Review Article

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Potassium Status of Indian soils: Need for Rethinking in Research, Recommendation and Policy

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A B S T R A C T

Growing population and its need pressurize Indian agriculture to produce more from shrinking arable land. Balanced nutrition plays a key role in enhancing the productivity of crops and sustainability of production systems. Potassium is third most important plant nutrient. Recent studies showed declining status of K in majority of the soils in India. High crop K removal than K addition by farmers and imbalanced use of NPK fertilizers contributed to large-scale K mining and K deficiency in soils and crops. K fertility depletion observed in all soil types. Widespread K deficiency was identified in rice-wheat system of Indo-Gangetic plains, horticultural, plantation, ornamental, aromatic and avenue plants. The current fertilizer recommendations are obsolete, very much generalized without considering the soil types, hence need revision and revalidation. Site-specific fertilizer recommendations, if followed can minimize the fertility K depletion and maintain productivity and sustainability and also economize the fertilizer cost. Awareness on K use by farmers needs immediate action.

Keywords
K status, Indian soils, Fertilizer misapplication, Site-specific K recommendation, Policy initiatives.

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Introduction

Potassium (K) is third most important plant nutrient, vital to many plant processes owing to its requirement for activation of at least 60 different enzymes involved in plant growth, important for osmoregulation, cation-anion balance, protein synthesis, water balance, reducing lodging, imparting disease resistance and improving quality and shelf life of crop produce. Nutrient K is less mobile in soils because of the strong affinity with exchange sites of clays. Large rates of K uptake can be attributed to its high mobility due to the large permeability of cell membranes to K-ions, which arise from the occurrence of a range of highly K selective, low and high affinity ion channels and transporters. The large K uptake rate achieved by roots result in a steep depletion of solution K in the rhizosphere. It has been well established that a significant proportion of plant needs of K are met from non-exchangeable fraction of soil K (Sreenivasa Rao et al., 2010; 2014).
Exchangeable K and non-exchangeable K can thereby significantly be depleted and contribute to a substantial proportion of plant uptake. Agronomically, the demand for K largely varies with plant species and cultivars and productivity. The large portion of K uptake essentially occurs during the vegetative stage and can reach values of 10 kg/ha/day and above. In India, until 1980's, potassium application did not receive much attention because of general belief that Indian soils were rich in potassium and a profitable response to applied K had not always been observed so as to warrant blanket application (Ghosh and Hasan, 1976). The fertilizer K use and fertilizer K consumption reached maximum peak in 2010-11 from 29000 t and 0.19 kg per in 1960-61 to 3514000 t in 2010-11 and 18.0 kg per ha, respectively (Table 1). However, total fertilizer nutrient consumption is increased especially N and P but the consumption of K fertilizers declined (Table 1), which lead to wide gap in NPK ratio leading to mining of soil K and imbalance nutrition. In this article an attempt has been made to review the past and recent information on K status of Indian soils.

**K status - scenario at country level**

Available K map prepared in 1969 showed that K availability was low in 20 per cent districts, medium in 52 per cent and high in 28 per cent (Ramamurthy and Bajaj, 1969). Seven years later, Ghosh and Hasan (1976) summarized the soil test results of 4.5 million samples and observed that soils in 20 per cent districts (63 districts) were low, 42 per cent (130) were medium and 38 per cent (117) were high in available K. States like Gujarat, Haryana, Madhya Pradesh and Rajasthan were rated high in K status. Andhra Pradesh, Arunachal Pradesh, Bihar, Karnataka, Kerala, Maharashtra, Orissa, Punjab, Tamil Nadu and West Bengal states showed maximum area under medium K status (Table 2). Assam, Himachal Pradesh, Jammu and Kashmir, Meghalaya, Mizoram, Tripura, Pondicherry and Uttar Pradesh (U.P.) states recorded more area under low K status. A comparison of the past two evaluations indicated that K status of soils in more than 40 districts of 10 states had made an upward shift (high K status), even though actual potassium use during this period was negligible. Based on 3.65 million soil samples analyzed between 1997 to 1999 (Motsari, 2002) (Table 2) and based on 11 million soil samples (Hasan and Tiwari, 2002), the considerable area under low potassium status was observed in the states of Tripura and Jammu & Kashmir, medium in Assam, Arunachal Pradesh, Haryana, Himachal Pradesh, Kerala, Meghalaya, Mizoram, Odisha, Puducherry, Punjab, Uttar Pradesh (U.P.) and West Bengal while high in Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Karnataka and Tamil Nadu (Naidu et al., 2010 and Naidu et al., 2011). The general trend indicated that K status in Indian soils had been sliding from medium to high (in year 1976) to medium to low (in year 2002). Similar trend of change in available K was reported in some of the bench mark soils spread in different states (Bansal et al., 2002; Sekhon, 1999).

**Recent K status - at regional and micro level**

Soil nutrient mapping had been gaining more importance in different states and among the farming community too. In this direction, central and state R&D departments had taken up soil analysis in extensive areas and the recent K status is presented below.

**Northern region**

The recent K status of 2003 in 126 districts in Indo-Gangetic Plains (IGP) indicated that Meerut, Shajapur, Rampur, Bijnor, Aligarh and Mainpuri districts of Uttar Pradesh
showed low to medium in K status, Faizabad, Gazipur, Siddarthnagar of Uttar Pradesh, Hoshiarpur, Kaprthula, Moga, Ludhiana, Mukatsar of Punjab, Ambala, Sonepat, Faridabad, Hisar, Sirsa, Kurukshetra of Haryana and Gorakhpur, Padrona, Mirzapur of Uttar Pradesh (Sharma, 2003). At district level, in Haryana, the K status in Panchkula district was rated as low to medium, Ambala, Gurgaon, Faridabad, Rewari and Mahendragarh districts were medium to low, Yamuna Nagar, Kurukshetra, Bhiwani and Jhajjar districts were medium to high while Kaithal, Fatehabad, Sirsa, Hisar, Jind, Panipat and Karnal were high.

**Eastern region**

About 70 percent of the Jharkhand state was rated medium to high in K status (Sarkar et al., 2007). Sitamadi, Madhuban, Gopalgunj of Bihar and Birbhum in West Bengal showed medium to low, Aurangabad in Bihar and West Dinjapur and Malda in West Bengal showed medium to high and Mursidabad, Midnapur and 24 Parganas-north of West Bengal showed high K status (Sharma, 2003). Sarkar et al., (2010) observed low to medium and medium to low in various districts in West Bengal.

**North-East region**

In Assam, Chirang, Goalpara, Kokrajhar districts were rated as medium to low (Baruah et al., 2009). In Tripura, three out of four districts showed medium to low K status (Sarkar et al., 2010).

**Southern region**

During 1970s, in Karnataka, about 17, 50 and 33 per cent of the total cropped area recorded low, medium and high K status, respectively. The subsequent soil test information indicated only 61 per cent of total soil samples analyzed were rated as high in K status (Motsari, 2002). Available K status map of Karnataka (Shivaprasad et al., 1995) at 10-km grid interval showed that small pockets in Dakshina Kannada, Uttara Kannada, Kodagu, Chikmagalur, Shimoga and Bijapur districts were low in available K while major parts of Kolar, Bangalore, Tumkur, Mandya, Mysore, Kodagu, Dakshina Kannada, Chikmagalur, Shimoga, Uttar Kannada, Belgaum and northwestern parts of Bijapur, southern parts of Dharwad and Gulbarga districts were medium in K status. At sub-district level (taluka) in Karnataka the K status declined either from high to medium or medium to low (Table 3). Recent studies indicated that K status improved from low to medium in Sringeri, Bijapur, Athani and Khanapur taluks might be due to regular K application to cash crops like sugarcane and plantation crops. The dominant soils that showed major decline in K status were red, lateritic and shallow black soils (Shivaprasad et al., 1995). During 2010-11, the analysis of surface soil samples of major land use types in Mysore, Shimoga, Hassan, Bijapur, Raichur, Haveri, Belagaum, Bagalkote, Chikkaballapur and Kolar districts indicated that K status was medium (Table 3) when compared to that of the year 2002 (Hasan and Tiwari, 2002). Similar exercise in H.D.Kote, Hunsur, Periyapatna and Mysore taluks of Mysore district during 2011 indicated that the available K status as compared to the year 2004, (Shetty et al., 2008), the K status of all the taluks (sub-district level) showed decline in K status.

In Andhra Pradesh, the trends in K status during the period 1975 to 1996 indicated that Guntur, Krishna, Prakasham, Srikakulam, Visakhapatnam, Anantapur, Chittoor, Kurnool, Mahabubnagar and Medak districts were rated medium, East Godavari, Nellore and Nalgonda medium to high and Adilabad, Kadapa, Khammam and Rangareddy districts rated high while in 1996, high K status was
observed in most of the districts except Adilabad (medium) (Naidu et al., 2002). The recent fertility assessment of Medak district indicated that overall available K status was rated as medium (54%) to low (43%) (Reddy et al., 2005). At cadastral level, in watersheds and research farms of Anantapur and Kadapa districts of Andhra Pradesh, even in medium deep and deep black soils, low to medium status of K was observed (Naidu et al., 2009; Nair et al., 2003). This indicated that decline in K availability more pronounced in recent days than earlier.

In 1976, in Kerala, the K status was medium in 56 percent area and low in 44 per cent area while in 1999, the trend indicated 62 percent area was low and 31 percent under medium (NBBSS and LUP, 1999). Soil fertility assessment of Kerala carried out in 2012 indicated 33 percent area was low, 37 percent medium and 31 percent high (Rajasekharan et al., 2013). At sub-taluk level, 42 panchayaths of Palakkad district showed low K status in eastern and central region while medium in western region (Kutty et al., 2008). The K status over a period shifted from medium to low, even though K fertilizer use was popular in Kerala. In Puducherry region, the K status was medium to low while in Karikal region it was medium to high (Vadivelu et al., 2008).

Western region

At sub- taluka level (Panchayat Samithi), the soil test information of 0.58 million surface samples from 14 districts in Rajasthan during 1990 to 2000 revealed that 97 per cent of the Panchayath Samities showed high available K (Kanthaliya et al., 2003).

K balance sheet in diverse soil regions

The nutrient addition, removal, balance and nutrient mining index for India and for different states covering alluvial, black, red, lateritic and desertic soil regions indicated that K removal by crops far exceeded than the K addition through fertilizers. At national level, the K depletion was about 10.2 m t/year and mining index for K was 8.0. In all the soil regions, K balance was negative. The K mining index was highest in Rajasthan (152.7) followed by Haryana (105.7) Punjab (40.7), Madhya Pradesh (35.2) and least in Kerala (2.01) and Karnataka (2.79) which indicated K depletion in all soil types (Table 4).

Fertilizer misapplication leads to K depletion

Misapplication of nutrients had been defined as excess or under application of nutrients required to soil and crops. The amount of N, P and K fertilizers applied over period in Indian agriculture indicated that K fertilizers were applied in much lower dose with wide ratios of NPK. The fertilizer consumption of N increased from 1.4 to 85 kg/ha from 1960 to 2010 whereas K consumption increased from 0.2 to 18 kg/ha during the same period (Table 1). The K application was still below i.e. 10 kg in major food grain producing states (Punjab, Haryana, Uttar Pradesh. etc.). The imbalanced use of NPK fertilizers was due to dual pricing policy of national government. The price of N and P fertilizers was almost maintained steadily for a long period where as the cost of K fertilizers had increased considerably. Besides this, easy access and availability of N and P fertilizers in the local markets and unawareness of importance and benefits of K application in crops by farmers since the effect of applied K would be visible at or after maturity stage. Further, the inadequate application of K fertilizers might be due to lack of crop response to applied K fertilizers in some situations even on low K status soils but in contrast significant responses to applied K were also recorded in soils with high K status.
Table 1 Fertilizer consumption in India

| Year  | Fertilizer consumption (000 t) | Fertilizer consumption (kg/ha) | Ratio of N: P: K |
|-------|-------------------------------|-------------------------------|-----------------|
|       | N | P₂O₅ | K₂O | N | P₂O₅ | K₂O |                   |
| 1960-61 | 210 | 53 | 29 | 1.39 | 0.35 | 0.19 | 7.3:1.8:1.0       |
| 1970-71 | 1487 | 462 | 228 | 8.92 | 3.26 | 1.43 | 6.3:2.2:1.0       |
| 1980-81 | 3678 | 1214 | 624 | 21.3 | 7.00 | 3.60 | 5.9:1.9:1.0       |
| 1990-91 | 7997 | 3222 | 1360 | 43.1 | 17.3 | 7.20 | 6.0:2.4:1.0       |
| 2000-01 | 10920 | 4215 | 1567 | 58.9 | 22.8 | 8.50 | 7.0:2.7:1.0       |
| 2010-11 | 16558 | 8050 | 3514 | 84.9 | 41.3 | 18.00 | 4.7:2.3:1.0     |
| 2015-16 | 17372 | 6979 | 2401 | 89.1 | 35.8 | 12.3 | 7.5:3.0:1.0       |

[Source: Department of Agriculture and Cooperation (DAC)]

Table 2 K status in different states over period

| State               | Percentage distribution of samples in different fertility classes |
|---------------------|---------------------------------------------------------------|
|                     | 1976       | 2002       |
|                     | Low | Medium | High | Low | Medium | High |
| Andhra Pradesh      | 9.5 | 62.0 | 28.5 | 9   | 30     | 61   |
| Arunachal Pradesh   | -   | 100   | -    | 9   | 46     | 45   |
| Assam               | 66  | 34    | -    | 30  | 46     | 34   |
| Bihar               | -   | 71.5  | 28.5 | -   | -      | -    |
| Gujarat             | -   | -     | 100  | 5   | 30     | 65   |
| Haryana             | -   | 18    | 82   | 27  | 41     | 32   |
| Himachal Pradesh    | 86  | 36    | 28   | 45  | 47     | 8    |
| J & K               | 57  | 43    | -    | 62  | 32     | 6    |
| Karnataka           | 17  | 50    | 33   | 7   | 32     | 61   |
| Kerala              | 44  | 56    | -    | 29  | 44     | 27   |
| Madhya Pradesh      | 7   | 21    | 72   | 10  | 32     | 58   |
| Maharashtra         | -   | 52    | 48   | 8   | 18     | 74   |
| Meghalaya           | 100 | -     | 34   | 63  | 3      | 3    |
| Mizoram             | 100 | -     | -    | 10  | 73     | 17   |
| Orissa              | 15  | 85    | -    | 33  | 41     | 26   |
| Pondicherry         | 100 | -     | -    | 2   | 97     | 1    |
| Punjab              | -   | 58    | 42   | 6   | 48     | 46   |
| Rajasthan           | -   | 26    | 74   | -   | -      | -    |
| Tamil Nadu          | -   | 54    | 46   | 12  | 36     | 52   |
| Tripura             | 100 | -     | -    | 54  | 22     | 24   |
| Uttar Pradesh       | 58  | 34    | 8    | 12  | 55     | 33   |
| West Bengal         | 13  | 80    | 7    | 30  | 36     | 34   |

(Source: Ghosh and Hassan, 1976; Naidu et al., 2002)
**Table 3** Long term fertility changes in available K status in Karnataka soils

| District       | Taluks       | Soil type       | Potassium Fertility Status |
|----------------|--------------|-----------------|----------------------------|
|                |              |                 | 1971 | 1980 | 1985 | 1995 | 2010 |
| Bangalore      | Hoskote      | Lateritic Soils | M    | M    | M    | L    | L    |
| Belgaum        | Khanapur     | Shallow red soils | M    | M    | M    | L    | M    |
|                | Athani       | Shallow red soils | H    | H    | M    | L    | M    |
|                | Belgaum      | Lateritic Soils | M    | H    | M    | L    | L    |
| Bellary        | Kudligi      | Shallow red soils | H    | M    | M    | M    | L    |
| Bijapur        | Bijapur      | Shallow black soils | M    | M    | -    | L    | M    |
|                | Indi         | Shallow black soils | M    | H    | -    | L    | L    |
| Chickmangalur  | Sringeri     | Lateritic soils | M    | M    | M    | L    | M    |
| Dharwar        | Shirhatti    | Shallow red soils | M    | M    | M    | L    | L    |
| Gulbarga       | Shapur       | Shallow red soils | H    | H    | -    | M    | -    |
| Kodagu         | Mercara      | Lateritic Soils | M    | M    | M    | M    | L    | -    |
|                | Virajpet     | Lateritic Soils | M    | M    | M    | L    | -    |
| Dakshina Kannada | Bantwal  | Lateritic soils | M    | M    | L    | L    | -    |
|                | Mangalore    | Lateritic soils | M    | M    | L    | L    | -    |
|                | Puttur       | Lateritic soils | M    | M    | L    | L    | -    |
|                | Udupi        | Lateritic soils | M    | M    | L    | L    | L    |
| Uttara Kannada | Honnavar     | Lateritic soils | M    | M    | L    | L    | -    |
|                | Siddapur     | Lateritic soils | M    | L    | L    | L    | -    |

(Source: Rao, 1971; Karnataka State Department of Agriculture (KSDA), Booklet, 1980; Singh et al., 2007)

**Table 4** K balance sheet in different states

| Alluvial Soils | State       | Nutrients (000 t) | Removal (R) | Balance | Mining index (R/A) | Source                  |
|----------------|-------------|-------------------|-------------|---------|--------------------|-------------------------|
|                |             | Addition (A)      |             |         |                    |                         |
| Punjab         | 18.7        | 763.5             | -744.8      | 40.7    | Aulakh and Behl, 2001 |
| UP             | 113.6       | 1777.2            | -1663.6     | 15.6    | Yadav et al., 2001  |
| Haryana        | 4.6         | 490.1             | -485.5      | 105.7   | Kumar et al., 2001  |

| Black soils    | State       | Nutrients (000 t) | Removal (R) | Balance | Mining index (R/A) | Source                  |
|----------------|-------------|-------------------|-------------|---------|--------------------|-------------------------|
| Maharashtra    | 196.9       | 2095.9            | -1899.1     | 10.6    | Patil et al., 2001  |
| Madhya Pradesh | 24.1        | 848.8             | -824.7      | 35.2    | Swarup et al., 2001 |

| Red soils      | State       | Nutrients (000 t) | Removal (R) | Balance | Mining index (R/A) | Source                  |
|----------------|-------------|-------------------|-------------|---------|--------------------|-------------------------|
| Karnataka      | 216.1       | 603.6             | -387.5      | 2.8     | Hegde and Sudhakar Babu, 2001 |

| Lateritic Soils | State       | Nutrients (000 t) | Removal (R) | Balance | Mining index (R/A) | Source                  |
|-----------------|-------------|-------------------|-------------|---------|--------------------|-------------------------|
| Kerala          | 87.3        | 175.6             | -88.3       | 2.0     | John et al., 2001  |

| Desertic Soils  | State       | Nutrients (000 t) | Removal (R) | Balance | Mining index (R/A) | Source                  |
|-----------------|-------------|-------------------|-------------|---------|--------------------|-------------------------|
| Rajasthan       | 7.0         | 1068.0            | 1061.1      | 152.7   | Gupta, 2001        |
| All India       | 1454.2      | 11656.5           | -10202.3    | 8.0     |                      |
| State | District | Crop       | K dose (kg/ha) | Rec   | F.P. |
|-------|---------|------------|----------------|-------|------|
|       |         |            | Recommended    | Farmer applied K | |
| A.P.  | Nellore | Paddy      | 40             | 60    |      |
| Punjab| IGP region | Paddy   | 30             | 0     |      |
| Haryana| IGP region | Paddy   | 60             | 0     |      |
| U.P.  | IGP region | Paddy   | 60             | 2.2   |      |
| Bihar | IGP region | Paddy   | 40             | 9.8   |      |
| West Bengal| IGP region | Paddy  | 40             | 32.7  |      |
| Punjab| IGP region | Wheat    | 30             | 0     |      |
| Haryana| IGP region | Wheat    | 60             | 0     |      |
| U.P.  | IGP region | Wheat    | 40             | 2.1   |      |
| Bihar | IGP region | Wheat    | 40             | 11.6  |      |
| West Bengal| IGP region | Wheat  | 70             | 27.6  |      |
| Rajasthan| Bhasatpur | Rape seed  | 20             | 0     |      |
| M.P.  | Morena   | Rape seed  | 20             | 0     |      |
| Orissa| Sambalpur | Rape seed  | 20             | 15    |      |
| Assam | Nagoan   | Rape seed  | 15             | 0.4   |      |
| Tamil Nadu| Thiruvannamalai | Groundnut  | 45             | 23.3  |      |
| Karnataka| Kolar    | Groundnut  | 25             | 10.5  |      |
| Karnataka| Tumkur  | Groundnut  | 25             | 11.4  |      |
| A.P.  | Ananthapur | Groundnut  | 20             | 5.3   |      |
|       | Kurnool   | Groundnut  | 20             | 4.5   |      |
|       | Vizianagaram | Groundnut | 20             | 0     |      |
| Gujarat| Junagadh | Groundnut  | 0              | 0     |      |
|       | Rajkot    | Groundnut  | 0              | 0     |      |
| Karnataka| Belgaum | Sugarcane  | 187.5          | 20.3  |      |
| Maharashtra| Nagpur | Cotton  | 50             | 10    |      |
|       | Nagpur    | Soybean    | 0              | 0     |      |
|       | Nanded    | Cotton     | 50             | 19.3  |      |
|       | Amravati  | Cotton     | 50             | 8.8   |      |
|       | Yavarmal  | Cotton     | 50             | 8.9   |      |
|       | Jalgaon   | Cotton     | 50             | 20.9  |      |
| Karnataka| Dharwad | Cotton  | 25             | 0.9   |      |

Rec – Recommended dose, F.P.- Farmers practice
(Source: Kumar et al., 2001; Challa, 2002).
### Table 6: Potash misapplication in various crops

| District (State)       | Crop            | Soils                        | Recommended practice | Farmers practice |
|------------------------|-----------------|------------------------------|----------------------|------------------|
|                        |                 |                              | Av. Yield (q/ha)     | K (Kg/ha)       |
|                        |                 |                              | STCR (Kg/ha)         | Misapplication   |
|                        |                 |                              |                      | Av. Yield (q/ha) | K (Kg/ha)       |
|                        |                 |                              | STCR (Kg/ha)         | Misapplication   |
| Nellore (AP)           | Paddy           | Red coastal clay             | 40.0                 | 40              |
|                        |                 |                              | 34                   | +6              |
|                        |                 |                              | 35.0                 | 60              |
|                        |                 |                              | 25                   | +35             |
|                        | Shrink swell    | (cal) clay                   | 45.0                 | 40              |
|                        |                 |                              | 36                   | +4              |
|                        |                 |                              | 40.5                 | 60              |
|                        |                 |                              | 28                   | +32             |
| Nagpur (Maharashtra)  | Cotton          | Shrink-swell clay            | 3.7                  | 50              |
|                        |                 | (shallow)                    | 49                   | +1              |
|                        |                 |                              | 2.6                  | 10              |
|                        |                 |                              | 33                   | -23             |
|                        | Shrink-swell     | clay                         | 7.4                  | 50              |
|                        |                 | (medium deep)                | 102                  | -52             |
|                        |                 |                              | 5.0                  | 10              |
|                        |                 |                              | 68                   | -58             |
|                        | Shrink-swell     | clay                         | 15.2                 | 50              |
|                        |                 | (deep)                       | 207                  | -157            |
|                        |                 |                              | 10.0                 | 10              |
|                        |                 |                              | 132                  | -122            |
| Nagpur (Maharashtra)  | Soybean         | Shrink-swell clay            | 8.7                  | 0               |
|                        |                 | (shallow)                    | 8                    | -8              |
|                        |                 |                              | 6.0                  | 0               |
|                        |                 |                              | 0                    | 0               |
|                        | Shrink-swell     | clay                         | 13.0                 | 0               |
|                        |                 | (medium deep)                | 25                   | -25             |
|                        |                 |                              | 9.0                  | 0               |
|                        |                 |                              | 9                    | -9              |
|                        | Shrink-swell     | clay                         | 16.0                 | 0               |
|                        |                 | (deep)                       | 0                    | 0               |
|                        |                 |                              | 11.8                 | 0               |
|                        |                 |                              | 0                    | 0               |
| Belgaum (Karnataka)    | Sugar cane      | Shrink-swell clay            | 1080.0               | 187.5           |
|                        |                 |                              | 229                  | -41.5           |
|                        |                 |                              | 825.0                | 203             |
|                        |                 |                              | 175                  | +28             |
|                        | Red gravelly    | clay                         | 1050.0               | 187.5           |
|                        |                 |                              | 223                  | -35.5           |
|                        |                 |                              | 920.0                | 203             |
|                        |                 |                              | 195                  | +8              |
| Ludhina (Punjab)       | Wheat           | Coarse loamy                 | 56.2                 | 30              |
|                        |                 |                              | 75                   | -45             |
|                        |                 |                              | 55.0                 | 35              |
|                        |                 |                              | 72                   | -37             |
|                        | Fine loamy      |                              | 59.2                 | 30              |
|                        |                 |                              | 55                   | -25             |
|                        |                 |                              | 60.0                 | 35              |
|                        |                 |                              | 57                   | -22             |
Fertilizer use by farmers in various crops cultivated across states showed wide variations in amount of nutrient K use, crop to crop and region to region.

Farmers did not apply recommended K except sugarcane (Table 5). Farmers seldom apply K in oilseed and pulse crops under rainfed situation.

Over all, the minimal or no K application over years led to continuous K depletion in soils.

**Suboptimal K recommendation vis-a-vis K depletion**

The status and application scenario of K had been contrast to that of N and P. In general, the recommended K was lower than the required due to the general belief that Indian soils were rich in available K.

In cotton, soybean, sugarcane and wheat, the recommended K and application of K by farmers was sub optimal except in sugarcane where farmers had been applying K slightly more than the required (8 to 28 kg/ha) in Belgaum region of Karnataka (Table 6).

In soybean, even there was no K recommendation and further, the farmers were also ignorant about K application leading to continuous K mining in black soils (Table 6). Further, in case of many rainfed crops such as groundnut, finger millet, pearl millet, chickpea and maize, K recommendation was missing in regional recommendations which led to K depletion by imbalanced application. The twin problems of suboptimal fertilizer recommendations and K misapplication by farmers lead to continuous K depletion. The present K recommendations for various crops in different states were developed in late 1970s which need revision and revalidation to bridge the gap between K application and crop removal.

**Factors affecting potash consumption in India**

In India, potash consumption depends mainly on three factors viz., maximum retail prices fixed by government, availability of potash based on import and availability of potash carrying complexes in the region. With launching of complex fertilizers in 1970s, significant improvement in the use of complex fertilizers in southern India was observed but, in major areas of northern India, it is meager. During last one and half decade, urea availability was satisfactory, but the same was not the case with other fertilizer products. Lack of availability of potash and potash carrying complexes is one of the reasons for imbalanced NPK ratio in northern India. Further, during last decade, there is no addition to manufacturing capacities of complex fertilizers in the country and production of complexes is more or less stagnant.

Tendency of the Indian farmer is to buy the fertilizer, whichever is available in the market. Seriousness on potash application was lacking due to lack of farmers’ education and awareness. Farmers tend to overlook the benefits of K application because; the effect of nutrient application on plants is visible only at maturity stage in the form of improvement in size, shape, colour and quality of the produce. In contrast, the effect of nitrogen and phosphorus is seen soon after the time of application.

**Nutrient Based Subsidy (NBS) - a policy initiative for K application**

In the context of Nation’s food security, the declining response of agricultural productivity to increased fertilizer usage in the country and to ensure the balanced application of fertilizers, the Government of India introduced the Nutrient Based Subsidy (NBS)
Policy with effect from 1st April 2010 for decontrolled P and K fertilizers which enabled to provide murate of potash, NPKS complexes along with other fertilizers to the farmers at subsidized rates based on the nutrients (N, P, K & S) contained in these fertilizers (http://pib.nic.in/news/erelease.aspx?relid=63723), further the policy also allowed import of complex fertilizers. It was observed that post implementation of NBS in P & K sector, in the first year the subsidy payout reduced but the increase in international prices resulted in increase in subsidy payout as well as increase in retail price. Subsidized fertilizers can also be used as inputs for customized fertilizers. The NBS policy has also allowed import of complex fertilizers which is a beneficial step. These major steps will help in promoting balanced use of fertilizers and in improving fertilizer availability in different parts of the country.

The other government programmes initiated to restore soil health are like Bhoo Chetan, is mainly focusing on micronutrient supplement. In such schemes, if K is also included along with micro and secondary nutrients based on site specific soil test, which help in maintenance of soil health and productivity. Issue of Soil Health Card (SHC) to each farmer is another programme initiated in Tamil Nadu and Kerala, where in SHC indicates the soil nutrient status, fertilizer application requirement for different crops to be grown by a farmer. It forms a part of land use planning at farm level. Farmer, soil and eco-friendly nutrient subsidy policies help in reducing the misapplication of nutrients and also cost of production.

The available K status in Indian soils over four decades, from national to cadastral level, showed a gradual decline in K status with more depletion in red, lateritic and shallow black soils. Recent isolated studies indicated that the K status declined to medium to low even in medium deep and deep black soils. These trends were due to low K application by the farmers, imbalanced use of NPK fertilizers, misapplication and blanket K recommendations leading to wide spread K deficiency in soils and crops. Also, the present fertilizer recommendations, which were of four decades old and still being followed in certain pockets, warrants revision and revalidation. Site-specific fertilizer recommendations, if followed can minimize the fertility K depletion and maintain productivity and sustainability and also economize the fertilizer cost. With more policy support like NBS which though encouraging, more farmer, soil and ecofriendly action plans can be drawn and implemented.

**Future research needs**

Need to harmonize data on K status and develop a new K fertility map for the country with revised rating limits.

Intensive research, both at national and state level, based on the benchmark soils and soil types on differential response of crops to applied K fertilizers, to make recommendations considering soil K pools. Fertilizer recommendations to be revised and revalidated based on soil-crop-climatic conditions.

Research efforts needed to increase K use efficiency in crops and its recycling to reduce the K loss from the soil-crop system.

Large scale on-farm demonstrations to sensitize the farmers on the need for K application, particularly in K deficient regions, in convergence with the ongoing national programmes like Rashtriya Krishi Vikas Yojana, National Food Security Mission etc.
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