

2. Soil and Water Productivity

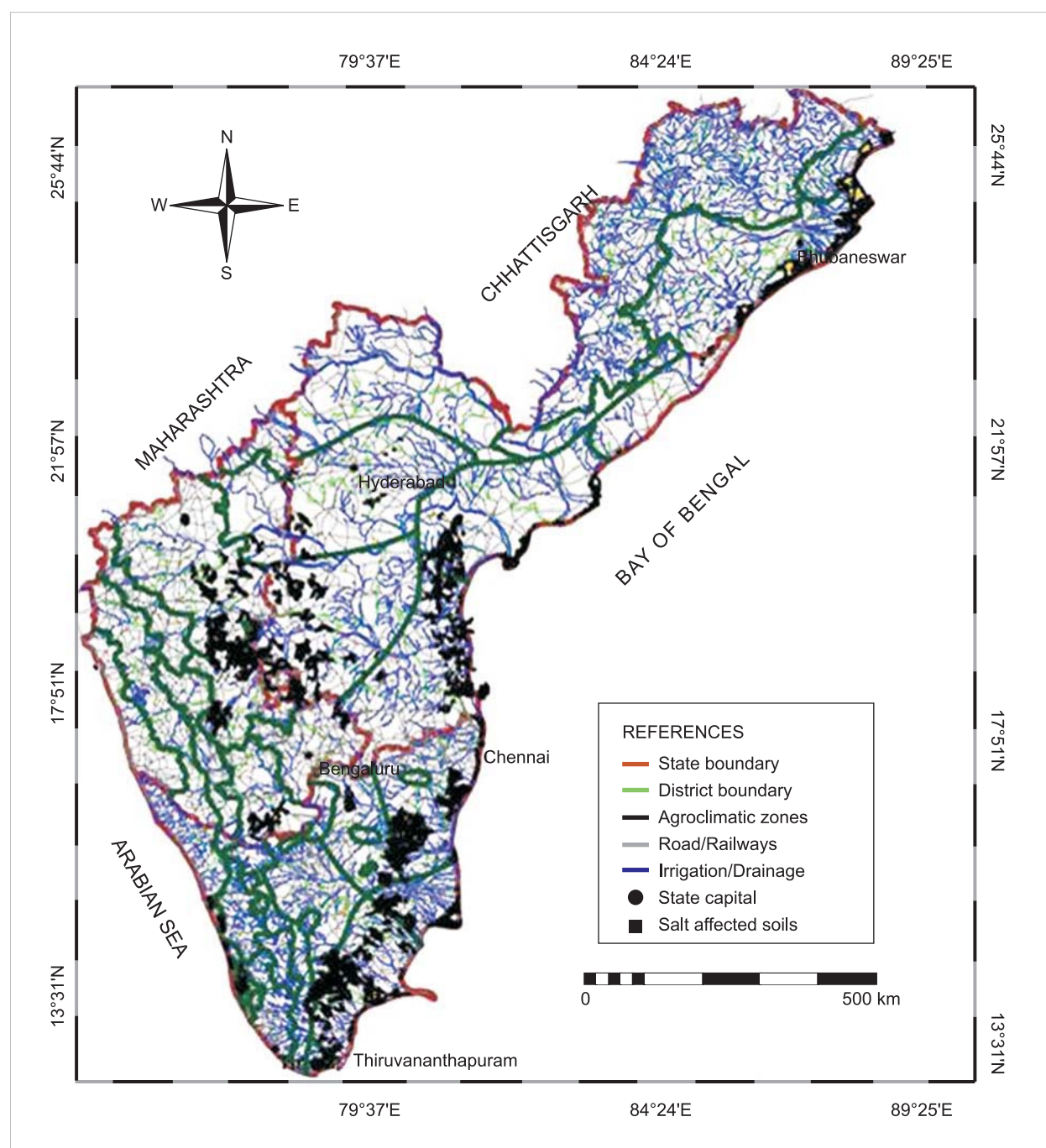
Soil resource inventory and management

Digitized database of salt-affected soils: The maps (NRSA and associates 1996) of salt-affected soils on 1 : 250,000 scale were geo-referenced and digitized to prepare the digital polygons of salt-affected soils using ILWIS software. The digital database facilitated preparation of geo-referenced maps for Andhra Pradesh, Odisha, Karnataka, Tamil Nadu and Kerala. The total

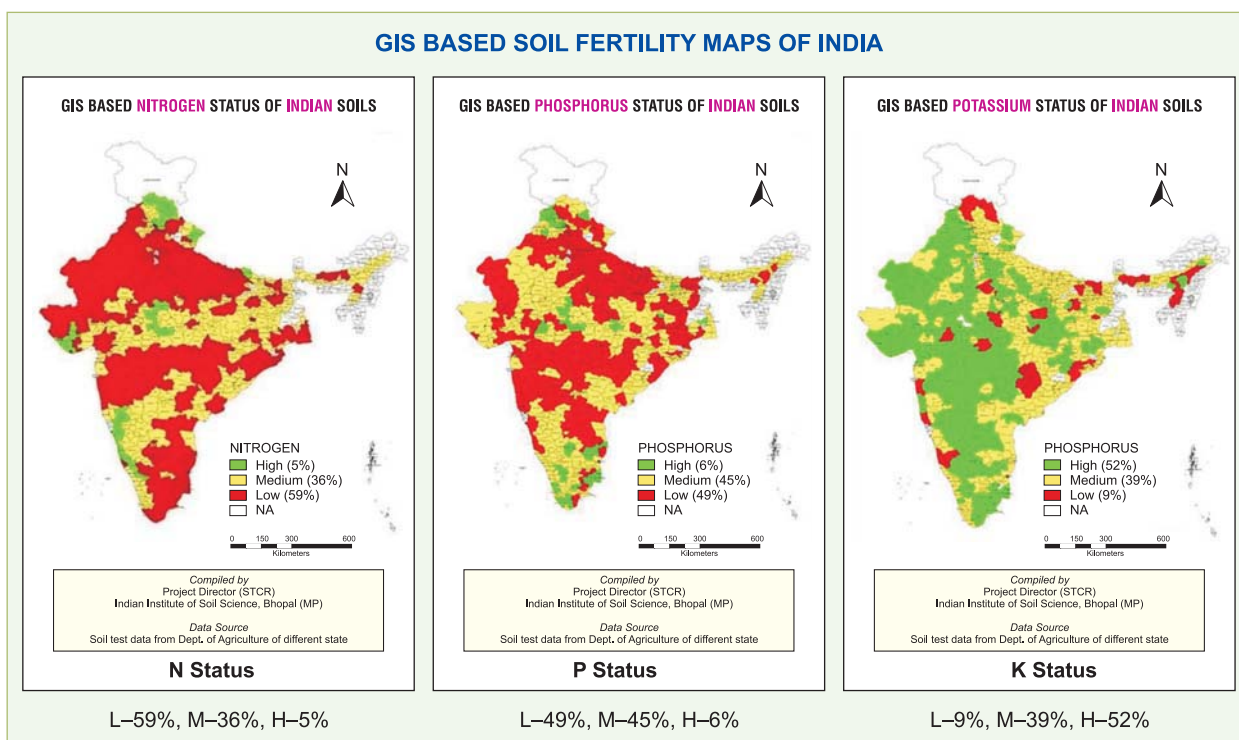
salt-affected area under the peninsular region is 0.959 million ha.

GIS based soil fertility maps of India: GIS-based soil fertility maps of India were prepared using soil test data representing 21 states and 500 districts. Majority of the districts were low to medium in N and P and medium to high in K.

Sulphur fertility map of Madhya Pradesh: Out



Salt-affected soils of peninsular region



of 46 districts, 10 districts were very low in available sulphur, 15 were medium, 3 were high and remaining 18 were very high. Overall, 41% of soils in Madhya Pradesh were deficient in available sulphur. The GIS-based sulphur fertility map of Madhya Pradesh has been generated and the same linked to sulphur recommendations to different crops. Application of 20 kg S/ha to each crop or 40 kg S/ha to alternate crop was found better in overcoming the sulphur deficiency.

Exchangeable and non-exchangeable K status of Indian soils : Recommendations of potassic fertilizer are generally made based on available K (exchangeable + water soluble) status of soils. However, recent studies indicate a substantial contribution of non-exchangeable K to crop uptake. Geographic Information System (GIS) was used for categorizing the districts into low, medium and high in terms of exchangeable and non-exchangeable K, utilizing information on K status in Indian soils for the last 30 years. K-deficient districts required normal K application. However, the districts having high exchangeable K but low non-exchangeable K required maintenance dose of K.

Soil survey for village-level land-use planning: Sixty-four villages of Kuppam Mandal, Andhra Pradesh were surveyed for developing an efficient land-use plan. For this purpose, different thematic maps were generated to delineate the potentials and problems of the soils for crop production. The soils were low to medium in available P and low to marginal in Zn. The soils were marginally to moderately suitable for finger millet (*ragi*), a dominant crop of the mandal.

Fly ash in managing surface cracks in medium deep black soils: Dominance of swelling and shrinking smectite clay mineral in black cotton soils leads to development of surface cracks on drying which is

one of the major soil management concerns in Vertisols regions. These cracks damage the soil conservation structures and accelerate erosion and soil desiccation processes. Fly ash application @ 10 tonnes/ha prior to preparatory tillage for four years improved the soil physical condition and reduced crack development. There was 17–43% reduction in the crack volume due to fly ash application. Its addition, yield of sorghum + pigeonpea intercropping system increased by 28% with an increase in net returns by about 43%.

Enhancing productivity of ravine land by agroforestry intervention: An agro-horti system is recommended for enhancing the productivity of ravine lands through plantation of sapota with cowpea–castor intercropping in Vasad (Gujarat). The pod and fodder yields of cowpea were almost similar both under pure plantation and intercropping with sapota.

Low-cost technology to enhance productivity of rainfed acid soils—a case study: Amelioration of acidic soils with low cost liming material (paper mill sludge) coupled with harvested rainwater helped to grow diversified crops (groundnut, maize, blackgram, pigeonpea, sunflower, sesame, rice) throughout the year in Balasore and Mayurbhanj districts of Odisha. The interventions raised the income of the farmers by ₹ 20,000–25,000/ha. The paper mill sludge addition @ 6.5 tonnes/ha corrected the soil acidity and increased the water-use efficiency by 34–60%. The Department of Agriculture, Government of Odisha has chalked out a massive plan to ameliorate acidic soils in 2.4 lakh ha of cultivated area by supplying paper mill sludge to farmers at subsidized rate of ₹ 10/50 kg bag.

Integrated water management

Water productivity enhancement through *in-situ* rain-water harvesting: For effective *in-situ* water

harvesting the existing ridge and furrow equipment was modified to make conservation furrows of 60 cm width and 25 cm depth and paired row planting at Hyderabad in castor–pigeonpea-based cropping system. The castor yield increased by 30% in paired row plots with conservation furrows while the runoff decreased from 10% to 1% compared to conventional method. The technology has a merit in simultaneously making a furrow and planting as against the usual practice of making furrows after 30 days of planting. The intervention allowed effective use of rainfall received during the initial 30 days also.

Tank silt as an organic amendment for improving water-use efficiency and productivity: The indigenous practice of tank silt application has been made more scientific by taking into consideration of textural properties of tank silt and the field soil and a software has been developed for the purpose. The addition of tank silt to the fields improved the water-use efficiency and water productivity of different crops at a number of locations in Anantapur, Warangal, Solapur and Bhilwara districts. There were about 140,000 tanks in states of Andhra Pradesh, Karnataka and Tamil Nadu and majority of these are silted up. Desilting of these tanks can ameliorate 5.6 million ha of dryland (@ 40 ha/tank) while creating additional storage capacity of 1.4 BCM.

Economic analysis of rain-water harvesting in farm ponds: The harvested rain-water in farm ponds showed significant impact on crop yields in Andhra Pradesh. The yield of groundnut, the most important crop in Ananthpur district, increased from 12.2 to 15.6 q/ha with application of one to two supplemental irrigations using harvested water. Considering a life of 10 years for the pond, the net present value (NPV) of the pond was about ₹ 0.61 lakh with the benefit : cost ratio of 2.7.

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 an alarming decline in water table, increasing pumping cost and related environmental impacts. The individual farmer-based technologies on groundwater recharge, integrated farming and laser leveling/improved irrigation have been implemented and evaluated at 90 sites in these states. The recharge structures replenished



Construction of recharge shaft on farmers' field in village Jatpura

groundwater as indicated by the rise in water-table and improvement in water quality. The clogging of recharge filter was a major problem and efforts are on to overcome the same. Laser levelling was an effective technology to improve water productivity of rice and wheat with 8–12% increase in yields and 18–21% saving in irrigation water.

Rubber dams for watersheds : Multipurpose rubber dams were successfully installed using indigenous technology in various watersheds of Odisha. The head wall of the check dam and/or emergency spillway has been replaced by rubber sheet. The installed rubber dam (5 m wide and 1.5 m max. height) in watersheds reduced soil erosion, created a reservoir in upstream side, enhanced the groundwater recharge and created a head for diverting water for irrigation during critical dry spells for crops. This was also useful in safe and quick disposal of sediment getting deposited in the upstream side to reduce capacity of reservoir. The best functionality of rubber dam was its flexibility to increase or decrease head so that damage of structure due to flash floods or heavy floods would be easily avoided. The head of the dam can be lowered during high flood and can be enhanced to store more water during dry period.

Integrated nutrient management

Biofertilizer enriched compost: Application of biofertilizer enriched compost (rice straw compost enriched with *Azospirillum* and P-solubilizing bacteria and amended with 1% rock phosphate) at 2 tonnes/ha

Water-use efficiency (WUE) and water productivity (WP) in different crops as influenced by tank silt application

| District | Crop | WUE (kg/ha/mm) | | | WP (₹/ha/mm) | | |
|------------------|--------------|----------------|--------------|-----------------|--------------|--------------|-----------------|
| | | With silt | Without silt | Improvement (%) | With silt | Without silt | Improvement (%) |
| Anantapur (n=20) | Groundnut | 2.60 | 1.41 | 84 | 65.25 | 30.90 | 111 |
| Warangal (n=22) | Cotton | 2.96 | 2.09 | 42 | 86.55 | 60.65 | 43 |
| Solapur (n=10) | Rabi Sorghum | 7.19 | 5.13 | 40 | 78.45 | 56.20 | 40 |
| Bhilwara (n=10) | Maize | 6.09 | 4.75 | 28 | 54.90 | 42.65 | 29 |

Note: Mean of two years; n=number of farmers



along with 25 % recommended doses of N and P (full dose of K) increased the rice yield by 23 and 10% under rice–toria and rice–wheat systems, respectively, over recommended dose of mineral fertilizers in Asom. Soil health improved as indicated by greater microbial biomass, dehydrogenase, phosphomonoesterase and fluorescein diacetate activities in soil.

Bacillus biofertilizer for sweet cherry: A highly efficient P-solubilizing *Bacillus* sp. VS9 capable of solubilizing phosphorus, producing IAA and siderophores and inhibiting *Pythium aphanidermatum*, *Rhizoctonia solani* and *Fusarium oxysporum* under *in-vitro* conditions was identified for temperate hill regions. The biofertilizer increased shoot and root biomass and nutrient uptake significantly.

Bionutrient package for rice in Bihar: Application of enriched mycostraw (spent residue or semi-decomposed straw + *Pseudomonas* spp) along with *Azospirillum* sp. and cyanobacteria to ten farmers' fields increased yield from 4 to 32% depending upon the fertilizer dose applied by the farmers. All the farmers used the mycostraw developed by them during the cultivation of oyster mushroom. Addition of *Aeschyomene* in bionutrient package further enhanced the saving of nitrogen and phosphorus.

Biofertilizer production and demonstrations in Madhya Pradesh: Soybean seed yield increased with INM option with biofertilizers by 18% over balanced fertilization and 54% over farmers' practice. Large-scale demonstrations were conducted on farmers' fields in Madhya Pradesh on use of soybean rhizobial and PGPR strains.

INM for resource conservation and sustainable crop production in degraded Shivaliks: The poor soil organic carbon and microbial activity are the major causes of low productivity in the Shivalik region. The integrated nutrient management using compost, vermicompost, biofertilizer and inorganic fertilizer improved soil organic carbon, microbial activity and

soil moisture in the Shivalik soils. The improved soil environment was reflected in higher annual returns of soybean–wheat (₹ 24,444) and tomato–popcorn (₹ 32,478).

Phosphorus in wetland sediment: idea versus reality: Freshwater environments are often deficient in phosphorus which limits the aquatic productivity. Fractionation study of sediment phosphorus in wetlands in West Bengal indicated that the available form of P was insignificant (up to 6.83 ppm) compared to the total sediment P-pool which amounts to as high as 6,555–7,440 mg/kg. Total mineral (Al, Fe, and Ca) bound P accounts for only 9–19% of total P. Interestingly, the organic form of phosphorus formed the bulk (78–95% of total P content) indicating that a significant pool of P is bound to sediment organic matter. Nearly 48% of this organically bound phosphorus was released from sediment by microbial decomposition processes during summer contributing a significant part of available phosphorus for primary productivity.

Valuation of wetland and reservoir in West Bengal for their goods and services: A holistic valuation exercise to value the goods and services provided by Chandania *beel* and Kangsabati reservoir in West Bengal by CIFRI documented major direct uses for these waters. The goods and services for Chandania *beel* were valued at over 86 lakh with fish as the major source of income (54%), followed by natural resource use (35%). Groundwater recharge/ irrigation for agriculture (6%), conservation of habitat for aquatic biomass, aesthetics, etc. (4%) and recreation and tourism (1%) had comparatively lower shares. The total goods and services provided by the Kangsabati reservoir were estimated at ₹ 18.11 crores, with maximum share for irrigation/ groundwater recharge (90%), followed by fish (5%), forest products (3%) and recreation and tourism, domestic water supply and conservation of habitat for aquatic biomass, aesthetics, etc. for the remaining share.

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