farm of the University of Pretoria, Pretoria. The crops used were soybean, cowpeas, maize, fodder sorghum and pearl millet. Each crop was subjected to four irrigation levels, ranging from a stressed (W1) to a well watered control (W4).

Maize had the highest yield potential under control (W4) conditions to moderate

water stress (W2 and W3), but under severely stressed conditions (W1) fodder sorghum and pearl millet tended to have the highest yields. This might be ascribed to the better drought tolerance of the latter crops. Where water is not a limiting factor, the production of maize can be recommended, but where water is limiting, pearl millet or fodder sorghum might be a better choice.

The legumes gave the lowest yields for all four irrigation treatments in both seasons. Soybean had a higher yield than cowpeas at all four irrigation levels. These low production figures may, at first glance, make the viability of legume production questionable. It is, however, very important to evaluate crops in terms of both quantity and quality, before discarding one or more as inferior.

The crude protein content of legumes, especially cowpeas (18%), was relatively high in comparison with grasses (average of 8.4%). From the literature it has been concluded that the presence of plant protein in animal diets can result in a more efficient use of non-protein nitrogen sources (NPN), such as urea. There were, however, no advantages in using animal protein rather than plant protein. With the production of plant proteins, the farmer has the additional advantage of carbohydrates, which are not available in either NPN or animal protein. Where livestock farmers need a protein source for the optimal utilisation of a low quality forage, the planting of legumes can, therefore, be recommended, despite a relatively low yield potential.

There were no significant differences in digestibility between cowpeas, pearl millet,

fodder sorghum and soybeans, although maize was the most digestible. The high digestibility of maize can be attributed to the large proportion of grain in the total yield.

Dry matter water use efficiency (WUE_{DM}) of maize was the highest for all the crops in both seasons, while that of cowpeas was the lowest. From the yield data it could not be ascertained whether pearl millet or fodder sorghum was the more drought tolerant. With the aid of WUE_{DM} data, however, this became more apparent. Pearl millet had a better WUE_{DM} at all irrigation levels. Under severe stress (W1) pearl millet had a markedly better WUE_{DM} than fodder sorghum. It may, therefore, be concluded that pearl millet would be a better choice under severe stress conditions than fodder sorghum, and definitely a better choice than maize. From a comparison between the WUE_{DM} of soybean and cowpeas, one might expect soybeans to do better than cowpeas in drought conditions.

Also of importance is the influence of irrigation level on the WUE_{DM} of the crops. Although there was only a significant interaction in the 1994/95 season, water was used more efficiently at the W1 and W2 irrigation levels than under well watered conditions.

Water use efficiency was also given in terms of digestible dry matter (WUE_{DDM}) and crude protein dry matter yield (WUE_{CP}). As could be expected, the WUE_{DDM} followed much the same trend as that of WUE_{DM}. In the case of WUE_{CP} , the legumes used water far more efficiently than in terms of dry matter or digestible dry matter than

the grasses.

From the information gathered during this trial, it was evident that all five annuals have the potential to develop a deep root system (between 800 and 1 200 mm) when deficit irrigation treatments (W1, W2 and W3) are applied. Using deficit irrigation also resulted to higher water use efficiencies. Following the W1 irrigation level can not, however, be advised, due to the marked reduction of yield. Following a W2 and W3 irrigation regime could, however, save water without compromising yield too much . These irrigation regimes can, however, not be followed without knowing the soil water content. Usage of tensiometers, neutron probes and other instruments together with climatic data should, therefore, form the basis of decision making.

This study was conducted on a relatively small scale and did not include different cultivars, soil types, irrigation systems and climatic conditions. These variables influence evaporation, transpiration, drought tolerance and ultimately the quantity and quality of product produced. This emphasizes the importance of scheduling methods, including models, to take advantage of available water.

Maize should rather be planted under conditions where water is not limiting, while fodder sorghum and pearl millet are better choices where fodder is being produced in areas where limited water is available. Soybeans should rather be cultivated under the same conditions as maize, although they do not give the same yields. For a good quality feed, both highly digestible and protein rich fodder is needed.

Combining one of the grasses and soybean should thus give excellent results. Cowpeas, on the other hand, used the least water in both years, but also gave the lowest yields. The crude protein content of this crop, however, surpasses that of the other crops evaluated and should be kept in mind when protein need, rather than energy, is of major importance.

According to an economic analysis, done with the IrriCost and FARMS models by Prof Meiring and Mr Botha, it is more expensive, in terms of specified cost per ton dry matter as well as millimetre water, to produce any of the five crops under severe drought (W1) than control (W4) conditions. The assumption was, however, made that none of the treatments would receive any rain in an on-farm situation, but that all the water would be supplied through the irrigation system. This assumption was made to make extrapolation of this data possible.

The cash flow closing balance (R ha^{-1}) is negative for all the treatments due to a zero starting balance. Despite this, the cash flows for the severely water stressed treatments (W1) were better than that of the control (W4).