Site-Specific Nutrient Management for Maximization of Crop Yields in Northern Karnataka

By D.P. Biradar, Y.R. Aladakatti, T.N. Rao, and K.N. Tiwari

On-farm rice, wheat, and chickpea demonstrations conducted across the region show substantial increases in yields and economic returns compared to recommended and common fertilization practices... which lead to stagnant and reduced food production.

Karnataka is predominantly an agrarian state of south India with nearly 71% of its population depending on agriculture and related activities which accounts for half of the state's economy. It has varied agro-climatic conditions and topographical features with diversified crops and cropping systems. Karnataka state is comprised of 10 agro-climatic zones based on soil types, rainfall pattern, and crops grown. Among these, the northern dry zone is the largest, encompassing the majority of northern Karnataka and is comprised of Bijapur, Bellary, and parts of Raichur, Dharwad, and Belgaum Districts. This is a relatively dry zone, receiving about 465 to 790 mm of annual rainfall. Soils primarily consist of deep, medium, and shallow Vertisols (black soils).

Northern Karnataka has well diversified cropping including rice, cotton, maize, and chili (red pepper) during *kharif* season, and wheat, chickpea, sorghum, and sunflower during *rabi* season. Only 13% of the area is currently irrigated. Rice is mainly grown in the Bellary District under the Tungabhadra irrigation project and the remaining crops are scattered over all districts both under rainfed and irrigated ecosystems. The productivity of important crops like rice, wheat, and chickpea is low if compared with state and national averages, showing potential for yield improvements (**Table 1**). Productivity is low as a result of imbalanced usage of major nutrients and under-fertilization without assessing the available nutrient status of soils.

District-level map of the Northern Karnataka region.

A research project was initiated during 2003-04 to study the effect of site-specific nutrient management (SSNM) on productivity of important crops of Northern Karnataka, and to disseminate the knowledge to surrounding farming communities. Research and demonstration trials were undertaken on farmers' fields. Five trials each on rice, wheat, and chickpea were

Table 1. Yield gaps (2001-02) in Northern Karnataka.

Crop	Cropping area, ha	Average productivity, t/ha		
		Northern Karnataka	Karnataka	National
Wheat	147,500	0.82	0.80	2.77
Rice	308,600	2.18	2.40	2.09
Chickpea	181,200	0.51	0.62	0.87

Source: Fertilizer & Agricultural Statistics, Southern Region (2002-03), FAI, New Delhi.

Table 2. Comparison of nutrients applied within the three fertilizer use strategies.

		Application rates, kg/ha							
		N	P_2O_5	K_2O	S	Zn	Cu	Mn	Fe
Wheat–SSNM goal of 4 t/ha	SSNM	125	100	50	25	10	10	5	10
	RDF	100	75	50	-	-	-	-	-
	FP	100	50	30	-	-	-	-	-
Rice–SSNM goal of 6 t/ha	SSNM	200	100	100	43	25	20	10	15
	RDF	150	75	75	-	-	-	-	-
	FP	120	30	30	-	-	-	-	-
Chickpea–SSNM goal of 2.5 t/ha	SSNM	40	75	25	20	5	5	5	5
	RDF	25	50	0	-	-	-	-	-
	FP	20	50	0	-	-	-	-	-

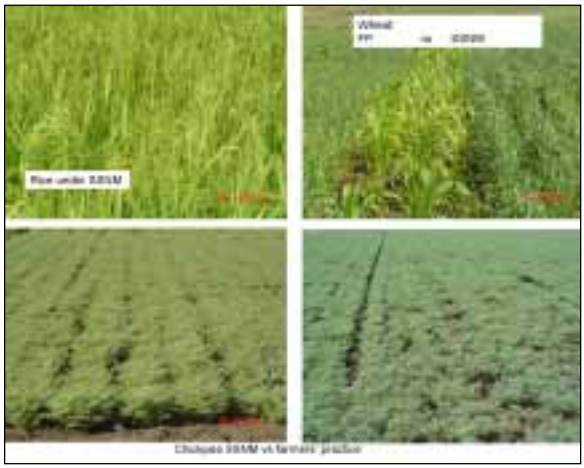

Photo at top left shows rice in SSNM plot. Photo at top right shows wheat with farmers' practice compared to SSNM. Lower photos show chickpea, SSNM at left and farmers' practice at right.

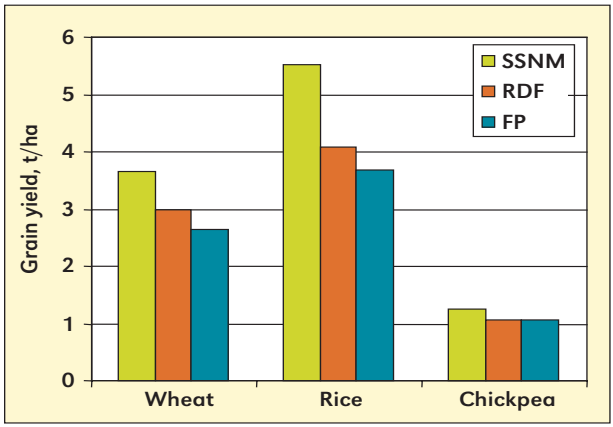

Figure 1. Average yield improvement due to SSNM at five locations.

conducted with three treatments comparing yields and economics of SSNM over recommended rates of fertilizers (RDF) and farmers' practice (FP). The trials were located at Siruguppa, Bijapur, and Navalgund Talukas of Karnataka. SSNM nutrient requirements were identified based on soil tests and the treatments were imposed considering set crop yield goals and available soil nutrients (**Table 2**). Economic analyses considered additional cost of inputs and yield in SSNM over RDF and FP. Trials used high yielding rice, wheat, and chickpea varieties... namely BPT-5204, DWR-162, and A-1, respectively. Rice was transplanted while the other two crops were under protective irrigation and recommended cultural practices.

Nutrient application on the basis of SSNM principles resulted in significantly higher grain yields over FP and RDF in all three crops under investigation. The average rice, wheat, and chickpea grain yields under SSNM, RDF, and FP are shown in **Figure 1**. The yield increases under SSNM show promise for yield improvement in the region.

Wheat yields ranged from 3.5 to 3.8 t/ha under SSNM, 2.8 to 3.2 t/ha under RDF, and 2.6 to 2.7 t/ha in FP. Average wheat yields were 3.66, 2.98, and 2.64 t/ha in the respective practices, signifying 23% higher productivity due to SSNM over RDF and 39% over FP (**Table 3**).

Rice yields ranged from 5 to 6 t/ha (SSNM), 3.7 to 4.5 t/ha (RDF), and 3.4 to 3.9 t/ha (FP), with average yields of 5.5, 4.1, and 3.7 t/ha, respectively. The average yield in-

Table 3. Yield of wheat, rice, and chickpea (t/ha) as influenced by SSNM.

	Wheat			Rice			Chickpea		
Site	SSNM	RDF	FP	SSNM	RDF	FP	SSNM	RDF	FP
1	3.70	3.20 (16)[1]	2.70 (37)[1]	5.70	4.20 (36)	3.70 (54)	1.38	1.14 (21)	1.13 (22)
2	3.80	2.84 (34)	2.60 (46)	5.32	4.00 (33)	3.56 (49)	1.18	1.03 (15)	1.01 (17)
3	3.50	2.96 (18)	2.70 (30)	5.50	4.06 (36)	3.91 (41)	1.22	1.08 (13)	1.08 (13)
4	3.60	3.00 (20)	2.64 (36)	5.00	3.71 (35)	3.36 (49)	1.25	1.06 (18)	1.05 (19)
5	3.72	2.90 (28)	2.56 (45)	6.08	4.50 (35)	3.90 (56)	1.26	1.07 (18)	1.06 (19)
Mean	3.66	2.98 (23)	2.64 (35)	5.52	4.09 (35)	3.69 (50)	1.26	1.08 (17)	1.06 (18)

[1]Numbers in brackets reflect SSNM yield increase (%) over RDF or FP.

crease due to SSNM over RDF was 35% and was 50% over FP (**Table 3**).

Chickpea yields were higher with SSNM compared to RDF and FP, although the yields were not close to the pre-set target of 2.5 t/ha in these trials. The prime reason for these poor yields was moisture stress as a severe drought-like situation prevailed. However, SSNM did increase the average yield by 17 to 18% over official recommendations or FP (**Table 3**), and showed the benefit of balanced fertilization even under low moisture conditions.

Economic Viability of SSNM

Yield increases under SSNM resulted in a vast improvement in the economic feasibility of food crop production. The average additional net income under SSNM in rice, wheat, and chickpea was US$53, 68, and 23 /ha over RDF, and US$115, 101, and 24/ha over FP (**Table 4**). Nutrient input costs resulting from implementation of SSNM will lessen in succeeding seasons as micronutrient applications are likely only required every 2 or 3 years. In such a circumstance, production will be profitable and sustainable in due course of time.

Table 4. Yield increase and economic advantage due to SSNM.

	Additional advantage under SSNM compared to:					
	RDF			FP		
Crop	Yield, t/ha	% yield increase	Net income, US$/ha	Yield, t/ha	% yield increase	Net income, US$/ha
Wheat	0.68	23	53	1.02	39	115
Rice	1.43	35	68	1.83	50	101
Chickpea	0.18	17	23	0.19	18	24

Average of five locations for each crop.

Conclusions

SSNM proved to be advantageous over RDF and FP both in yields and net returns in wheat, rice, and chickpea. These results hold promise as an example showing higher yields could be achieved with balanced use of nutrients as per soil test results and crop requirement. The results suggest that there is opportunity to improve the RDF for these crops. The government's aim is to achieve a second Green Revolution from dryland areas. SSNM is capable of producing hundreds of thousands of additional tonnes of rice, wheat, and chickpea within the region, annually generating billions in additional local currency within the state economy. BC

Dr. Biradar (email: dpbiradar@yahoo.com) is Associate Director of Research, RARS, Bijapur, and Mr. Aladakatti is Senior Scientist (Agronomy), WMRC, Belvatagi, University of Agricultural Sciences, Dharwad, Karnataka. Dr. Rao is Deputy Director and Dr. Tiwari is Director of the PPI/PPIC-India Programme.

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