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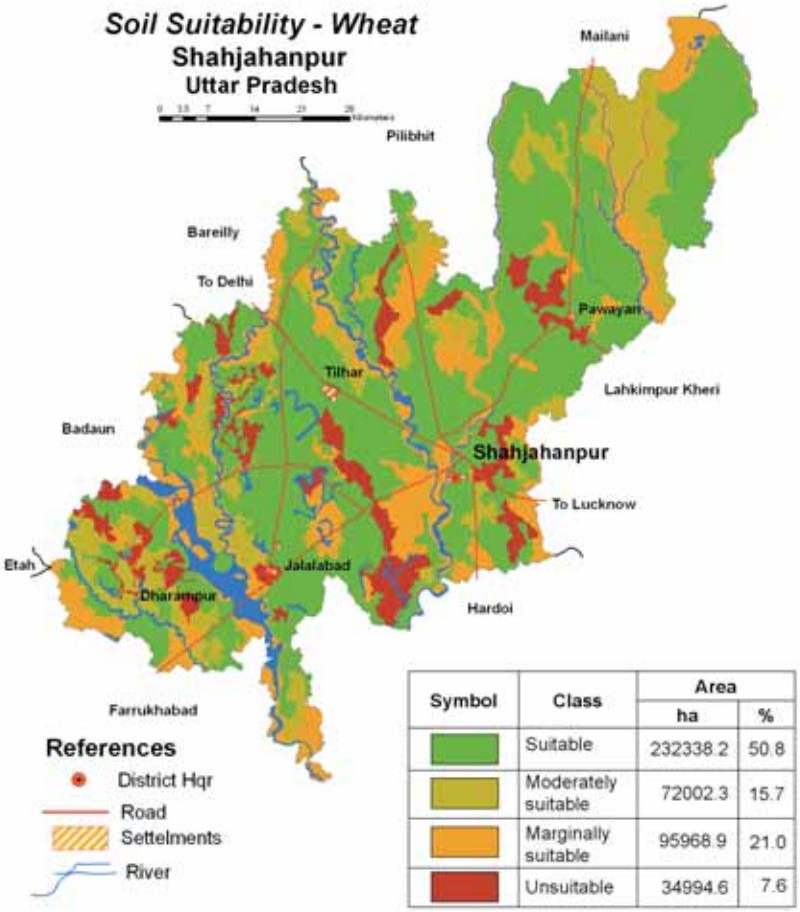
Soil and Water Productivity

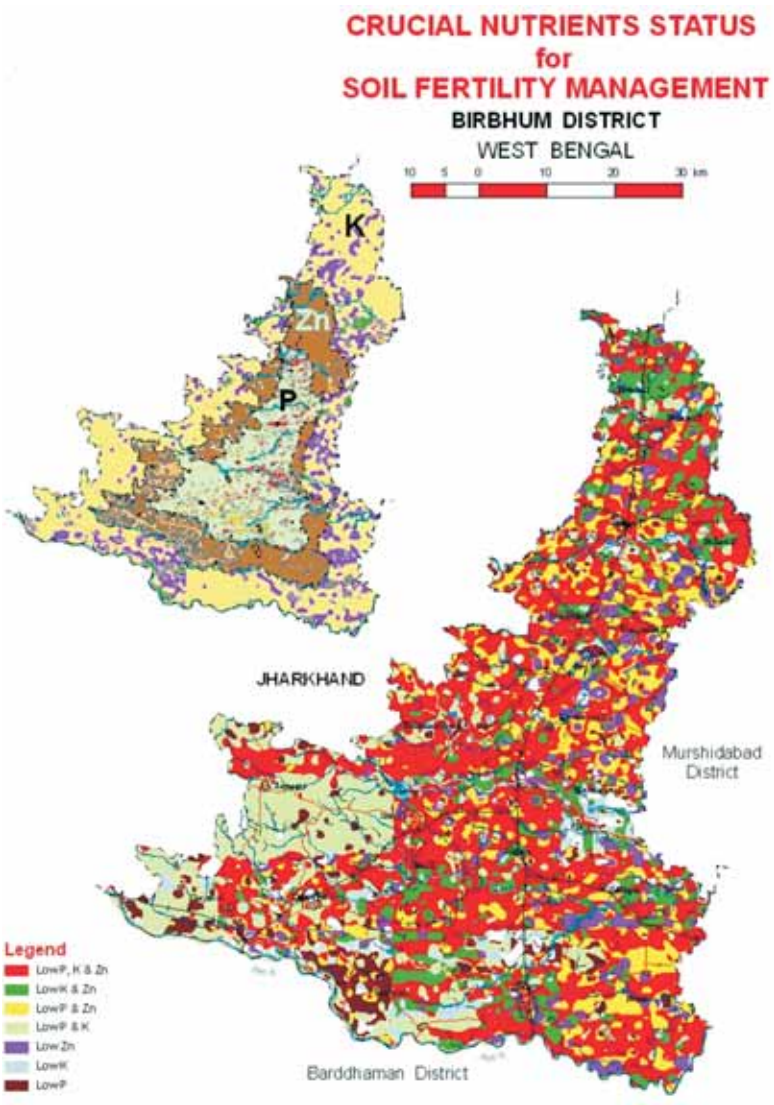
Soil site suitability map: The soil site suitability map for wheat in Shahjahanpur district of Uttar Pradesh was mapped on 1:50,000 scale. A total of 18 soil series were identified and mapped into 25 units as series associations. The dominant wheat-based cropping systems recommended in the district are rice-wheat and sugarcane-wheat.

Critical soil-nutrient status of Birbhum district of West Bengal: GIS-based soil nutrient mapping at 1 km interval in Birbhum district showed multiple nutrient deficiencies, namely phosphorus, potassium and zinc in 37.4% area; phosphorus and potassium; phosphorus and zinc; potassium and zinc in another 15.9, 14.4 and 11.7% area, respectively.

Digitized database of salt-affected soils: The salt-affected soils maps on 1:250,000 scale were digitized to prepare a composite map for the arid and semi-arid regions, covering Rajasthan, Gujarat, Madhya Pradesh and Maharashtra using GIS.



Symbol	Class	Area	
		ha	%
	Suitable	232338.2	50.8
	Moderately suitable	72002.3	15.7
	Marginally suitable	95968.9	21.0
	Unsuitable	34994.6	7.6



Spatial analysis with the agro-climatic zones was done to show regional and zonal distribution of salt-affected soils.

Soil carbon stocks under major rainfed production systems in India: Soil carbon pool (SOC) plays a crucial role in soil quality, availability of plant nutrients and ecosystem services. Dryland soils in India have potential to sequester carbon, if appropriate land use and management practices are adopted. The SOC stocks in soil profiles across the country showed wide variations and followed the order of Vertisols> Inceptisols>Alfisols>Aridisols. Inorganic carbon and total C stocks were higher in Vertisols than in other soil types. Soil organic carbon stocks decreased with depth in the profile, while inorganic carbon stocks increased with depth. Among the production systems, soybean, maize and groundnut-based systems showed higher organic carbon stocks than other production systems**.** The highest contribution of organic carbon to total carbon stock was found in upland rice system. Organic carbon stocks in surface soil layer increased with rainfall (r=0.59), while inorganic carbon stocks were found to be more in low rainfall regions (less than 550 mm). Cation-exchange capacity (CEC) showed better correlation with organic carbon stocks than with clay content in soils.

Rainwater harvesting in dryland: Water is most crucial resource for sustainable agricultural production in the dryland/rainfed areas. However, the major part of the rainwater coming over the farmers' field in these areas goes away unused as runoff. The runoff from the contributing fields is chanalized into the pond. In light soil, the dugout ponds are lined to improve the storage efficiency by containing the seepage.

This technology was taken to the farmers' field by the CRIDA team as a drought-proofing measure in Sithagonthi village of Adilabad district, Andhra Pradesh receiving average rainfall of 1,050 mm annually. The amount spent in digging the pond was recovered within the first year with a good harvest of tomatoes, chickpea crop and growing fishlings in pond.

This injected enthusiasm in the farmers of this

area and the district authorities of Adilabad had allocated an amount of Rs 20 lakh for upscaling this intervention.

Enhancing groundwater recharge and water productivity in north-west India: The sustainability of agriculture in north-western states comprising Punjab, Haryana and Uttar Pradesh is threatened due to alarming decline in water-table, increasing pumping cost and related environmental impacts. The efforts to increase water productivity and multiple use of water and pond renovation are planned in a major way by the CSSRI in 100 villages in Haryana, Punjab, Uttar Pradesh and Gujarat. The project aims to augment groundwater resources and improve water productivity per drop of water to handle contingencies arising on account of climate change and water scarcity. Recharge shafts and recharge cavities were installed at 55 sites in Haryana, Punjab, Uttar Pradesh. Further, intervention by laser-land leveling was completed in another 20 sites. Recharge of rainwater through recharge shaft during monsoon raised the groundwater levels considerably and improved groundwater quality in the vicinity.

Recharge filter–a low and effective method for groundwater augmentation in Vasad (Gujarat): The low-cost recharge filter is useful in removing suspended impurity and rejuvenating groundwater aquifer through abandoned tubewells and open wells in arid and semi-arid regions. The design has been useful for small farmers having contributing runoff area less than 4.5 ha. The

A CASE STUDY

Watershed management in drought-prone Bundelkhand region

Garhkundar-Dabar in Tikamgarh district of Madhya Pradesh is a true representative of Bundelkhand region and one of the most disadvantaged districts identified by Planning Commission, Government of India. The NRC for Agroforestry, Jhansi, an ICAR unit, has started a watershed development programme during 2005–06 in participatory mode. This watershed comprises 3 village panchayats (partially) and inhabits 895 human and 2,648 animal populations. About 72% farmers are marginal land holders and majority belongs to OBC (50%), SC (28%) and ST (16%).

Conservation measures in watershed included construction of 8 check dams in series of approximately 10 km length in the *nallah.* These check dams were constructed on third and fourth order streams. In addition, 150 gabion structures of various sizes were laid down in first and second order streams, so as to check silt inflow in main water course. Three *khadins* (water spreader) were constructed in depression to check concentrated flow of runoff. About 40 ha of land was protected by construction of marginal bunds along *nallah.* These bunds were provided with proper spillways (15 nos.) to safely drain excess runoff.

In addition to mechanical measures, plantation of about 6,000 multipurpose trees was made along the nallah, 12 different agroforestry models were introduced at the farmer's field (6.5 ha) along with suitable crop demonstration for dissemination of technologies. Further, for the additional livelihood support, lac cultivation and value-addition to the system through natural resin and gum were also introduced. Local variety of *ber* was improved through budding which yields additional income. Four Self-Help Groups [(SHGs) (2 men and 2 women)] were formed and exposed to other successful SHGs for getting confidence and capacity building. They have started activities like *agarbatti* making, earthen pots making, goat rearing, *murti* making, hiring diesel pump and cooking vessels, aquaculture etc. Two of the woman SHGs have net asset value of Rs 31,856 and 25,000, respectively as on date in a span of 3 years and both of them have become reliant in terms of small credit requirement.

During this year when rainfall is below normal (24%), there is sufficient surface (24,000 m^3) and sub-surface water (all 107 open wells are filled with water) harvested in the watershed, whereas more than 90% wells are dry outside the watershed in nearby villages. Watershed development programme increased the cropping intensity (96–116%) vis-à-vis productivity and generated employment for 7,500 man-days.

recharge filter consists of a pit of 1 m dug into the soil and lined with LDPE (250 micron thickness) sheet. The base is graded towards middle where lies a perforated pipe leading to the recharge well. A wire mesh (2 cm × 2 cm opening) box casing filled with suitably graded stones/ geo-textiles is fixed around the collecting pipe to ensure dirt and sediment-free water. The graded filter materials are laid in layers of 30 cm each, with the bottom layer consisting of pebbles/ gravels of size 40 mm preceded by the middle layer having size of pebble/grits of 20 mm. The upper layer is coarse sand (clean) of grain size a little higher than 2 mm. The maximum size of graded stones laid in the bottom layer should not exceed 40 mm to avoid damage due to punctures in LDPE sheet. The top of the recharge filter is covered with agro-net / geojute (0.25 mm opening) to stop sediments to clog the sand surface. The approximate cost of the recharge filter is between Rs17,000 and 50,000 excluding the delivery cost to the open/tube well.

Zinc-solubilizing bacteria for alleviating Zn deficiency: An effort was made to develop a cost-effective, socially acceptable and environmentally safe bio-zinc formulation for maize growers. The CRIDA under AMAAS Project isolated 2 zinc-solubilizing *Pseudomonas* strains (P29 and P33) to cater to zinc deficiency. These strains were found most promising and comparable with that of 25 kg/ha zinc sulphate application or seed priming with 1% zinc sulphate solution treatments.

Alleviating drought stress in plants: In addition to genetic and management options, a low-cost option of utilization of stress-tolerant rhizosphere microorganisms for enhancing drought stress-tolerance in plants was studied. A large number of *Pseudomonas* strains were isolated from rainfed regions of India and based on number of desirable characters *P. putida* 'GAP-P 45' was found most promising in terms of rhizosphere colonization and production of extra-cellular polysaccharides and soil aggregation. Inoculation with this strain improved the rhizosphere soil aggregation significantly and resulted in better water potential of maize and sunflower plants when subjected to stress. There was a significant improvement in the root adhered soil owing to the gum production and bio-film formation. Detailed studies showed that the organism was able to induce synthesis of novel proteins in the plants conferring tolerance to drought stress. Preliminary field evaluation on sunflower indicated that seed treatment with 'GAP-P 45' resulted in better crop growth and yield during the *kharif* season of 2009 which was a severe drought year.

Inland fishery resources assessment: Remote sensing imageries were used to establish relation between water quality of closed water bodies and land-use pattern of watershed. Digital Elevation Model technique was utilized to delineate catchment area and streams for 4 water bodies in West Bengal to create a land-use map.

Isolation of arsenic-transforming microbes for remediation: More than 40 species and strains of bacteria were isolated from aquatic environments and some other sources. These strains can reduce soil-bound arsenic by oxidizing it and thus help reduce its mobilization and toxicity.

Arsenic in inland open water environments: An appreciable level of arsenic was detected in ponds and fish from arsenic-affected and industrially exploited Damodar river system in West Bengal, but not in the unaffected areas. *Catla catla* exhibited the maximum accumulation of arsenic (60% samples above permissible limit of 100 ppb), followed by *Labeo rohita* (39% samples >100 ppb) and *Cirrhinus mrigala* (21% samples >100 ppb) indicating risk of arsenic poisoning through consuming fish produced in the arsenic-affected region.

Remote sensing techniques for estimation of aquaculture farms: Methodology to automatically delineate aquaculture farms was developed. The selected images comprised water class, aquaculture farms and agriculture. The vector layer was created for water bodies by digitizing water class features in the digital image. Using this methodology, the automatic delineation of aquaculture farms for larger areas in less time has become possible with high resolution data.

Bioremediation of shrimp farm discharge water: Bagasse as biostimulator to remove ammonia and nitrate from shrimp farm discharge water was assessed by carrying yard experiments and field trials. Enhanced growth of nitrifying bacteria was observed on the bagasse and the same was confirmed by molecular techniques including RT-PCR. Hence, bagasse can be used as a successful biostimulator for the removal of ammonia and nitrate in shrimp aquaculture. This technology is available for adoption by farmers.

Coral and sponge resources on a GIS platform: Documentation of coral and sponge resources on a GIS platform in Netrani islands of Karnataka, Grande island of Goa, and Palk Bay area using Line Intercept Transact method revealed that coral cover has decreased from 41% to 13% in Palk Bay and alterations in community structure were also noticed as compared to that in 2004. ❑