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Impact of potassium management in coastal rice crop on socio-economic status in west coast of southern India

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Abstract
Background: The importance of potassium management in low-fertile soils in heavy rainfall areas, with respect to rice crop productivity, is crucial for developing sustainable rice cultivation in the west coast of southern India. As nitrogen remains heavily subsidized, there is a continued imbalance in the use of nitrogen, phosphorus, and potassium fertilizers. The removal of potassium by the rice crop exceeds its addition through fertilizers and recycling. Most of the soils in the west coast of southern India are low to medium in plant-available potassium. Therefore, the response of rice crops to applied potassium is generally found to be significant in improving yield quality.
Methods: Field experiments were conducted through frontline demonstrations (FLDs) for three consecutive years during the kharif season from 2020-21 to 2023-24 at ten farmers' fields in the Dakshina Kannada district to validate the impact of FLDs on potassium management in coastal rice crops. The fields were randomly selected in Mangaluru, Puttur, and Belthangady taluks. The farmers' practices were maintained as the local check. Observations such as yield, quality parameters, and economics were recorded using the minimum support price of the crop in the respective years for both demo and check plots.
Results: The average grain yield in demo plots was 73.1 q/ha, while it was 53.7 q/ha under farmers' practices. The increase in yield in demo plots may be attributed to the split application of potassium to ensure its availability throughout the crop growth period, resulting in an increase in average growth parameters such as the number of tillers per square meter (623.1) compared to farmers' practices (468.7). On average, demo plots achieved higher net returns (Rs. 1, 54,719) and a B: C ratio of 3.90, compared to farmers' practices (Rs. 1, 05, 414 and B:C 3.05). The higher grain yield in demo plots compared to farmers' practices was reported by Gautam *et al.* (2014).

Keywords: Front line demonstration (FLD), technology gap, potassium management, integrated nutrient management, growth and yield parameters, soil acidity, sustainable production

Introduction
Rice is the predominant crop of prominent land use in many coastal and deltaic regions of the tropics. Mostly deep water and floating rice subjected to devastating floods and cyclone occupy the coastal rice. Because of prolonged waterlogging during the monsoon season, continuous monocropping of rice with long duration tall Indica varieties were cultivated in several coastal areas and the yield level is practically low in the region.
The coastal zone represents the transition zone between terrestrial and marine influence. India has an 8129 km long coastline. Its peninsular region is bounded by the Arabian Sea on the west, the Bay of Bengal on the east and Indian Ocean to its south. It has two island-ecosystems, the Andaman and Nicobar Islands in the Bay of Bengal and the Lakshadweep Islands in the Arabian Sea. Usually the marine influence with distinctive coastal flora and fauna exists approximately up to 50 km inshore. Owing to the peculiar climatic, edaphic and geomorphologic circumstances the entire ecosystem is highly fragile and risk prone to degradation. The high intensity of heavy rainfall received during a short period together with impeded drainage causes prolonged waterlogging in several areas. The flash floods and water submergence reduces the input use efficiency, lowers the crop yield and affects the human health. The coastal area along the shoreline is generally flat with slope towards the sea and is interposed by innumerable river, deltas, channels, creeks, marshes, lagoons and other features.

Thus, the coastal areas are more vulnerable to the environmental effects with continuous expansion of urbanization, industrialization, tourism and other activities.

Potassium (K) is the most neglected nutrient in Indian agriculture and accounts only 10% of the total fertilizer use. The increased cropping intensity and use of high yielding cultivars since the green revolution led to heavy removal of K from soil. Recurrent K uptake over the past six decades has mined soil K level in many cultivated areas and continuously transforming sufficiency into deficiency. A recent soil tests a little over 1 lakh samples from 33 states of India have categorized 41.1%, 29.3%, and 29.5% of soil samples as low, medium and high in available K respectively. Further, the trend of soil available K status showed a persistent decline in percentage of area under high and medium soil K. Consequently, the evidence of rice crop responding to K nutrition is increased (Vijayakumar S *et al*. 2021) [11].

Materials and Methods

Field experiments through frontline demonstrations (FLDs) were conducted for 3 consecutive years during kharif season 2020-21 to 2023-24 at thirty farmer's fields of Dakshina Kannada districts to validate impact of FLD on Potassium management in coastal rice crop at randomly selected farmer's fields in Mangaluru, Puttur and Belthangady taluks. Each demonstration size was 0.40 ha and provided 15 quintals of muriate of potash (MOP) as critical input to motivate 30 farmers for adoption of demonstrating new technology covering an area of 06 hectares. During the period from 2020 to 2023 eight capacity building programmes were organized at different villages of Dakshina Kannada and the activities were also covered in local media's, All India Radio, local newspapers, folders, popular article for promotion of the potassium management. The farmer practices were maintained in case of local check. Observations like yield, quality parameters recorded and economics were calculated using minimum support price of the crop in respective years for both demo and check plots.

Soil samples from the FLD farmer fields were analysed before and after harvest of the rice crop through following standard soil testing procedures to know its fertility status.

Table 1: Treatment details of the FLD technology demonstrated

Technology	RDF: 60:30:75 NPK kg/ha 100% P as Basal dose N and K applied in 3 equal splits during Basal, Maximum tillering stage (30 DAT) and between panicle initiation and boot leaf stage (55-60 DAT) $ZnSO_4$ @ 20 kg/ha, INM comprising of Farm Yard Manure (FYM) 10 t/ha, Soil test-based Lime application
Farmers Practice (Check)	Application of NPK complex fertilizers (15:15:15 or 17:17:17 or 19:19:19 one bag) (30 DAT), no application of lime and $ZnSO_4$ and least or no application of FYM

Table 2: Red rice varieties suitable to different land situation in Coastal Karnataka

Land situation	Water depth (cm)	Salinity level (ECe: dS/m)	Suitable rice varieties
Upland	0-20	0.04-0.16	Mahaveera, KPC-1,
Medium land	20-40	0.16-0.64	MO-4, Sahyadri Panchamukhi, Netravati, Sahyadri brahma
Low land	40-60	0.64-2.56	Mukti, Jyothi, Sahyadri Panchamukhi, Sahyadri Kempumukthi, Jaya

Results and Discussions

Table 3: Soil fertility status of demo plots collected before and harvest of the rice crop

Soil Properties	pH	EC (dS/m)	Avail N (kg/ha)	Avail. P_2O_5 (kg/ha)	Avail. K_2O (kg/ha)	Exch. Ca (C.mol (p+)/kg)	Exch. Mg (C.mol (p+)//kg)	OC (g/kg)
Initial	5.88	0.039	214.33	32.4	104.8	0.74	0.17	8.6
Final	5.91	0.044	211.42	31.3	107.7	0.72	0.17	8.7

Soils of all the demo plots were moderately acidic with 5.88 and slightly increased to 5.91 due to lime application at rate of 200 kg/ha during crop cultivation to manage soil acidity as per the recommendations of package of practice. The acidic pH of the soil might be attributed mainly to the leaching of the bases due to the existing high rainfall conditions and to some extent due to the acidic parent materials. Similar findings have been documented by Mallikarjuna *et al*., 2024 [5] and reported that the soils were persisted acidic in reaction, with very low salt content, medium to high in organic carbon status. These soils are non-saline in nature (Free of soluble salts) with average electrical conductivity ranges between 0.039-0.044 dSm^{-1} (Table 3). The average soil organic carbon content of both initial (8.6 g kg^{-1}) and final (8.7 g kg^{-1}) soils was found high in all the demo plots. This is attributed to the addition of plant residues and farmyard manure to surface horizons. These results were justifiable with the studies of Shenoy, 2019 [7]. The available nitrogen content in all the demo plots was found low both in initial (214.33 kg ha^{-1}) and final (211.42 kg ha^{-1}) as shown in Table 3. Nitrogen status may due to the fact that the soil could retain only a limited quantity of mineralized Nitrogen and significant amount of Nitrogen loss through leaching and DE nitrification in these soils (Usha and Jose 1983) [10].

The available nitrogen was less than 280 kg ha^{-1} hence rated low (Srinivasamurthy *et al*., 1999) [9]. Available phosphorus content of both initial (32.4 kg ha^{-1}) and final (31.3 kg ha^{-1}) plots was recorded medium. Soils of all demo plots were low in available potassium. Ratings for available potassium indicate that values less than 141 kg ha^{-1} are low 141 to 336 kg ha^{-1} as medium as and more than 336 kg ha^{-1} as high (Srinivasamurthy *et al*., 1999) [9]. Similar results were reported in the studies of Singh *et al*., 2007 [8]. Exchangeable calcium and magnesium in all the demo plots were low, this is due to the occurrence of excess and frequent rainfall in the study areas which leached most of the basic cations like calcium, magnesium, potassium and sodium from the surface soil to lower horizons.

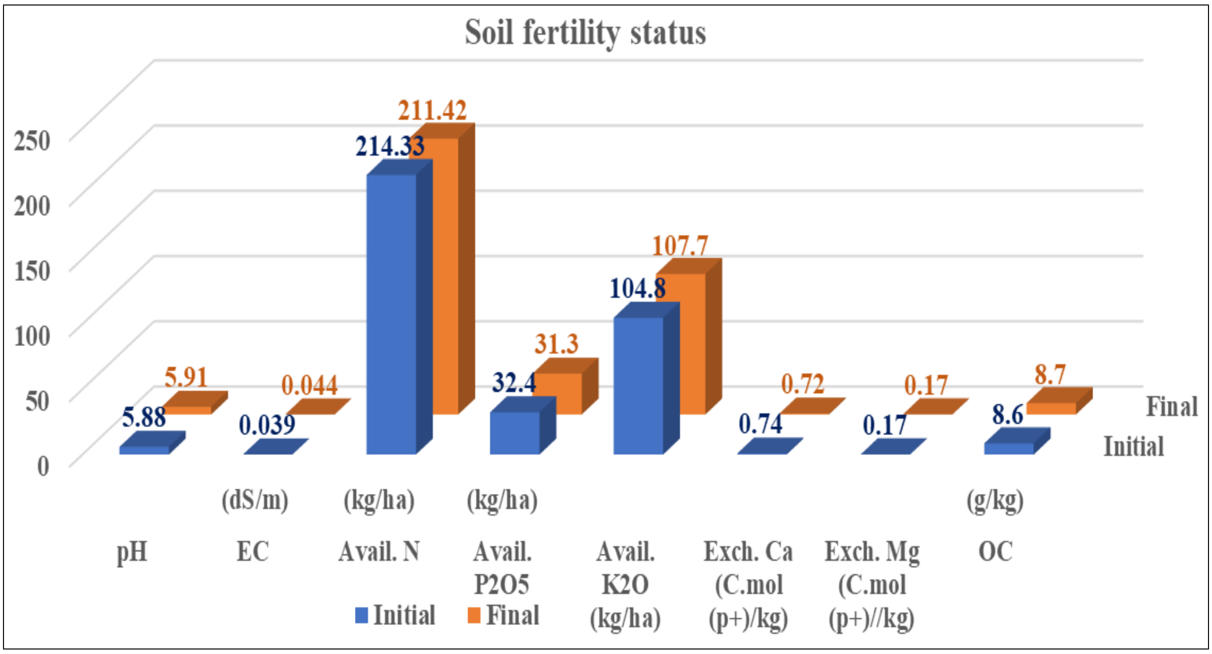

Fig 1: Initial and final soil fertility status of demonstration plots

Table 4: Growth and yield attributes of coastal rice crop in Demo and Check under FLD.

Year	Treatment	Plant Height (cm)	No of Tillers /M2	Straw yield (q/ha)	Grain Yield (q/ha)	% Increase in Yield over check	Technology gap (q/ha)
2020	Check	106.3	549	76.7	64.5	-	
	Demo	109.0	672	89.8	76.0	17.9	11.6
2021	Check	105.5	451	74.6	64.1	-	
	Demo	113.3	579	86.1	73.4	14.4	9.4
2022	Check	97.7	406.2	39.7	32.6	-	
	Demo	115.4	618.4	72.4	69.8	53.2	37.2
Average	Check	103.2	468.7	63.7	53.7	-	
	Demo	112.6	623.1	82.8	73.1	28.5	19.4

Growth and yield parameters: The growth and yield parameters from both the demo and check (Farmer's practices) plots were assessed under supervision of the KVK scientists and it was obvious that an average yield of demonstrated plots was 28.5% higher than that of farmer's practice. The average grain yields under demo and check plots were 73.1 q ha^{-1} and 53.7 q ha^{-1} respectively (Table 4). The increase in yield of demo plots might be due to split application of potassium to make its availability throughout crop growth period with enhanced nutrient use efficiency and increase in average growth parameters like number of tillers per square meter (623.1) over farmer's practice (468.7). The explanations behind the increase of yield under demonstrated plots might be due to timely planting, withstand against flood, effective utilization of nutrients and adoption of other recommended technologies about which the farmers were ignorant (Das *et al*., 2002; Bouman *et al*., 2017 and Darthiya *et al*., 2021) [3, 1, 2].

Extension gap: An extension gap between demonstrated technology and farmers practices was also calculated and on an average basis, the extension gap of 19.4 q ha^{-1} was chronicled. This gap might be attributed to the adoption of potassium management, timely application of balanced nutrition, acceptance of advanced technologies and improved production practices such as liming, proper seed rate, use of seed treatment material, integrated nutrient management, pest management in demonstrated plots which resulted in higher grain yield than the traditional farmer's practices (Panda *at al*., 2011) [6].

Technology gap: The technology gap was calculated by deducting the demonstrated plot yield from the potential yield of the rice crop. The recorded technology gap was 11.6, 9.4 and 37.2 q ha^{-1} during the study period (Table 4). The difference in technology gap during three years could be due to more feasibility of recommended technologies like planting time, seed treatment, integrated nutrient management and plant protection measures.

Economics: On an average basis, demo plot recorded higher net returns (Rs. 1, 54, 719) and B: C ratio (3.90) over farmer's practice (Rs. 1, 05, 414 and B: C 3.05) (Table 5). Due to higher grain yield, net returns and B: C ratio was also higher in demo plot as compared to farmer practice (Gautam *et al*., 2014) [4].

Impact: From the year 2020-21 to 2022-23, eight capacity building programmes were organized at different villages of Dakshina Kannada benefiting 243 farmers also provided 15 quintals of fertilizer (Muriate of potash) and 3 tonnes of agricultural lime as critical input to motivate the farmers for adoption of new technology covering an area of 6 hectares under Front Line Demonstration programme. During the period of three years there was 2192 quintals of rice production and increase in productivity from 18 to 20%. The total additional returns gained was Rs. 1.47 Lakhs due to potassium management in coastal rice crop (Red rice). Among total farmers attended training and field day programmes, 38 per cent of the farmers were adopted this technology which may upsurge with the time advancement.

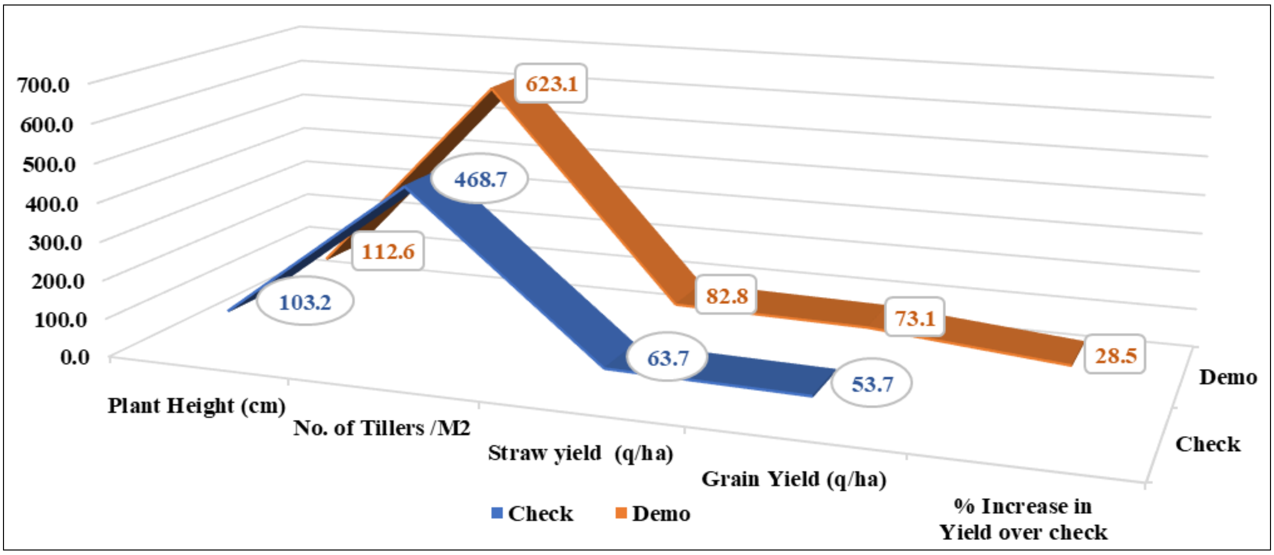

Fig 2: Growth and yield parameters of rice crop under demo and check plots

Table 5: Grain yield, economics of FLDs (Demo) and farmer practices (Check)

Year	Treatment	Grain Yield (q/ha)	Gross Return (Rs)	Gross Cost (Rs)	Net Return (Rs)	B:C Ratio
2020	Check	64.3	148747.5	36480	112267.5	3.07
	Demo	74.7	173217.5	37330	135887.5	3.64
2021	Check	64.1	160390	38160	122230	3.20
	Demo	73.4	185115	39060	146055	3.74
2022	Check	32.6	1,10,165	28,425	81,745	2.87
	Demo	69.8	2,24,373	42160	1,82,213	4.32
Average	Check	53.7	139768	34355	105414	3.05
	Demo	72.6	194235	39517	154719	3.90

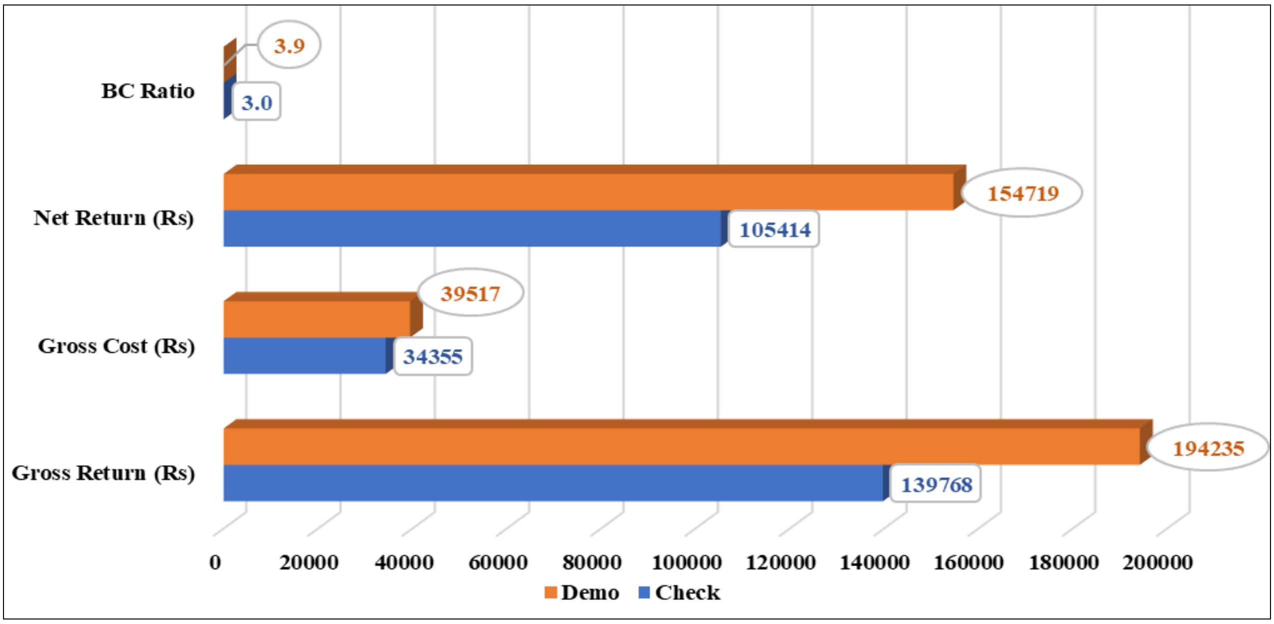

Fig 3: Economic benefits of technology over check

Conclusions

A better understanding the importance of potassium management at low fertile soils in heavy rainfall area in relation to rice crop productivity is vastly imperative to develop sustainable rice production in the west coast of southern India. Due to nitrogen remaining heavily subsidized, there exists a continued imbalance in the use of nitrogen, phosphorus and potassium fertilizers. Removal of potassium by rice crop far exceeds its additions through fertilizers and recycling. Most of the soils in the west coast of southern India were low to medium in plant available potassium. Therefore, response of rice crop applied potassium generally was found enormous in terms of quality yield. Farmers apply very small quantities of potassium fertilizers to rice whereas total annual potassium removal by rice exceeds 156 kg K_2O ha^{-1} causing depletion of soil potassium supply. Highly negative potassium balances (applied through fertilizers minus removal by crops) mean that it will be impossible to maintain the present production levels of the rice crop in this prevailing climatic and edaphic conditions. Potassium balances worked out after taking into consideration management of straw and potassium inputs from irrigation water may, however, suggest means and ways to achieve sustainability of rice cropping system.

References

1. Bouman BAM, Humphreys E, Tuong TP, Barker R. Rice and water. Adv Agron. 2007;92:187-237.
2. Darthiya M, Lokanadhan S, Muralidharan C, Sankaran VM, Lakshmanan A, Meena S, *et al*. Yield evaluation of red rice land races of Tamil Nadu under organic practices. Biol Forum. 2021;13(4):1175-1178.
3. Das KK, Panda K, Sarkar RK, Reddy JN, Ismail AM. Submergence tolerance in relation to variable floodwater conditions in rice. Environ Exp Bot. 2002;66(3):425-434.
4. Gautam P, Lal B, Raja R, Baig MJ, Mohanty S, Tripathi R, *et al*. Effect of nutrient application and water turbidity on submergence tolerance of rice (*Oryza sativa*). Ann Appl Biol. 2014;166(1):90-104.
5. Lingappa M, Kumar BTN, Ramesha TJ, Rashmi R, Kedarnath. Characteristics of west coast lateritic soils of Southern India. Int J Res Agron. 2024;7(3):659-664.
6. Panda MM, Reddy MD, Sharma AR. Yield performance of rainfed lowland rice as affected by nursery fertilization under conditions of intermediate deep water (15-50 cm) and flash flood. Plant Soil. 2011;132(1):65-71.
7. Shenoy H. Study of soil nutrient status of Arecanut gardens of Dakshina Kannada district of coastal Karnataka. Int. J Agric Sci. 2019;11(5):7996-7998.
8. Singh RS, Singh AK, Shyampura RL. Soil resource survey and mapping of soils of Bundi District. Annual Report 2007-08. NBSS & LUP; c2007.
9. Srinivasamurthy CA, Chidanandappa HM, Nagaraja MS. Laboratory manual for methods of soil analysis. Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAS, GKVK, Bangalore; c1999.
10. Usha PB, Jose AI. Carbon-nitrogen relationship in laterite soils of Kerala. Agric Res J Kerala. 1983;21(2):15-22.
11. Vijayakumar S, Kumar D, Kulasekaran R, Prabhu G, Jinger D, Khanam R, *et al*. Potassium nutrition in rice: A review. Oryza. 2021;58(3):341-353.