Productivity of maize-bean intercropping in a semi-arid region of South Africa

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Abstract

Food shortage is known to have been caused by overpopulation, natural disasters and poor food distribution. In areas facing food insecurity, such as Africa, peasants or small-scale farmers have practised intercropping since old times. In this study, an investigation was carried out to determine whether intercropping increased production for small-scale farming in a semi-arid region (Free State, South Africa). Crop productivity of maize and bean intercropping systems was evaluated in terms of crop yield and growth. The effect of radiation and water utilisation by these systems was measured to determine their productivity. Field trials were carried out during three summer crop growing seasons (plant densities, row orientation and sowing date trials. In all growing seasons, rainfall was below normal, and air temperatures were normal. The total land equivalent ratios for yield and growth ranged between 1.06 to 1.58 and 1.38 to 1.86 respectively, showing yield and growth advantage of intercropping. Concerning radiation and water use, the intercropping of maize and beans had both radiation and water use efficiencies (RUE and WUE, respectively) as high as maize sole cropping, and intercropping RUE and WUE were greater than bean sole cropping. From these results, it has been concluded that maize-bean intercropping can be recommended to small-scale farmers in this semi-arid region.

Keywords: intercropping, land equivalent ratio, *Phaseolus vulgaris*, radiation use efficiency, water-use efficiency, *Zea mays*

Introduction

Over-population, natural disasters and food distribution and low food production are causes of food insecurity in Africa as well as other developing countries. Most African farmers are small-scale farmers. According to an FAO Report on the State of Food Insecurity in the World 2000 (FAO, 2000), about 800 million people in the developing countries do not have sufficient food. In Southern Africa, large populations are malnourished as well. The bulk of these populations reside in rural areas, with large numbers experiencing food insecurity (Van Rooyen and Sigwele, 1998). In these areas, small-scale farming plays an important role in food security. Food insecurity is increased by adverse weather conditions and droughts throughout Southern Africa. Variable rainfall is characteristic in Southern Africa, with annual rainfall varying from 100 mm in the arid zones to 1 500 mm in the humid zones (Le Houérou et al., 1993). This results in high variation in the potential of natural resource-based farming. Specifically, seasonally erratic rainfall and sandy soils cause low production in many areas.

The improvement of crop productivity is the common aim of farmers and agriculturists. The key to sustainable agriculture probably lies in increased output per unit area together with arable land expansion. In terms of cropping systems, the solutions may not only involve the mechanised rotational mono-culture cropping systems used in developed countries such as North America and Western Europe, but also the poly-culture cropping system traditionally used in developing countries such as Africa and Latin America (Francis and Adipala, 1994). The main reason for using a multiple cropping system is the fact that it involves integrating crops using space and labour more efficiently (Baldy and Stigter, 1997). Biophysical reasons include better utilisation of environmental factors, greater yield stability in variable environments and soil conservation practices. Socio-economic reasons include the magnitude of inputs and outputs and their contribution to the stabilisation of household food supply (Beets, 1982).

Intercropping, which is one type of multiple cropping system, has been practised traditionally by small-scale farmers in the tropics. In particular, cereal and legume intercropping is recognised as a common cropping system throughout tropical developing countries (Ofori and Stern, 1987). Typically, cereal crops such as maize (*Zea mays*), millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) are dominant crop/plant species, whereas legume crops such as beans (*Phaseolus vulgaris*), cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogaea*), pigeonpea (*Cajanus cajan*) and soybean (*Glycine max*) are the associated plant species. Generally, in Southern Africa, maize and beans are staple and supplementary crops respectively. Canopy structures and root systems of cereal crops are generally different from those of legume crops. The formative rate is comparatively greater in cereal crops than in legume crops. In cereal-legume intercropping, cereal crops form relatively higher canopy structures than legume crops and the roots of cereal crops grow to a greater depth than those of legume crops. This indicates that the component crops probably have differing spatial and temporal use of environmental resources such as radiation, water and nutrients (Willey, 1990). Therefore, this cropping system may help improve productivity of low external input farming, which depends largely on natural resources such as rainfall and soil fertility.

In developed countries, agricultural scientists, consultants and extension officers usually provide timely and proper meteorological information to farmers, but on-farm advisories in Africa are lacking (Stigter and Weiss, 1986). Small-scale farmers have practised traditional cropping techniques, such as intercropping, in

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