CHAPTER I

INTRODUCTION

The productivity of a soil in response to the levels of water and fertilizer nitrogen, the master inputs for intensifying agricultural production, can be realistically assessed by predicting the performance and behaviour of soils based on matching the requirements for efficient use of water and fertilizer nitrogen by a crop to the relevant characteristics of the soil. The mismatches that often crop up in these predictions, result generally from spatial variability of the soil. The users of the soil resources must therefore, document the magnitude and form of soil variability and accommodate their existence in the models of soil-water-nutrient availability and crop productivity.

Efficient management of water and fertilizer nitrogen in cropped fields essentially requires reliable estimate of their field balances as affected by the retention and flow processes. Earlier studies on the movement of water and solute under field conditions have demonstrated that accurate estimation of the fluxes must consider spatial variation in soil physical, chemical and biological processes that affect water and solute distribution in soil (Wagenet, 1984). The major hurdle to the quantification of the flow processes of water and solute has been identified in spatial variability of soil water and solute characteristics as well as their transmission functions (Warrick and Nielsen, 1980). Spatial variability of plant available water is a specific important factor that affects crop yield (Warrick and Gardner, 1983; Bresler and Dagan, 1988). The variability in water availability is in turn dependent on the variability of soil physical properties, nature of water application as well as on other sources of field variability such as climate and genetic factors. Similarly, heterogeneity in the levels of fertilizer nitrogen in soil results from variability of chemical and physical soil characteristics, native and residual nitrogen, fertilizer application pattern and transformation processes affecting its plant uptake and soil losses. Spatial variability in the total soil nitrogen pool is generally reflected in the variability of available nitrogen pool which, in turn affects the variability of the use of fertilizer nitrogen by crop plants (Ledgard et al., 1984). The variability of water and fertilizer nitrogen in cropped fields can be expressed in terms of the variability or in terms of responses of plants growing on soil (Bresler et al., 1981). There has been a little development in the sampling technology that can take care of spatial variability of water and fertilizer nitrogen in the cropped fields.

The spatial variability of soil properties as well as of water and solute transport have generally been studied using classical statistical methods, such as analysis of variance which provides a measure of the variability across the field and number of samples required to estimate the mean value within some specified confidence interval from the frequency distribution of the sample. The use of this technique assumes that the observations in the field are independent of one another regardless of their location. However, there is a significant body of literature (Warrick and Nielsen, 1980; Nielsen and Alemi, 1989) which strongly advocates that the values of soil properties particularly the physical properties are not independent of each other. There is some degree of dependency between sample values which is a function of distance between them (Vieira et al., 1981; Hajrasuliha et al., 1980). Generally the samples taken close together are more alike than samples taken at greater distances. Thus, classical methods are inadequate for interpolation of spatially dependable variables. However, the recent advances in geostatistics have taken care of the spatial dependency of soil properties. Webster and Caunalo (1975) have used a time series method to compute correlograms for expressing the spatial dependence of the sample values measured at equal distance along the transact. Autocorrelograms and semivariograms are commonly used to assess the spatial dependence of the soil properties and to determine the maximum sampling interval for which the sample values remain correlated.

The phenomenon of spatial variability is of great significance to upland rice soils. Large differences in the yields of crops have generally been observed on the uplands of the lateritic tract of West Bengal. These variations are largely attributed to the genetic variability of the soils. The intrinsic variability of these upland rice soils are further complicated by the nonuniform moisture regimes that vary the sequence and cycles of oxidized and reduced soil layers affecting the transformation and leaching of applied fertilizer nitrogen under rainfed rice. Yield variability of post monsoon winter crops in a field with uniform cultivation, irrigation and other management practices is however, mainly attributable to the variability in soil properties. Thus, the spatial distribution in crop yield is determined by irrigation induced soil water variability as well as by other random effects due to variation in intrinsic properties, tillage effects and residual effects of water and fertilizer nutrients.

A little is known about the spatial variability of soil water and applied fertilizer nitrogen in upland rice soils. An assessment of this variability would greatly help decide the management criteria for fertilizer nitrogen under rainfed rice as well as of water and fertilizer nitrogen under irrigated wheat. It will also help characterize the variability in leaching behaviour of the soil. A knowledge of the spatial structure of soil water and fertilizer nitrogen may help reduce the need for large sampling that would have required otherwise and provide experimental means for studying its effect on irrigation decisions and resulting variability in crop yields. With these in view a controlled field investigation of spatial variability was undertaken on a lateritic sandy loam soil to meet the following objectives:

i) to evaluate the spatial variability of soil physical properties affecting retention and movement of water and fertilizer nitrogen.

ii) to quantify the spatial variability of water and fertilizer nitrogen distribution at different growth stages under rainfed upland rice and irrigated wheat, and

iii) to assess the spatial variability of growth and yield of rice and wheat crops in response to the variability of soil water and fertilizer nitrogen distribution.