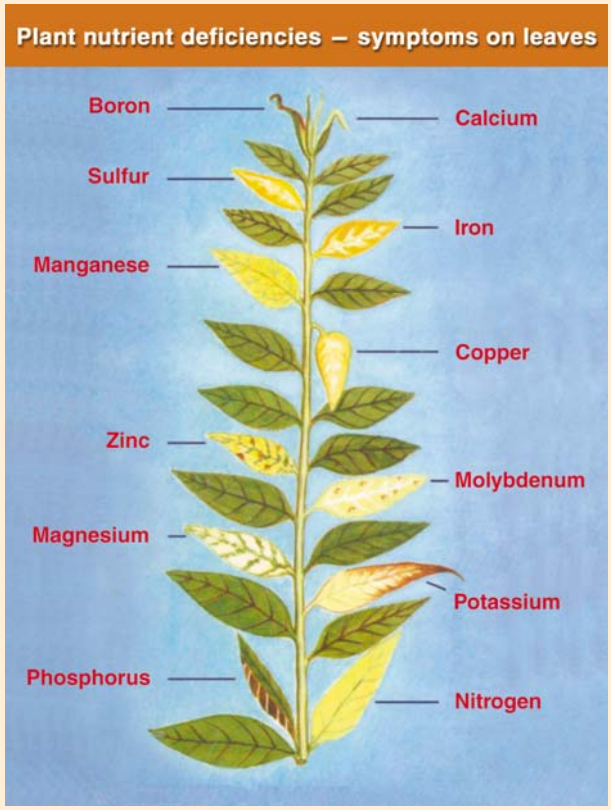
Macro benefits from Micronutrients

Plants require 16 nutrients for proper growth and development. Some, such as nitrogen (N), phosphorus (P), and potassium (K), are needed in large quantities (macronutrients). Others, such as calcium (Ca), magnesium (Mg) and sulfur (S), are required in small quantities (secondary nutrients). Others, such as zinc (Zn), boron (B), manganese (Mn), iron (Fe), copper (Cu), molybdenum (Mo) and chlorine (Cl), are required in very small quantities (micronutrients).

Most farmers in India apply only those fertilizers that supply macronutrients. Micronutrient deficiencies in several crops have therefore increased in recent years. Rainfed crops such as sorghum are known to deplete 72 g Zn and 54 g B to produce a ton of grain yield. Continuous uptake of such nutrients without periodic replenishment leads to decline in soil fertility and crop productivity. Although micronutrients are needed in small quantities by the crop, they play a significant role in plant nutrition, growth and production.



The problem

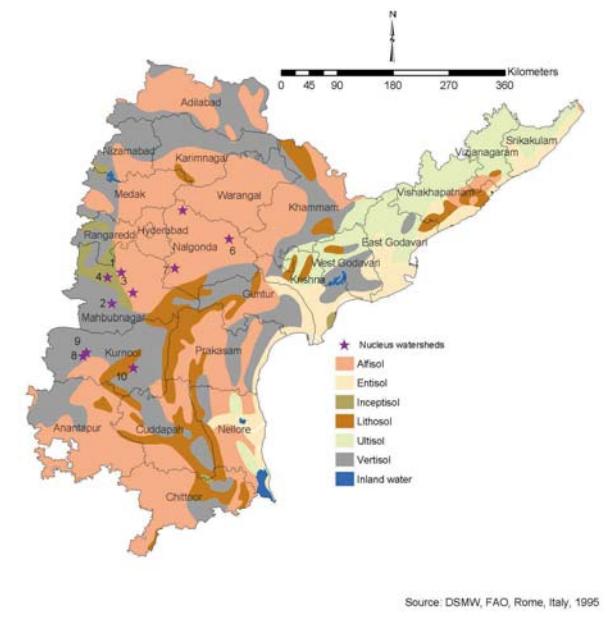
Increased use of chemical fertilizer as source of major nutrients, combined with the declining use of organic sources of nutrients over time, has led to deficiency of micronutrients in soils, resulting in poor soil fertility. Nutrients such as B, Fe, Mn, Cu, Zn, Mo and S are as important to plant growth as N, P and K. When these micronutrients are not available to the plant in required quantities, growth is affected.

Sulfur deficiency in sorghum showing pale yellow younger leaves and healthy dark green lower leaves.

Zinc deficiency in maize showing stunted leaves ('little leaf').

Boron deficiency in groundnut showing seeds with hollow heart.

The Strategy



Soil types and watersheds in Andhra Pradesh, India.

Under the Andhra Pradesh Rural Livelihood Programme (APRLP), watersheds are used as entry points for improving the livelihoods of rural poor in Kurnool, Anantapur, Mahbubnagar, Nalgonda and Prakasam districts of Andhra Pradesh, India. To achieve convergence and integration of various soil, water, crop, nutrient and other livelihood opportunities, an innovative farmer participatory consortium model for watershed management has been adopted. The watershed consortium consists of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), APRLP, the Central Research Institute for Dryland Agriculture (CRIDA), Acharya NG Ranga Agricultural University (ANGRAU), the National Remote Sensing Agency (NRSA), and the District Water Management Agency (DWMA), Government of Andhra Pradesh. ICRISAT and APRLP provide technical backstopping to watershed committees and farmers in the districts.

Activities

Preparing micronutrient mixture.

Incorporating micronutrients into soil.

- Participatory rural appraisal was conducted in the *Gram Sabha* of 50 villages. This revealed that crop yields were declining and that increasing amounts of fertilizers were required to maintain the yield levels year after year.
- As part of the biophysical characterization of the 50 watersheds (10 nucleus and 40 satellite watersheds) in Mahbubnagar, Nalgonda and Kurnool districts, soil samples were collected from 20 farmers' fields per watershed at 0–15 cm depth by adopting stratified random sampling method.
- Soil samples were analyzed for biological, chemical and physical parameters to identify constraints limiting crop yields.
- Based on the nutritional constraints identified in the fields in watersheds, 15 volunteer farmers evaluated the responses to micronutrients.
- In each farmer's field, two plots measuring 0.2 ha were used for experimentation. In the first plot, both normal fertilizers and micronutrients were applied. The second plot, which received only normal fertilizers, served as a check.
- Farmers applied 5 kg borax (0.5 kg B ha^{-1}), 200 kg gypsum (30 kg S ha^{-1}) and 50 kg zinc sulphate (10 kg Zn ha^{-1}) to maize, sorghum, mung bean, pigeonpea and groundnut. The crops varied depending on farmers' choices.

Table 1. Soil analysis across three districts in Andhra Pradesh, India, 2002–03 (values for each district in a column represent mean, range, and percentage of deficient fields).

District	No. of farmers	pH	EC (mmhos cm^{-1})	Total N (ppm)	Available P (ppm)	Available K (ppm)	S (ppm)	Zn (ppm)	B (ppm)	Organic C (%)
Mahbub-nagar	262	7.1 5.4–9.1	0.12 0.03–0.56	342 123–783 100	8.6 0.7–61.0 37	104 25–416 7	4.5 1.2–30.8 89	0.52 0.1–1.5 83	0.15 0.02–0.74 98	0.3 0.1– 0.8 59
Nalgonda	176	7.7 5.7–9.2	0.15 0.02–0.58	410 144–947 100	7.6 0.7–35.2 39	130 34–784 3	4.4 1.4–50.5 89	0.4 0.1–2.2 94	0.21 0.02–0.80 99	0.4 0.1–1.0 80
Kurnool	223	7.8 5.9–9.7	0.2 0.03–1.84	295 26–966 100	7.9 0.4–31.5 40	127 33–335 8	4.4 1.4–24.7 88	0.4 0.1–1.2 81	0.27 0.04–1.48 92	0.3 0.1–0.8 91
Critical limits			<0.8 (normal)				8–10	0.75	0.58	
Low				500–1200	<5	<50				<0.5
Medium				1200–2500	5–10	50–125				0.5–0.75
High				>2500	>10	>125				>0.75

Nutrient Deficiencies in the Soil

- The soils in most of the farms in the three districts were deficient in nutrients.
  - N was deficient in all the farms. Total N in the soil was 123–783 ppm in Mahbubnagar, 144–947 ppm in Nalgonda and 26–966 ppm in Kurnool (Table 1).
  - Available P was deficient in about 37% of the farms surveyed in Mahbubnagar and Nalgonda and in 40% of the farms in Kurnool.
  - Available K was not deficient in any of the three districts.
  - Micronutrients such as B, Zn and S were deficient in 81 - 98% of the farms in all three districts.
- Prior to the watershed project interventions, farmers applied only diammonium phosphate (DAP) and urea as sources of major nutrients. As a result soils were deficient in micronutrients due to either little or no application of other chemicals (eg, borax) or organic fertilizers (eg, farmyard manure).

Benefits to Farmers

- Despite severe drought in all three districts, application of micronutrients showed a remarkable difference in yield in the rainfed crops usually grown in these areas (Table 2).
  - Although most of the soils were deficient in the three micronutrients (B, S, Zn), crop response varied from field to field.
  - In plots treated with micronutrients, on average, yield of castor increased 50% over the control in the castor/pigeonpea intercropping system, that of mung bean by 30% in mung bean/pigeonpea, and that of sole pigeonpea by 60%.
- A small investment of Rs 1750 ha^{-1} (Rs 1550 for the micronutrients + Rs 200 for the application) towards micronutrient application enhanced net profits to farmers.
  - In Mahbubnagar, net profit for maize was Rs 8200 ha^{-1} while that for pigeonpea was Rs 2900 ha^{-1}.
  - In Nalgonda, net profit for castor was Rs 1600 ha^{-1} while that for mung bean was Rs 2700 ha^{-1}.
  - In Kurnool, net profit for groundnut was Rs 6500 ha^{-1} while that for pigeonpea was Rs 3200 ha^{-1}.

Good response to micronutrients in maize.

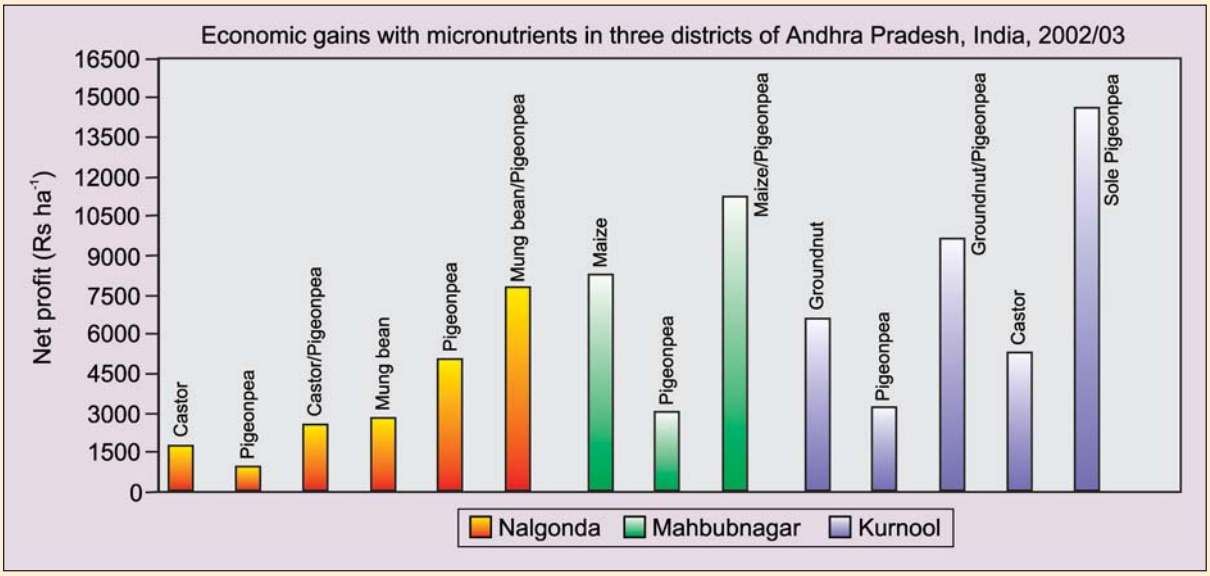
Table 2. Crop response to micronutrients in watersheds in Andhra Pradesh, India, 2002/03.

Watershed	Crop	Grain yield (kg ha^{-1}) Control	Grain yield (kg ha^{-1}) Treated	Yield increase over control (%)
Mahbubnagar				
Sripuram	Maize	2380	4370	84
	Pigeonpea[1]	240	420	75
Malleboinpally	Maize	2980	4570	53
Mentepally	Maize	1200	1740	45
Nalgonda				
Tirumalapuram	Castor	430	640	49
	Pigeonpea[1]	410	460	12
Nemikal	Mung bean	840	1100	31
	Pigeonpea[1]	350	660	89
Kurnool				
Karivemula	Groundnut	1440	1960	36
	Pigeonpea[1]	130	330	154
Devanakonda	Groundnut	940	1240	32
	Pigeonpea[1]	230	500	117
Nandavaram	Castor	860	1290	50
	Pigeonpea	1630	2640	62

1. Represents intercrop.

What farmers said!

"We apply only DAP and urea and think that this is good enough for increasing yield. We used to apply manure, but not any more because we don't have enough. So far no one told us about this type of fertilizer. We never knew that small quantities of fertilizers could make such a big difference. We only wish that these fertilizers are easily made available at the right time."



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