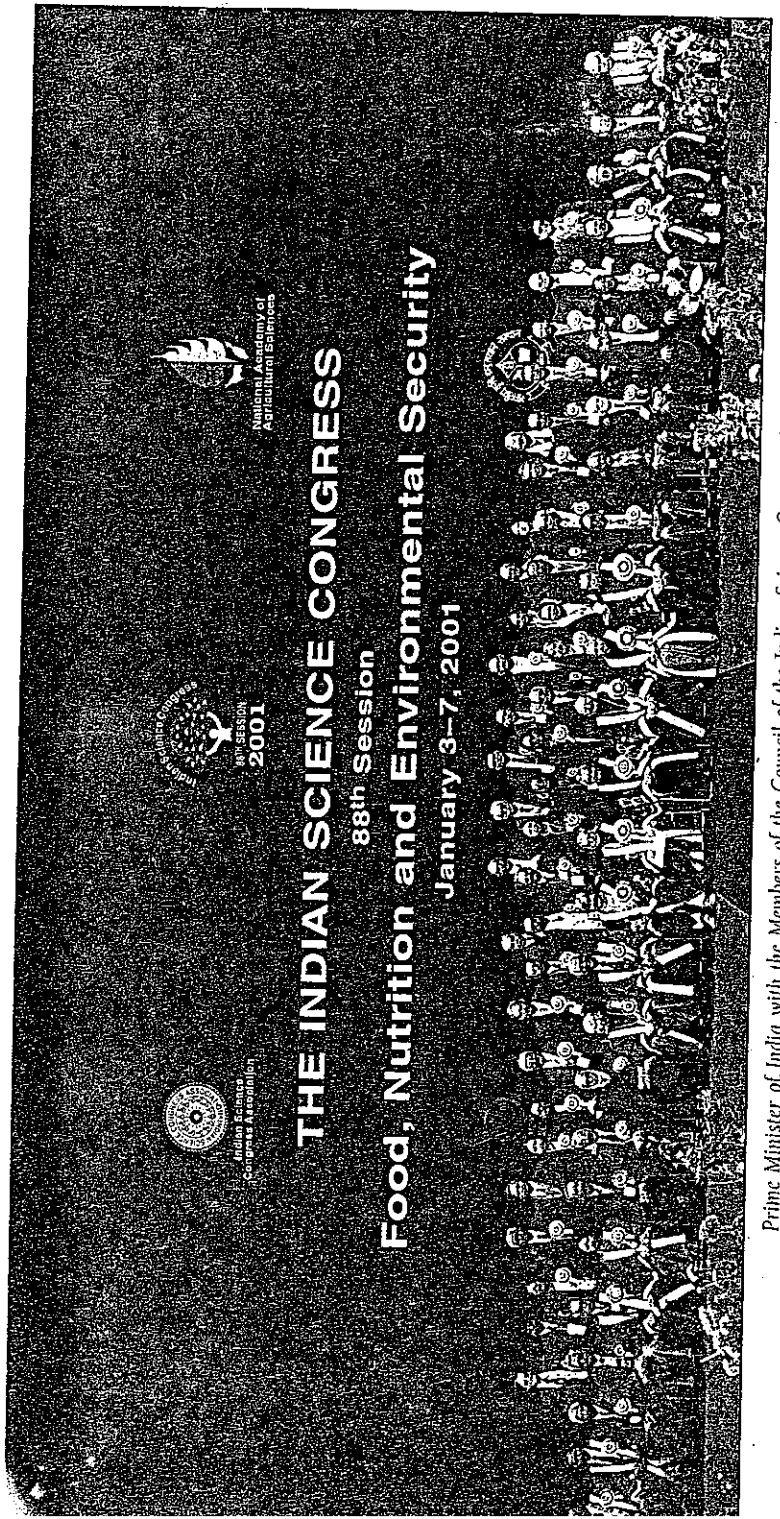

Prime Minister of India with the Members of the Council of the Indian Science Congress Association

TOWARDS FOOD SECURE INDIA

PROCEEDINGS OF THE
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SOIL: A VALUABLE NATURAL RESOURCE TO BE NURTURED FOR OUR SUSTENANCE

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Soil is not merely a medium which provides physical support for plant growth but it is one of the most vital and precious natural resources for the existence of humankind. Soil is a habitat for a vast complex and interactive community of soil organisms whose activities largely determine its chemical and physical properties. Soil is not a renewable resource in the short term and has been formed over thousands of years. If not cared and nurtured, this valuable resource can become unproductive in a short period. Asia is the home of 3 billion people of whom 788 million are poor, and unable to meet minimum standards of health and nutrition. Ever increasing population, growing incomes and changing food habits are placing increasing demands on food quality and quantity. Limited land resources are strained to produce more and more, thereby causing degradation of natural resources resulting in decreased productivity (Eswaran *et al.*, 1999).

Alfisols and Vertisols are the two major soil types of the semi-arid tropics (SAT) and together occupy 68% of the soils in SAT of Asia. Water is one of the key constraints to sustainable agriculture. If not managed properly, it reduces crop productivity and also causes land degradation through runoff and soil erosion. SAT soils are also nutrient poor, low in organic matter content, have poor structure, and are prone to severe degradation. Inappropriate soil, water and nutrient management (SWNM) practices, low adoption of improved varieties, and lack of appropriate pest and disease management result in unsustainable crop yields and degradation of the natural resource base. Water erosion is the major cause of land degradation in Asia. Of the 173.3 million tonnes of sediments discharged into the

sea by soil erosion, half is contributed by Asia. The whole process not only impoverishes the parent soil but the mineralization of particulate and soil organic carbon becomes a degradation-induced source of carbon emission causing unpredictable climatic repercussions.

Through integrated natural resource management (INRM) we can achieve the goal of increasing productivity and reducing poverty while maintaining natural resources. As much as 70% of rainfall in the SAT is lost as runoff, all too often carrying with it significant quantities of soil. If this rainwater were better managed, runoff could be controlled in order to decrease erosion and increase soil moisture levels and excess runoff could be channelled and harvested for later use. ICRISAT's INRM strategy for the Asian SAT is to focus on developing rainfed agriculture through better water harvesting and management in community watersheds and crop diversification by introducing legumes into cereal systems. New tools and approaches for sustaining production are used in INRM, for example, simulation models assist in estimating the agroecological potential, yield gap and probable constraints for sustaining productivity.

Integrated watershed management of these Vertisols sustained productivity, improved the soil quality and also sequestered 335 kg C ha^{-1} yr^{-1}. Over a 10 year period, if such soil quality is enhanced it is possible to capture 0.5 gigatonnes of C in the total Vertisols of the SAT (Wani *et al.*, unpublished data). This process will help to alleviate the C emission and accompanying global warming process. Integrated watershed management of Vertisols also increased grain productivity (4.7 vs 0.9 t ha^{-1}), increased rainwater use efficiency (67 vs 30%); decreased runoff and deep percolation (33 vs 70%), and reduced soil loss (1.5 vs 6.4 t ha^{-1}). The carrying capacity was increased from 4–18 persons ha^{-1} (Wani *et al.*, 2000).

Crop diversification is a recommended option to sustain the productivity of cereal-based systems. Legumes add to income generation along with improvement in soil fertility. Legumes are rich sources of protein and they play a significant role in vegetarian diets by improving nutrition (Peoples and Crasswell, 1992). The beneficial effects of legumes in sustaining productivity and environmental protection through diversification of cereal-based systems must be explored fully. Integrated nutrient management is a key component of INRM. Inappropriate use of chemical nitrogenous fertilizers contaminates surface water bodies and groundwater with nitrates, posing environmental and health hazards.

Legume yields can be improved through appropriate nutrient amendments or simple seed treatments such as priming. For example, boron (B) deficiency is a major yield constraint to chickpea and lentil in many parts of Nepal, India, and Bangladesh. B deficiency symptoms are often confused with the symptoms of botrytis gray mold of chickpea. However in partnership with Nepal, the problem has been resolved and farmers now harvest 42–92% higher yields through 1 kg B ha^{-1} application. In the Barind area of Bangladesh, chickpea following paddy does not establish itself well, and has low yields. In partnership with ADB, DFID and Bangladesh, simple seed priming (soaking seeds 8 hours prior to sowing) technology was evaluated. Increased grain yields of 47% were observed in 100 on-farm trials in Bangladesh.

Future challenges include the development of efficient and sustainable soil and water use innovations to tackle diminishing arable land per capita, and the water scarcity situation. More efficient farm management systems, drought tolerant varieties, and simulation modelling for increased resource use efficiency will be needed. New science-based improved approaches are needed for developing crops/varieties with higher water and nutrient use efficiency. ICRISAT seeks to share its comparative advantage in doing research in the Asian SAT as a Bridge – fostering north-south and south-south exchanges of technologies and information; as a Broker-helping stakeholders find win-win solutions; and as a Catalyst – convening international initiatives built on striving for excellence in science.

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