A SYSTEMS ANALYSIS APPROACH TO DEVELOPING CROPPING SYSTEMS IN THE SEMI-ARID TROPICS

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ABSTRACT

The semi-arid tropics (SAT) are characterized by a high climatic water demand. The mean annual temperature is greater than 18°C and rainfall exceeds evapotranspiration for only 2 to 4½ months in the dry and 4½ to 7 months in wet/dry SAT. The coefficient of variability of rainfall ranges from 20 to 30 percent. Alfisols and Vertisols are two major soil types found in these areas.

The interdisciplinary farming systems research team at ICRISAT aims to develop basic principles, approaches, and methodologies that can be readily used in alternative, economically viable farming systems in the seasonally dry SAT. Dry-seeding technology on deep Vertisols for double cropping, a small watershed concept for land and water management, and the broadbed-and-furrow system are a few of the technologies developed so far for increased crop production. The simulation technique will be useful to integrate in a holistic way all aspects of operational-scale systems research being carried out in ICRISAT watershed units. The process-based dynamic models of crop production system involving soil, crop, weather, and management data will also be valuable as research tools for analyzing the usefulness of prospective technologies across locations. Preliminary results obtained from a sorghum growth model indicate that under a given set of climatic conditions the analyses could assist in the selection of crop genotypes in relation to the amount of water available in the soil profile at seeding and to the runoff collection available in the reservoirs. Since soil types and rainfall patterns in the SAT show considerable location specificity, such analyses will assist considerably in deriving estimates of the crop growing periods and suitable cropping systems.

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INTRODUCTION

A farming system is based on complicated interactions of several physical, biological, and socio-economic factors that include climate, soil, crops, etc. A suitable farming system is therefore unique for a locale and differs from place to place according to available resources, the state of development of these resources, the methods of production, and the crop(s) grown. Farming systems research should therefore be conducted with a recognition of and a focus towards the interdependencies and interrelationships that exist between elements of the farming systems, and between these elements and the farm environment.

The task of improving farming systems in the semi-arid tropics (SAT)[1/] is complicated by the presence of several constraints in these areas. These include intensive rainfall interspersed with unpredictable droughts, a relatively short rainy season, highly variable rainfall during the rainy season, high evapotranspiration rates throughout the growing season, low soil organic matter content, low infiltration capacity of soils, great water erosion hazard, small farms with fragmented holdings, limited capital resources, severe unemployment during the long dry season, etc. Because of these constraints and the ever-present risk of drought (or flood), farmers are reluctant to invest in high yielding varieties, fertilizers, and other inputs even when available. Thus unstable food production

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[1/] The SAT are characterized by a mean annual temperature greater than 18°C and rainfall that exceeds evapotranspiration for only 2 to 4½ months in the dry and 4½ to 7 months in wet/dry SAT (Troll 1965).