Balanced Fertiliser Use and Liming Sustain High Yields in Corn-Wheat Rotation on Acid Soil

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Using an existing long-term manure experiment on acid soil, researchers in India developed a sustainable yield index (SYI) capable of comparing the cumulative effect of applying inorganic nitrogen (N), phosphorus (P), and potassium (K) fertilisers with farmyard manures and lime.

Red and lateritic soils cover an area of about 91 million hectares in India, representing 31 percent of the country's geographical area. These soils are moderately to highly weathered with high concentrations of secondary forms of iron (Fe) and aluminium (Al). They are also low in organic matter and depleted in bases. Therefore, soil acidity is a limiting factor for the production of major crops such as pulses, oilseeds, corn, wheat, cotton, and others.

Erosion of the soil surface in sloped areas often aggravates the problem of soil management. Here balanced fertiliser use with proper soil amelioration can sustain productivity and boost crop yields.

This research utilised one of the oldest soil fertility experiments in India, which is a long-term manure study initiated in 1956 at Ranchi, India. Important soil characteristics for this site include: clay loam texture, pH 5.5, 0.53 percent organic carbon (C), and cation exchange capacity (CEC) 10.5 cmol (+)/kg.

Researchers compared six treatments in a corn-wheat cropping sequence replicated 4 times in a randomised block design. Plot cropping history included improved crop varieties (corn Var. Kalimpong, wheat Var. R 319) up to 1969-70, after which high yielding varieties of corn (Var. Ganga Safed 2 Hybrid) and wheat (Var. Sonalika) were tested. Until 1994, the fertiliser sources were strictly ammonium sulphate

Table 1. Treatment effect on corn and wheat yield (t/ha) from 1956 to 1994, Ranchi, India.

	1956-69		1970-79		1980-89		1990-94	
Treatment	Corn	Wheat	Corn	Wheat	Corn	Wheat	Corn	Wheat
No fertiliser	0.6	0.5	0.5	0.6	0.5	0.7	0.5	1.0
FYM	2.0	1.2	2.0	1.6	2.5	2.4	3.9	3.7
N	1.5	0.4	0.3	0.3	0.03	0.0	0.02	0.06
NP	2.1	1.3	1.5	2.3	0.1	0.5	0.05	0.9
NPK	2.4	1.4	2.0	2.6	0.3	1.2	0.1	1.3
NPK + lime	3.0	1.7	3.6	3.3	4.1	4.0	4.8	5.0

Table 2. Treatment effect on the SYI for corn and wheat, Ranchi, India.

Treatment	Average grain yield from 1970 to 1994				Sustainable yield index (SYI)	
	Corn yield, t/ha	Yield loss[1], %	Wheat yield, t/ha	Yield loss[1], %	Corn	Wheat
No fertiliser	0.50	87.9	0.76	81.5	0.06	0.09
FYM	2.80	32.7	2.50	39.0	0.30	0.23
N	0.11	97.3	0.12	97.1	–	–
NP	0.55	86.8	1.20	70.7	–	–
NPK	0.80	80.8	1.70	58.5	0.07	0.14
NPK + lime	4.16	–	4.10	–	0.58	0.47

[1]Relative to the NPK + lime treatment.

$[(NH_4)_2 SO_4]$, single superphosphate (SSP), and muriate of potash (MOP). From 1956 to 1969, N, P_2O_5 and K_2O were supplied at 44 kg/ha, after which rates were increased to 100-60-40 kg/ha. From 1976 to 1994, fertiliser rates were increased once more to 110-90-70 kg/ha. The farmyard manure (FYM) treatment included an annual application based on the amount of N added to non-manured treatments. Burned lime was applied at 50 percent of the requirement.

Results from the last 4 decades (**Table 1**) show consistently higher grain yields were obtained by applying lime + NPK. It was also noted that crop yields were lowest in the N-only treated plots.

A Sustainable Yield Index (SYI) was calculated over the last 25 years using the following relation:

$$SYI = \frac{\overline{Y} - ó}{Y_{max}}$$

where; $\overline{Y}$ = average yield over years;
ó = standard deviation;
Y_{max} = maximum yield obtained with any treatment.

A high SYI would indicate a more progressive management practice capable of producing high yields over the past 25 sampled years. Results show SYI values for NPK + lime plots were highest at 0.58 for corn and 0.47 for wheat (**Table 2**). The SYI for organically manured plots was 0.30 for corn and 0.23 wheat. Control and NPK treatments had the lowest calculated SYI values.

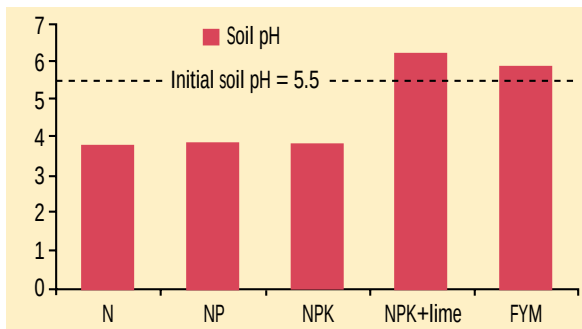

Figure 1. Change in soil pH with continuous cropping and fertiliser use in an acid soil (pH in control plot = 5.8), Ranchi, India.

Through continual monitoring of changes in soil properties, the

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Dr. Shihua Tu Joins PPIC Staff as Deputy Director, China Program

Dr. Shihua Tu joined the staff of PPIC in the new position of Deputy Director, Southwestern China. He will work from a newly inaugurated office in the Sichuan Academy of Agricultural Sciences (SAAS) in Chengdu, Sichuan province. PPIC offices are already established in Hong Kong, Beijing, and recently in Wuhan.

Dr. Tu received his B.Sc. degree at Sichuan Agricultural University in 1982 and began his career with the Soil and Fertilizer Institute of the Sichuan Academy of Agricultural Sciences. He later continued his education at the University of Manitoba, Canada, earning his M.Sc. in Soil Science in 1989 and completing his Ph.D. in Soil Chemistry in 1993.

In 1994, Dr. Tu rejoined the Soil and Fertilizer Institute of the Sichuan Academy of Agricultural Sciences. He is a leading soil scientist on soil chemistry and fertility research. In 1995 and 1996, he was appointed Vice-Director of the Institute, and in December 1996 became Director, continuing until May of 1998.

Dr. Tu will direct programs in agronomic research and education related to market development for potash and phosphate in Sichuan, Chongqing, Yunnan, and Guizhou provinces. **BCI**

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study determined soil pH was most affected in fertilized plots that were unlimed (**Figure 1**). The use of NPK + lime or FYM did not result in a significant increase in soil acidity.

Long-term experimentation reveals that acid soils of eastern and northeastern India would clearly benefit from balanced fertiliser use along with adequate liming. This best management practice (BMP) has been proven to produce high yields in corn and wheat crops. The application of FYM caused no appreciable effect on soil acidity, but produced yields that were about one-half to two-thirds of those obtained with a combined treatment of NPK + lime. **BCI**

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