Report on Rationalizing Phosphorous Use in India : Recommendations

Natural Resource Management

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Phosphorus in Crop Production

Phosphorus (P) is one of the major nutrients that constitutes about 0.1 to 0.4 percent of a plant's dry weight and plays very important role in plant metabolism. Thus, application / making phosphorus available for crops is very essential for successful crop production. Phosphorus is supplied through application of chemical fertilizers (DAP, SSP, TSP and Rock phosphate).

Phosphorus is highly immobile nutrient with 1-3% of the total phosphorus and 15-25% of the applied fertilizer P is available to plants. It leads to a continuous build-up of P in soil through fertilizer application. The problem is again aggravated since the rock phosphate (RP), the basic raw material used to manufacture P fertilizers, is non-renewable resource that is continuously getting depleted.

Continuous application of P at higher rates to different crops may cause P pollution and also escalating prices of P fertilizer in the recent past may reduce the profitability of the farmers. Enhancing use efficiency of applied P in different crops/ cropping systems would be an economically viable and environmentally benign way of efficient P management. Alternatively, it is also necessary to reduce the dependence on industrial fertilizers by recovering and reusing P from the food production and consumption chain.

Indian soils were initially low to medium in P, however continuous use of phosphate fertilisers in irrigated and assured rainfall area of the country, soil

P status has shown build up. Soils which were initially low in available P status have now shifted to medium and the medium soils have moved to high-P category. Low P fertilizer use efficiency suggests limited access of P fertilizers to plants, which could also indicate that P availability in soils is already high, and that plants no longer need the extra P supplied as fertilizer.

District-wise integrated fertilizer P consumption and available P status map of India (Figure.3) has been prepared by integrating district-wise P consumption intensity (Figure.1) with soil available P status map (Figure 2). The figure 2 is based on 16 crore Soil Health Card mission datasets (2015-2020). These maps showed that 21 high P consuming districts have high available P status and 67 high P consuming districts have medium available P status. Similarly, 17 medium P consuming districts have high available P status and 141 medium P consuming districts have medium available status. It means in about 246 districts (Table 1), reduced recommended doses

of fertilizers can be recommended to major crops/cropping systems without significant adverse impact on crop productivity.

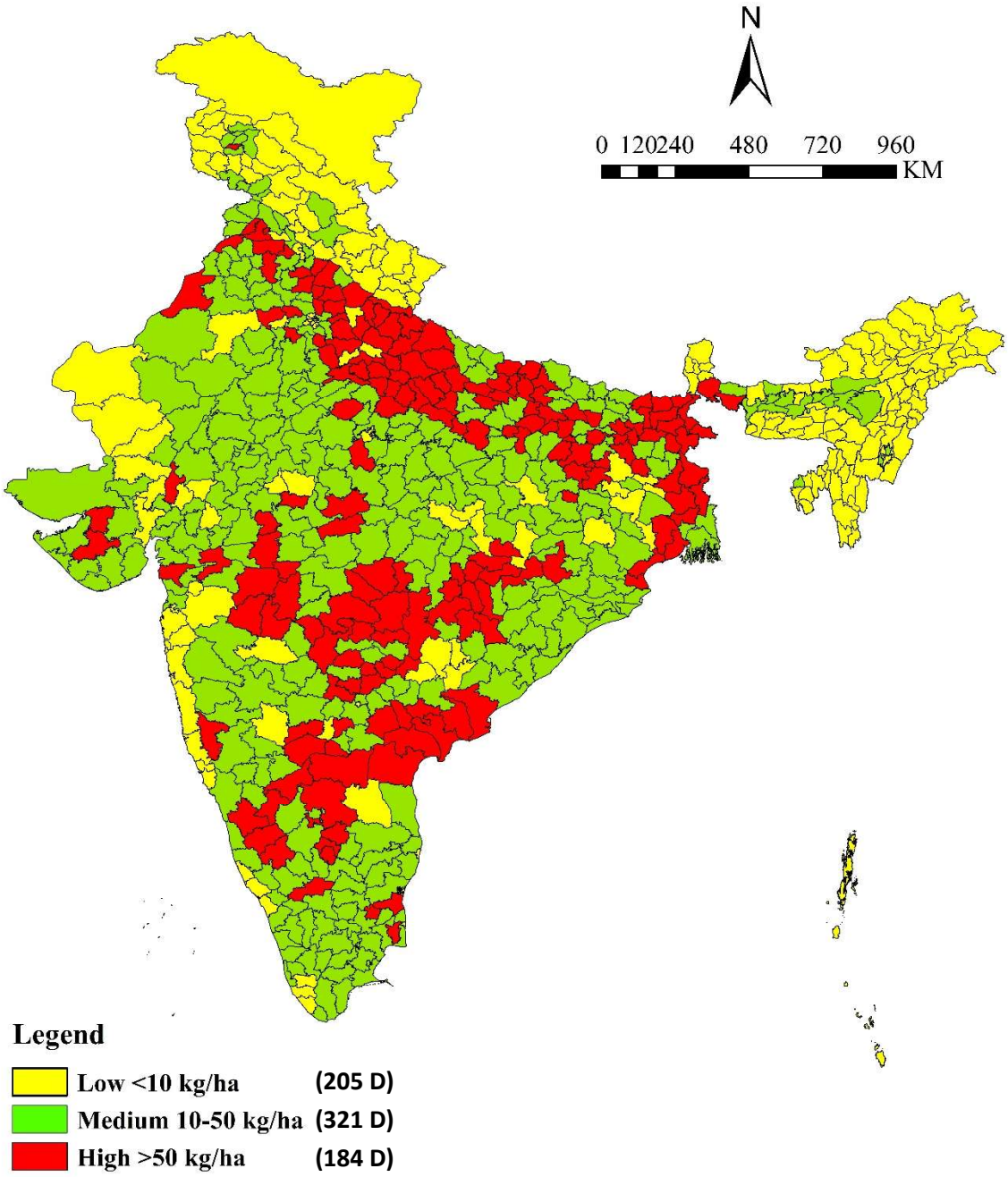

Fig. 1: Phosphorus consumption Intensity (kg P_2O_5/ha) (2024-25)

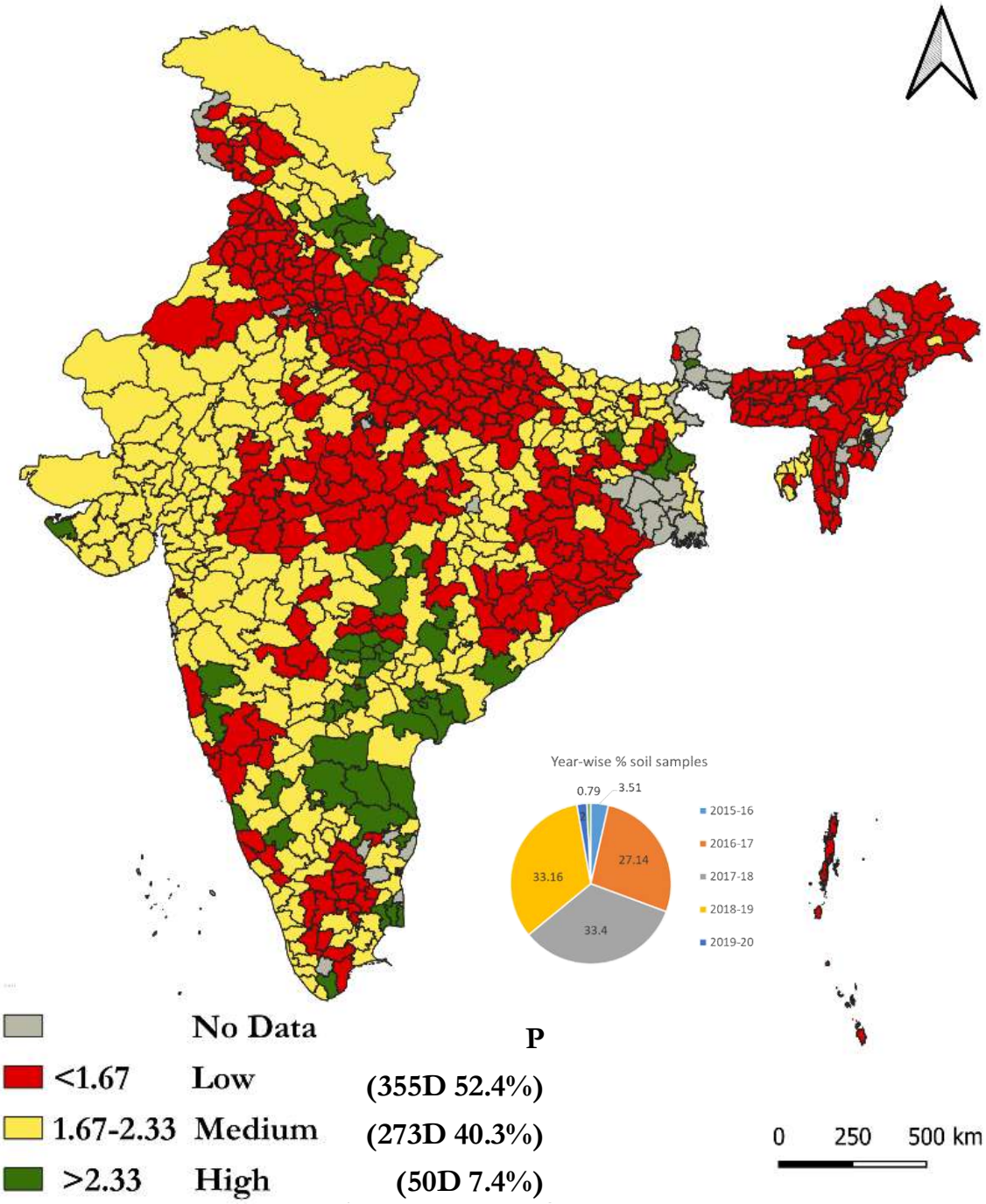

Fig.2: Available Phosphorus Nutrient Index based of Soil Health Card Datasets (2015-2020)

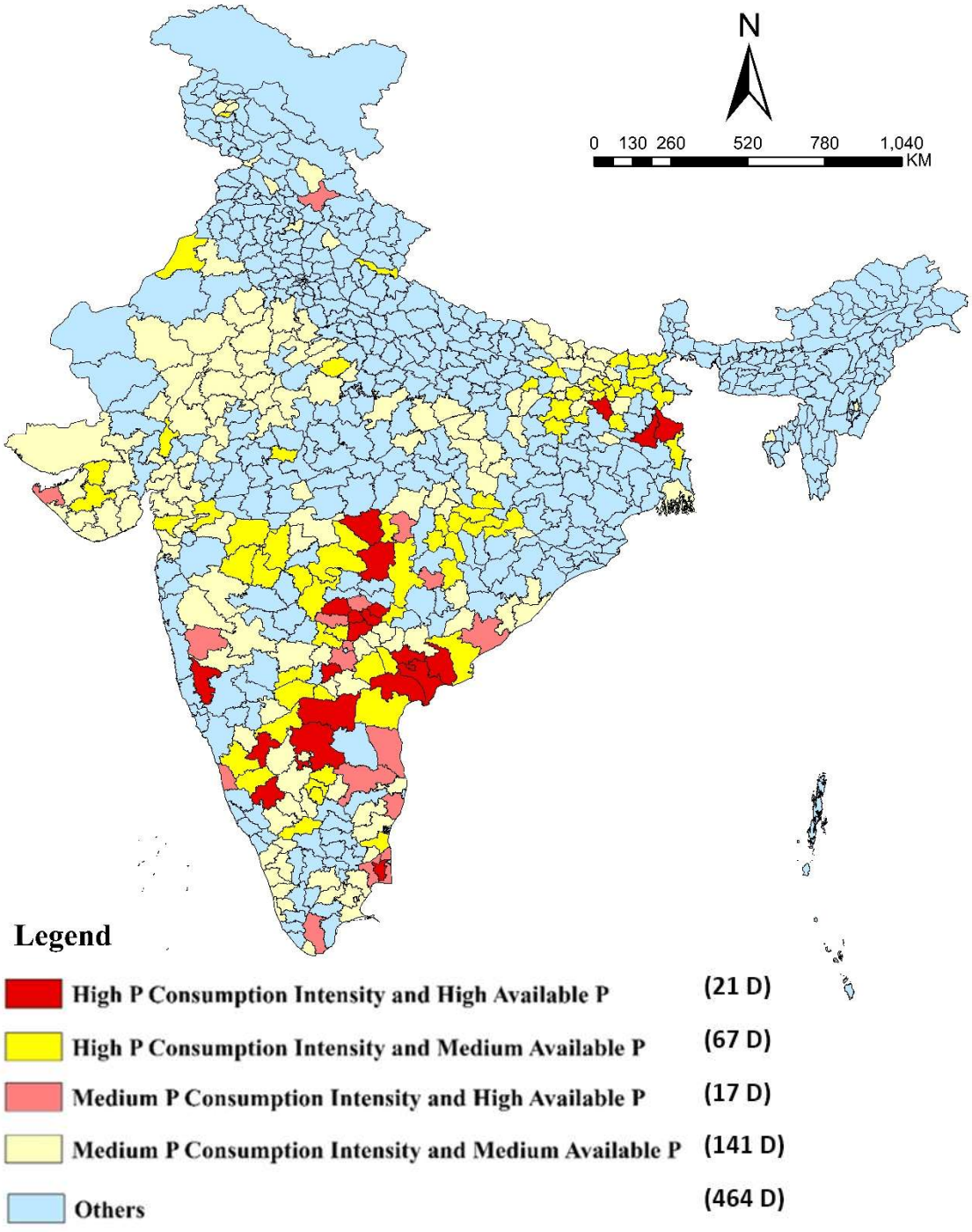

Fig: 3: P Consumption Intensity and Soil Available P Status integrated maps

Table 1: Medium to high p consumption and available P status districts (246)

SR. NO	Dist_Name	State_Name
High fertilizer p consumption and high soil available P status districts (21)		
1.	Anantapur	ANDHRA PRADESH
2.	Mahbubnagar	TELANGANA
3.	Guntur	ANDHRA PRADESH
4.	West Godavari	ANDHRA PRADESH
5.	Nizamabad	TELANGANA
6.	Kurnool	ANDHRA PRADESH
7.	Davangere	KARNATAKA
8.	Murshidabad	WEST BENGAL
9.	Birbhum	WEST BENGAL
10.	Krishna	ANDHRA PRADESH
11.	Khammam	TELANGANA
12.	Jamui	BIHAR
13.	Peddapalli	TELANGANA
14.	Nagpur	MAHARASHTRA
15.	Thiruvarur	TAMIL NADU
16.	Karimnagar	TELANGANA
17.	Chandrapur	MAHARASHTRA
18.	Kolhapur	MAHARASHTRA
19.	Hassan	KARNATAKA
20.	Siddipet	TELANGANA
21.	Rajanna	TELANGANA
High fertilizer P consumption and medium soil available P status districts (67)		
22.	Purnia	BIHAR
23.	Araria	BIHAR
24.	Bhagalpur	BIHAR
25.	Khagaria	BIHAR
26.	Deoghar	JHARKHAND
27.	Jogulamba	TELANGANA
28.	Prakasam	ANDHRA PRADESH
29.	Shopian	JAMMU & KASHMIR
30.	Bengaluru Urban	KARNATAKA
31.	Surat	GUJARAT
32.	Bhandara	MAHARASHTRA
33.	Suryapet	TELANGANA
34.	Nadia	WEST BENGAL
35.	Yadgir	KARNATAKA
36.	Bangalore Rural	KARNATAKA
37.	Maldah	WEST BENGAL
38.	Dhamtari	CHHATTISGARH
39.	Bellary	KARNATAKA
40.	Raichur	KARNATAKA
41.	Udham Singh Nagar	UTTARAKHAND
42.	Arwal	BIHAR

43.	Raipur	CHHATTISGARH
44.	Katihar	BIHAR
45.	Supaul	BIHAR
46.	Chatra	JHARKHAND
47.	Begusarai	BIHAR
48.	Chikballapur	KARNATAKA
49.	Gaya	BIHAR
50.	Morbi	GUJARAT
51.	Gwalior	MADHYA PRADESH
52.	Shimoga	KARNATAKA
53.	Munger	BIHAR
54.	Buxar	BIHAR
55.	Mahasamund	CHHATTISGARH
56.	Aurangabad_M	MAHARASHTRA
57.	Durg	CHHATTISGARH
58.	Nanded	MAHARASHTRA
59.	Bargarh	ODISHA
60.	Jalna	MAHARASHTRA
61.	Jayashankar	TELANGANA
62.	Nalgonda	TELANGANA
63.	Shajapur	MADHYA PRADESH
64.	Lakhisarai	BIHAR
65.	Kondagaon	CHHATTISGARH
66.	Jalgaon	MAHARASHTRA
67.	Chamarajanagar	KARNATAKA
68.	Sri Ganganagar	RAJASTHAN
69.	East Godavari	ANDHRA PRADESH
70.	Sangareddy	TELANGANA
71.	Kishanganj	BIHAR
72.	Medak	TELANGANA
73.	Buldana	MAHARASHTRA
74.	Baloda Bazar	CHHATTISGARH
75.	Saran	BIHAR
76.	Koderma	JHARKHAND
77.	Balod	CHHATTISGARH
78.	Janjgir-Champa	CHHATTISGARH
79.	Chikmagalur	KARNATAKA
80.	Nandurbar	MAHARASHTRA
81.	Wardha	MAHARASHTRA
82.	Yavatmal	MAHARASHTRA
83.	Nalanda	BIHAR
84.	Rajkot	GUJARAT
85.	Hingoli	MAHARASHTRA
86.	Sabarkantha	GUJARAT
87.	Gadchiroli	MAHARASHTRA
88.	Cuddalore	TAMIL NADU

Medium fertilizer P consumption and high soil available P status districts (17)		
89.	Kamareddy	TELANGANA
90.	Thanjavur	TAMIL NADU
91.	Rangareddi	TELANGANA
92.	Chittoor	ANDHRA PRADESH
93.	Jagitial	TELANGANA
94.	Satara	MAHARASHTRA
95.	Gondiya	MAHARASHTRA
96.	Nagapattinam	TAMIL NADU
97.	SPSR Nellore	ANDHRA PRADESH
98.	Shimla	HIMACHAL PRADESH
99.	Kanchipuram	TAMIL NADU
100.	Medchal	TELANGANA
101.	Narayanpur	CHHATTISGARH
102.	Tirunelveli	TAMIL NADU
103.	Devbhumi Dwarka	GUJARAT
104.	Visakhapatanam	ANDHRA PRADESH
105.	Udupi	KARNATAKA
Medium fertilizer P consumption and medium soil available P status districts (141)		
106.	Haveri	KARNATAKA
107.	Kota	RAJASTHAN
108.	Ambala	HARYANA
109.	Sheikhpura	BIHAR
110.	Navsari	GUJARAT
111.	Harda	MADHYA PRADESH
112.	Bemetara	CHHATTISGARH
113.	Vikarabad	TELANGANA
114.	Surguja	CHHATTISGARH
115.	Wanaparthy	TELANGANA
116.	Jangoan	TELANGANA
117.	Mahabubabad	TELANGANA
118.	Bastar	CHHATTISGARH
119.	Samastipur	BIHAR
120.	Baran	RAJASTHAN
121.	Solapur	MAHARASHTRA
122.	Kolar	KARNATAKA
123.	Muzaffarpur	BIHAR
124.	Ahmadnagar	MAHARASHTRA
125.	Rohtas	BIHAR
126.	Saharsa	BIHAR
127.	Purbi Champaran	BIHAR
128.	Surajpur	CHHATTISGARH
129.	Koppal	KARNATAKA
130.	Banka	BIHAR
131.	Akola	MAHARASHTRA
132.	Vizianagaram	ANDHRA PRADESH

133.	Bharatpur	RAJASTHAN
134.	Patna	BIHAR
135.	Yadadri	TELANGANA
136.	Amravati	MAHARASHTRA
137.	Darbhanga	BIHAR
138.	Dhule	MAHARASHTRA
139.	Kaimur	BIHAR
140.	Villupuram	TAMIL NADU
141.	Haridwar	UTTARAKHAND
142.	Mandya	KARNATAKA
143.	Datia	MADHYA PRADESH
144.	Bhadradri	TELANGANA
145.	Jamnagar	GUJARAT
146.	Bundi	RAJASTHAN
147.	Morena	MADHYA PRADESH
148.	Sangli	MAHARASHTRA
149.	Mysore	KARNATAKA
150.	Jhalawar	RAJASTHAN
151.	Kabirdham	CHHATTISGARH
152.	Pashchim Champaran	BIHAR
153.	Dholpur	RAJASTHAN
154.	Sheohar	BIHAR
155.	Srikakulam	ANDHRA PRADESH
156.	Pune	MAHARASHTRA
157.	Pulwama	JAMMU & KASHMIR
158.	Thiruvallur	TAMIL NADU
159.	Amreli	GUJARAT
160.	Ariyalur	TAMIL NADU
161.	Sitamarhi	BIHAR
162.	Tiruvannamalai	TAMIL NADU
163.	Satna	MADHYA PRADESH
164.	Jehanabad	BIHAR
165.	Mungeli	CHHATTISGARH
166.	Chittorgarh	RAJASTHAN
167.	Shivpuri	MADHYA PRADESH
168.	Junagadh	GUJARAT
169.	Gir Somnath	GUJARAT
170.	Botad	GUJARAT
171.	Katni	MADHYA PRADESH
172.	Nawada	BIHAR
173.	Madhubani	BIHAR
174.	Pratapgarh	RAJASTHAN
175.	Tapi	GUJARAT
176.	Kanniyakumari	TAMIL NADU
177.	Karauli	RAJASTHAN
178.	Warangal Urban	TELANGANA

179.	Hanumangarh	RAJASTHAN
180.	Bhavnagar	GUJARAT
181.	Dausa	RAJASTHAN
182.	Gajapati	ODISHA
183.	Chitradurga	KARNATAKA
184.	Balaghat	MADHYA PRADESH
185.	Gandhinagar	GUJARAT
186.	Subarnapur	ODISHA
187.	Alwar	RAJASTHAN
188.	Surendranagar	GUJARAT
189.	Nagarkurnool	TELANGANA
190.	Gulbarga	KARNATAKA
191.	Siwan	BIHAR
192.	Korea	CHHATTISGARH
193.	Kullu	HIMACHAL PRADESH
194.	Pathankot	PUNJAB
195.	Tonk	RAJASTHAN
196.	Malkangiri	ODISHA
197.	Tumkur	KARNATAKA
198.	Madurai	TAMIL NADU
199.	Porbandar	GUJARAT
200.	West Tripura	TRIPURA
201.	Kachchh	GUJARAT
202.	Una	HIMACHAL PRADESH
203.	Badgam	JAMMU & KASHMIR
204.	Vadodara	GUJARAT
205.	Rewa	MADHYA PRADESH
206.	Bharuch	GUJARAT
207.	Narmada	GUJARAT
208.	Dindigul	TAMIL NADU
209.	Valsad	GUJARAT
210.	Bhilwara	RAJASTHAN
211.	Anand	GUJARAT
212.	Chhatarpur	MADHYA PRADESH
213.	24 Paraganas South	WEST BENGAL
214.	Pudukkottai	TAMIL NADU
215.	Ajmer	RAJASTHAN
216.	Banswara	RAJASTHAN
217.	Alappuzha	KERALA
218.	Patan	GUJARAT
219.	Ernakulam	KERALA
220.	Jaipur	RAJASTHAN
221.	Palakkad	KERALA
222.	Sirohi	RAJASTHAN
223.	Korba	CHHATTISGARH
224.	Ramanagara	KARNATAKA

225.	Kheda	GUJARAT
226.	Ramanathapuram	TAMIL NADU
227.	Rajsamand	RAJASTHAN
228.	Imphal East	MANIPUR
229.	Mahisagar	GUJARAT
230.	Dhanbad	JHARKHAND
231.	Garhwa	JHARKHAND
232.	Panchmahal	GUJARAT
233.	Nagaur	RAJASTHAN
234.	Kottayam	KERALA
235.	Jodhpur	RAJASTHAN
236.	Thrissur	KERALA
237.	Udaipur	RAJASTHAN
238.	Sikar	RAJASTHAN
239.	Sidhi	MADHYA PRADESH
240.	Srinagar	JAMMU & KASHMIR
241.	Pali	RAJASTHAN
242.	Sivaganga	TAMIL NADU
243.	The Nilgiris	TAMIL NADU
244.	Singrauli	MADHYA PRADESH
245.	Malappuram	KERALA
246.	Jhunjhunu	RAJASTHAN

Rationalizing P use in agriculture

In this context, the data emanating from the long-term fertilizer experiments (LTFE) have shown that the continuous application of recommended P (for 2 to 4 decades) led to build-up of P in soils with highest accumulation in Inceptisols followed by Alfisols, Vertisols and Mollisols in major crops and cropping systems. Based on the studies conducted in India, it is recommended either to skip P application in one season or reduce the P dose. The details are as follows:

- The study conducted at Inceptisols of PAU, Ludhiana clearly demonstrated that reducing the P dose by half resulted in yields of maize and wheat that were statistically at par with 100% recommended dose of P.
- The package of practices of PAU, Ludhiana on P recommendations for farmers suggests skipping of the P application in *kharif* crops like rice, maize, cotton if the preceding crop of wheat in *rabi* season received full dose of P.
- In Alfisols of Kerala and Jharkhand, it is recommended to skip the recommended dose of phosphorus by half in rice crop in high P soil of Kerala and for different crops of Jharkhand, respectively.

- At LTFE sites of Bangalore and Coimbatore, reducing the recommended P dose by half, the yield did not decline. In Chhattisgarh, Himachal Pradesh, Madhya Pradesh and Vidarbha region of Maharashtra, 25% of RDF of phosphorus can be reduced in high P soils.
- In West Bengal also phosphorus fertilizer application can be reduced by 30 to 60% in high to very high P soils of jute crop.
- At the same time, the data from All India Network Project on Soil Biodiversity and Biofertilizers (AINP-SBB) suggest that yield of crops on utilising phosphorous solubilising bacteria (PSB) along with 75% recommended P dose was at par with 100% RDF at Jabalpur (Madhya Pradesh), Jorhat (Assam) and Udaipur (Rajasthan). It is recommended to reduce 50% of RDF-P for pearl millet and wheat if PSB is applied with *Azospirillum* and *Azotobacter*, respectively in North Saurashtra region of Gujarat.

Table 2: Recommendation for high P districts (based on compiled information)

State	Crop/cropping systems	Recommendation
ASSAM	Rice and jute	• Reduce 50% of RDF-P with PSB in high P soil
CHHATTISGARH	Rice-Wheat	• Reduce 25% of RDF-Pin high P soil
GUJARAT	Groundnut, Pearl millet – Wheat	• Reduce 50% of RDF-P with FYM in groundnut • Reduce 50% of RDF-P + FYM @ 5 t ha^{-1} + seed inoculation with PSB + *Azospirillum* (pearl millet) /*Azotobacter* (wheat) in North Saurashtra region
HIMACHAL PRADESH	All crops	• Reduce 25% of RDF-P in high P soil
JHARKHAND	All crops	• Reduce 50% of RDF-P in high P soil
KARNATAKA	Maize and Fingermillet	• Reduce 50% of P fertilizer application for both maize and fingermillet with application of 7.5 t /ha of FYM for maize and lime for finger millet
KERALA	Rice	• Reduce 50% of RDF-P in high P soil
MADHYA PRADESH	All crops	• Reduce 25% of RDF-P in high P soil • Reduce 50% of RDF-P in very high P soil
MAHARASHTRA	Soybean	• Reduce 20% of RDF-Pin Vidarbha region • Reduce 25% of RDF-P with PSB and FYM in Marathwara region
NEW DELHI	Maize- Wheat	• Reduce 50% of RDF-P with AM+ PSB in medium P soil
ODISHA		• No recommendation for P reduction as there is no build-up in soil phosphorus
PUNJAB	Rice-wheat, Maize-wheat and Cotton-wheat	• Skip P application to *kharif* crop in medium to high P soil • Skip P application both *kharif* and *rabi* for 2-3 years in very high P soil
RAJASTHAN		• No recommendation for P reduction as there is no build-up in soil phosphorus
TAMIL NADU	All crops	• Reduce 50% of RDF-P in high P soil
TELANGANA	Paddyand Maize	• Reduce 25% of RDF-P in high P soil • Reduce 50% of RDF-P in very high P soil

UTTAR PRADESH	Sugarcane	• Reduce 25% of RDF-Pin high P soil
UTTARAKHAND		• No recommendation for P reduction as there is no build-up in soil phosphorus
WEST BENGAL	Jute	• Reduce 33% of RDF-P in high P soil • Reduce 66% of RDF-P in very high P soil

Summary

In general, the data generated from AICRP-LTFE across different soil types, showed that the continuous application of recommended doses of phosphatic fertilizers in various cropping systems, increased the soil P status.Thus, the phosphorus management strategies have to be modulated to reutilize the accumulated P by reduction of the P dose to half or skipping of P in alternate year from the fertilizer schedule of the *kharif* crops in medium to high P soils. Therefore, any policy decision to rationalize or minimize P fertilizer use will be an appropriate choice in Indian context.