

# Zinc Deficiency Holding Back the Potential of Rainfed Crops in Semi Arid Central India: Learnings from Participatory Watershed Management Experiences

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## INTRODUCTION

Rain-fed areas in India are behind in increasing agricultural productivity, which is mainly due to the adoption of the compartmental approach. A consortium led by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) developed and evaluated an innovative community watershed-management approach. The baseline characterization of farms in benchmark watersheds revealed that most of the dry-land soils in India are deficient in micronutrients, such as Zn and B, besides N, P and S. However, most farmers in India only apply major nutrients and no more than sub-optimal amounts. The lack of balanced fertilization and water management are major constraints holding the true potential of agriculture back. In the present study, results from benchmark watersheds in Vidisha, Guna, and Dewas (Madhya Pradesh (M.P.)) and Bundi (Rajasthan) districts were analyzed, and the impact of balanced plant nutrition on the productivity of dry-land crops was examined.

## METHODS

Benchmark watersheds in Vidisha, Guna, and Dewas (M.P.) and Bundi (Rajasthan) districts, all are Sir Dorabji TaTa Trust and Asian Development Bank supported projects, were chosen as test sites. Most of the watersheds were about 500 ha (micro-watersheds). The number of farmers cultivating the arable land varied for each watershed. All soils were alkaline, and no salt-related soil problems were reported. Soils varied in organic carbon, P, K and S contents from low to high. Available Zn and B concentrations varied from deficient to sufficient levels. The number of farms with deficiencies in P varied from 53% in Bundi to 96% in Dewas. No K deficiency was recorded, except for Bundi (up to 18%). Sulfur and Zn deficiencies were widespread in all districts. Sulfur deficiency was reported in 72 to 100% and Zn deficiency in 67 to 100% of farms (Table 1). Treatments for a balanced-nutrient application were designed based on the soil test data. Volunteering farmers evaluated these treatments with ICRISAT facilitation in all districts.

**Table 1. Extent of Zn deficiency in participatory watersheds in India.**

Watershed	No of farm fields	Range (mg/kg)	% Deficient
Vidisha	31	0.10-0.42	100
Dewas	24	0.12-0.56	100
Guna	18	0.24-1.74	78
Bundi	36	0.20-1.80	67

## RESULTS AND DISCUSSION

The results of the balanced nutrient application in the Bagli watershed in Dewas (M.P.) showed that including S + Zn + B (200 kg gypsum + 5 kg borax + 25 kg ZnSO<sub>4</sub> ha<sup>-1</sup>) with the traditional application of N and P improved sorghum yield by 60% in Neemkheda village and soybean yield by 75-79% in Semli.

The effect of a balanced nutrition was studied in four chickpea varieties during post rainy seasons of 2004, 2005 and in soybean during rainy seasons in the Madhusudangadh watershed in Guna (M.P). The treatments were T1 = traditional farm practice (FP), T2 = FP + Zn + S + B, T3 = Zn + S + B + optimum NP, and T4 = FP + optimum NP. The amounts of applied nutrients were 50, 200, 5, 30 and 60 kg ha<sup>-1</sup> for Zn as ZnSO<sub>4</sub>, S as gypsum, B as borax, N and P, respectively. The treated chickpea varieties were KAK 2, ICCV 2, ICCV 10 and ICCV 37. The highest grain (2.24 t ha<sup>-1</sup>) and straw (1.83 t ha<sup>-1</sup>) yields were recorded in KAK-2 with the T2-treatment. The other chickpea varieties and soybean produced the highest grain and straw yields with the T3-treatment. In another experiment, we estimated the economics of Zn applications in chickpeas grown in Guna. Significant increases in net returns and the benefit:cost (B:C) ratio were obtained with an application of 50 kg ZnSO<sub>4</sub> ha<sup>-1</sup> (Table 2).

**Table 2. The economics of Zn applications on yields and net returns in chickpea.**

Treatment	Grain yield q ha <sup>-1</sup>	Straw yield q ha <sup>-1</sup>	Cost of cultivation Rs ha <sup>-1</sup>	Gross returns Rs ha <sup>-1</sup>	Net Rs ha <sup>-1</sup>	B:C Ratio
Control*	13.3	16.5	10480	22918	12437	2.18
Zn	18.7	21.2	12499	32053	19554	2.56
Zn + S	20.5	23.9	13569	35206	21637	2.59
CD (5%)	1.87	1.43		280	250	0.13

\* Farmer's practice (Sub-optimal N+P)

In the Bundi watershed (Rajasthan), balanced-nutrition trials were conducted with maize and urdbean in rainy season, and with wheat and chickpea in post-rainy season. The treatments were: T1 = FP, T2 = T1 + 5 kg ha<sup>-1</sup> borax + 200 kg ha<sup>-1</sup> Gypsum + 50 kg ha<sup>-1</sup> ZnSO<sub>4</sub>, T3 = T2 + 100 kg ha<sup>-1</sup> urea + 100 kg ha<sup>-1</sup> DAP, and T4 = T1 + 100 kg ha<sup>-1</sup> urea + 100 kg ha<sup>-1</sup> DAP. All crops produced the highest yields under the T3 treatment. The increase in crop yields under T3 compared with T1 was highest in urdbean (47%), followed by maize (45%), chickpea (43%) and wheat (16%). The economic analysis showed that higher B:C ratios were obtained with balanced-nutrition treatments than with traditional farm practices. These results show that a balanced nutrition based on the application of limiting nutrients is essential for improving productivity of various dry-land crops.