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Impact of Land Resource Inventory Based Fertilizer Recommendations on Cotton Yield and Soil Sustainability

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Indiscriminate fertilizer use has become a key factor in land degradation with blanket applications, often depleting resources and weakening soil health. Land Resource Inventory (LRI) serve as a farmer-friendly approach to tackle the problem of unscientific fertilizer use, ensuring more precise and balanced nutrient application. To address this, a field study was conducted during *Kharif* 2024-2025 in Bu Koppa and Bu Tharlagatta villages of Kundgol *Taluk*, Dharwad district, to test the

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benefits of LRI based fertilizer management in cotton. The experiment was carried out with two treatments: farmers in Bu Koppa continued with conventional fertilizer practices, while those in Bu Tharlagatta adopted LRI-based recommendations. Post-harvest analysis showed that LRI fields retained higher levels of organic carbon, nitrogen, phosphorus, potassium, iron and copper along with enhanced dehydrogenase activity. Cotton performance improved with better plant growth attributes and nutrient uptake compared to non LRI plots. Additionally, it delivered significant benefits, boosting seed cotton yield by 50.9% and lint yield by 35.4%. Economically, LRI adoption increased gross returns, net returns and benefit-cost ratio, despite an additional fertilizer cost. These findings demonstrate that LRI based fertilizer recommendations not only enhance productivity and profitability but also support agricultural sustainability.

Keywords: LRI; Land Resource Inventorization; fertilizer recommendation; cotton; LRI cards.

1. INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is one of the most important commercial crops cultivated worldwide and is known for its high nutrient demand. Being an exhaustive crop, cotton removes large quantities of nutrients from the soil and imbalanced or insufficient fertilizer application often leads to nutrient mining and declining soil fertility. To sustain productivity, there is a clear need for site-specific and balanced nutrient management that aligns with both soil characteristics and crop requirements.

Land Resource Inventory (LRI) cards have emerged as a practical solution to this challenge. Unlike conventional soil health cards, which primarily report the nutrient status of soil, LRI cards provide comprehensive and farm-specific information (Ravi et al., 2022). They are developed from micro-watershed-level LRI databases and act as detailed information guides for each land parcel. These cards include insights on soil fertility status, land and water conservation measures, soil limitations and suitable crop choices, thereby equipping farmers with actionable recommendations for sustainable resource use (Ravi et al., 2022).

By translating complex scientific data into farmer-friendly guidance, LRI cards bridge critical knowledge gaps, particularly in rainfed regions where resource mismanagement often limits productivity. They not only suggest crop and fertilizer choices but also promote soil and water conservation, helping farmers manage their land more effectively. Land resource inventory is a detailed investigative assessment of the site-specific status and dynamic conditions of soil, water, land use, weather and related features, observed and measured at the ground level, (Sathishkumar and Rajesh, 2021). Adopting LRI-based fertilizer recommendations is especially important in cotton cultivation, where the common practice of blanket fertilizer application often results in overuse or underuse of nutrients. Tailored nutrient management through LRI improves efficiency, enhances yields and safeguards long-term soil health. Assessing the on-field benefits of such approaches is essential to build farmer confidence in LRI cards and to highlight their relevance for sustainable agriculture. In this context, the present study was undertaken to evaluate the influence of LRI-based fertilizer recommendations on soil properties, crop growth, yield performance and economic returns in cotton.

2. MATERIALS AND METHODS

The field experiment was conducted on farmers fields in Bu Koppa and Bu Tharlagatta villages, located in the Shirur Sub-watershed (4D5B5j) of Kundgol *Taluk*, Dharwad district, within the Northern Transitional Agro-climatic Zone (Zone 8) of Karnataka. The soils in the study area are *Vertisols*, poorly drained and ranging from deep to very deep, with a predominantly clayey texture. They are found on gently sloping terrain (1-3%) and are prone to slight to moderate erosion.

A detailed land resource inventory of the study area was conducted by RS & GIS experts under the REWARD project at UAS Dharwad. Soil sampling followed a systematic 320 × 320 m grid design and the collected samples were analysed for their physico-chemical properties. The results were used to determine nutrient status and establish ranges for classifying soil fertility levels across individual farm holdings. Based on this information, LRI cards were generated. For the study, two villages were selected: Bu Tharlagatta, where farmers adopted LRI-based demonstration trials and Bu Koppa, where farmers continued with conventional practices without LRI cards,

Table 1. Nutrient range classification

Available soil nutrient (per ha)	Very low	Low	Medium	High	Very high
Available Nitrogen (kg ha^{-1})	<140	140 - 280	281 - 560	561 - 700	>700
Available Phosphorus (kg ha^{-1})	<11.45	11.45 - 22.9	22.91 - 57.25	57.26 - 91.60	>91.60
Available Potassium (kg ha^{-1})	<72.3	72.3 - 144.6	144.7 - 337.4	337.5 - 674.8	>674.8
Correction factor	RDF × 1.67	RDF × 1.33	RDF × 1.00	RDF × 0.67	RDF × 0.33

serving as the non LRI. In Bu Tharlagatta, fertilizer application was tailored using nutrient categorization derived from LRI data, ensuring crop and plot-specific recommendations. The recommended dose of fertilizers (RDF) was further refined with correction factors to develop modified LRI-based fertilizer schedules.

T_1: Village 1: Bu Koppa: Non LRI plot (4 ha)

T_2: Village 2: Bu Tharlagatta: Demonstration plot with given input (LRI plot - 4 ha)

The initial soil test revealed that nitrogen was low, phosphorus (P_2O_5) was at a medium level and potassium (K_2O) was very high. Using this, the recommended dose of fertilizers was revised with appropriate correction factors to arrive at the LRI adjusted fertilizer dose.

T_1: Non LRI: 72.5: 50: 12.5 N: P_2O_5: K_2O kg ha^{-1}

T_2: LRI: 133: 75: 25 N: P_2O_5: K_2O kg ha^{-1}

Where:

RDF: 100: 75: 75 N: P_2O_5: K_2O kg ha^{-1}

Farmyard manure @ 6 t ha^{-1} was applied once in two years in both LRI and non LRI fields.

The field experiment was carried out using Bt cotton hybrid Kanaka (*GossyPium hirsutum* L.), a variety well known for its high yield potential, resistance to bollworms and good fibre quality. The crop was grown during the *Kharif* 2024 season on 4 ha each under LRI and non LRI treatments, with a planting spacing of 120 × 60 cm. To assess soil properties, twenty composite samples were collected at two stages, before the start of the experiment and after harvest, from both LRI and non LRI plots. These samples were drawn randomly and independently at each stage. All samples were processed and analysed. Additionally, five fresh soil samples were taken at peak crop growth to study dehydrogenase activity. For plant growth assessment, twenty plants were randomly selected from each treatment to record parameters such as plant height, relative chlorophyll content (SPAD) and dry matter accumulation per plant. Another set of twenty plants was used to estimate nutrient uptake. Yield components were recorded at harvest by sampling twenty randomly selected locations, each covering 1 m^2, and the data were extrapolated to calculate yield on a per-hectare basis. Production economics was calculated for both treatments and fertilizer savings or expenditure were estimated by using data collected from the farmers. The data were analysed using descriptive statistical methods and tests of significance were conducted based on the procedures described by Gomez and Gomez (1984). The level of significance used in “F” and “T” test was p=0.05.

3. RESULTS AND DISCUSSION

3.1 Yield and Yield Parameters

Cotton performance improved markedly under LRI, with significant increases of 35.6% in seed cotton yield per plant, 50.9% in seed cotton yield (kg ha^{-1}) and 35.4% in lint yield over non LRI. A significantly higher harvest index was also recorded under LRI, reflecting a 7.6% increase compared to the non LRI fields. The average ginning percentage was higher in LRI plots than in non LRI plots. Similarly, straw yield and biological yield were significantly greater under LRI, showing increases of 20.2% and 25.7%, respectively, in relation to non LRI plots. These improvements can be linked to the balanced nutrient application based on soil test values, which ensured steady crop growth, enhanced photosynthate production and more efficient translocation from source to sink. This process supported better boll development and improved lint formation. Similar improvements in cotton yield components have been documented by Gudadhe et al. (2011) and Sankaranarayanan et al. (2011).

3.2 Growth Parameters

Plant height, relative chlorophyll content, and dry matter production per plant were all markedly higher under LRI management, with increases of 37.6%, 16.3%, and 29.7%, respectively, compared to non-LRI plots. These gains can be linked to improved nutrient uptake and availability, which provided better support for overall plant growth. The higher concentrations of essential nutrients in plant tissues, particularly those vital for protein formation and chlorophyll synthesis, likely enhanced photosynthesis and carbohydrate production. The additional carbohydrates, in turn, boosted active cell division and expansion, resulting in stronger growth attributes. Similar trends have also been reported by Satpute et al. (2020) and Veeramani & Subramaniyan (2012).

3.3 Nutrient Uptake

LRI plots exhibited enhanced nutrient uptake, with mean values of nitrogen, phosphorus and potassium significantly higher than those recorded in non LRI plots. Nitrogen uptake rose by 16.1%, phosphorus by 22.4% and potassium by 14.4% under LRI management. This improvement can be attributed to the balanced and adequate supply of fertilizers, which provided nutrients tailored to the crop's requirements. Such synchronization ensured efficient absorption, greater dry matter production and higher nutrient concentrations in plant tissues. Comparable results demonstrating the link between balanced fertilization and improved nutrient use efficiency have also been reported by Gundlur et al. (2013), Upperi & Kuligod (2011), Dhawan et al. (2005) and Singh et al. (2003).

3.4 Soil Fertility Parameters

Soil pH showed statistically significant differences both within (LRI and non LRI) and across the treatments, which is likely due to the balanced fertilizer application. The improved nutrient balance promoted higher biomass production, stimulating microbial activity and root exudation which leads to the production of organic acids, while the addition of FYM further supported this process. Similar observations have been reported by Vijaya & Seethalakshmi (2011) and Chu et al. (2007). In contrast, the EC showed a non-significant reduction during the crop period, both within and between treatments. The slight decrease observed in post-harvest samples may be attributed to leaching of excess salts caused by rainfall during the season. Post-harvest analysis showed significantly higher levels of OC, N, P and K within and between treatments, except for potassium in the non-LRI fields. The combined application of fertilizers and FYM, tailored to crop demand and soil condition, enhanced microbial activity, which facilitated the release of nutrients temporarily bound to clay minerals and the mineralisation process thereby contributing to overall nutrient buildup (Katharine et al., 2014; Srinivasarao et al., 2013; Kamara et al., 2011 and Andersson et al., 2007). Post-harvest analysis showed that iron levels increased significantly within both treatments, although between treatments, it was non-significant. Manganese and copper levels increased significantly under LRI, while changes were non-significant under non-LRI; however, between treatments, copper was significantly higher in LRI plots. Unlike other micronutrients, zinc levels decreased significantly both within and between treatments. The overall improvement in micronutrient availability can be attributed to favourable redox conditions, FYM application, optimal pH and enhanced microbial activity stimulated by balanced fertilizer use. Microbial decomposition of organic matter likely released carboxylic acids and soluble phenolic compounds, which facilitated micronutrient solubilization through chelation and reduction processes (Wani et al., 2015; Kondapa et al., 2009; Stemmler & Berthelin, 2003). The observed decline in zinc levels is likely due to the antagonistic interaction between phosphorus and zinc (Bhardwaj et al., 2024).

3.5 Dehydrogenase Activity

In the non-LRI plots, dehydrogenase activity varied between 15.0 to 19.6 μg TPF g^{-1} d^{-1}, with a mean value of 17.6 μg TPF g^{-1} d^{-1}. In comparison, the LRI plots showed much higher activity, ranging from 25.5 to 35.8 μg TPF g^{-1} d^{-1}, with a mean of 30.3 μg TPF g^{-1} d^{-1}. This significant increase under LRI can be attributed to the balanced fertilizer application, which enhanced microbial biomass and provided greater substrate availability. Conversely, nutrient imbalances in the non-LRI plots limited enzyme activity, aligning with the observations of Chu et al. (2007).

Table 2. Effect of LRI based fertilizer recommendation on yield and yield parameters in cotton fields

Yield parameters	Non LRI	LRI
Seed cotton yield per plant (g plant^{-1})	65.2±2.68	88.2±2.44
P value (between group)	< .0001**	
Seed cotton yield (kg ha^{-1})	905±24.3	1225±31.2
P value (between group)	< .0001**	
Ginning percentage (%)	53.2±0.37	59.3±0.30
P value (between group)	< .0001**	
Lint yield (kg ha^{-1})	481±13.1	726±18.3
P value (between group)	< .0001**	
Straw yield (kg ha^{-1})	1468±54.6	1765±59.1
p value (between group)	.001*	
Biological yield (kg ha^{-1})	2379±58.2	2991±71.8
P value (between group)	< .0001**	
Harvest Index (%)	38.2±1.04	41.1±0.95
P value (between group)	.04*	

Note: The values represent the mean of 20 random observations and the standard error of the mean
***Significant at 1 per cent level; *Significant at 5 per cent level*

Table 3. Effect of LRI based fertilizer recommendation on growth parameters in cotton fields

Growth parameters	Non LRI	LRI
Plant height (cm) [At harvest - 250 DAP]	141±5.16	194±4.19
P value (between group)	< .0001**	
Relative Chlorophyll content (SPAD) [At peak growth stage -60 DAP]	34.4±1.41	40.0±1.55
P value (between group)	.01*	
Dry matter production per Plant (g plant^{-1}) [At harvest - 250 DAP]	101±3.84	131±5.10
P value (between group)	< .0001**	

Note: The values represent the mean of 20 random observations and the standard error of the mean
***Significant at 1 per cent level; *Significant at 5 per cent level*

Table 4. Effect of LRI based fertilizer recommendation on nutrient uptake in cotton fields

Nutrient uptake	Non LRI	LRI
N uptake (kg ha^{-1})	92.2±3.17	107±3.19
P value (between group)	.002*	
P uptake (kg ha^{-1})	8.17±0.26	10.0±0.18
P value (between group)	< .0001**	
K uptake (kg ha^{-1})	71.4±2.40	81.7±2.93
P value (between group)	.009*	

Note: The values represent the mean of 20 random observations and the standard error of the mean
***Significant at 1 per cent level; *Significant at 5 per cent level*

3.6 Production Economics and Fertilizer Savings

The adoption of LRI based fertilizer recommendations in cotton cultivation brought significant economic benefits, even though it required a higher investment in fertilizers. This additional cost proved to be worthwhile, as LRI fields achieved 48.4% higher gross returns, along with a 71.0% increase in net returns and an 18.2% improvement in the B:C ratio compared to non LRI fields. These outcomes are consistent with earlier reports by Vidyavathi et al. (2014), Hosamani et al. (2013) and Pawar et al. (2010). Under LRI, the recommended fertilizer dose was 133:75:25 kg ha^{-1} of N: P_2O_5: K_2O, which represented increases of 83% in nitrogen, 50% in phosphorus and 100% in potassium over the conventional non LRI dose of 72.5: 50: 12.5 kg ha^{-1}. While this led to a higher fertilizer expenditure of ₹6,999 ha^{-1} under LRI, about ₹2,784 more than the ₹4,215 ha^{-1} incurred in non LRI, the substantial improvements in yield and returns compensated for the extra cost.

Table 5. Effect of LRI based fertilizer recommendation on soil fertility parameters in cotton fields

Soil parameters	Non LRI			LRI		
	Before sowing	**After harvest**	**Group mean**	**Before sowing**	**After harvest**	**Group mean**
pH	7.90±0.05	7.71±0.04	7.80±0.03	7.81±0.08	7.51±0.03	7.66±0.03
P value (within group)		.01*			.01*	
P value (between group)			.005*			
EC	0.23±0.01	0.21±0.01	0.22±0.01	0.24±0.01	0.23±0.01	0.24±0.01
P value (within group)		.06			.051	
P value (between group)			.24			
SOC	4.05±0.16	5.28±0.20	4.67±0.14	4.31±0.16	6.06±0.20	5.18±0.13
P value (within group)		< .0001**			< .0001**	
P value (between group)			.01*			
Available N	167±6.15	196±8.01	182±4.63	178±4.50	210±8.13	194±4.00
P value (within group)		.02*			.01*	
P value (between group)			.04*			
Available P_2O_5	23.5±0.52	30.1±0.97	26.8±0.60	24.2±0.56	33.4±1.25	29.4±0.79
P value (within group)		< .0001**			< .0001**	
P value (between group)			.01*			
Available K_2O	669±9.29	685±8.96	677±6.05	681±6.28	713±8.63	697±4.94
P value (within group)		.27			.01*	
P value (between group)			.02*			
Available Fe	4.18±0.15	4.94±0.14	4.56±0.11	4.42±0.16	5.23±0.20	4.82±0.15
P value (within group)		< .0001**			< .0001**	
P value (between group)			.15			
Available Mn	4.75±0.17	5.16±0.19	4.95±0.13	4.83±0.19	5.42±0.18	5.13±0.15
P value (within group)		.13			.02*	
P value (between group)			.37			
Available Cu	0.93±0.03	1.01±0.03	0.97±0.02	1.07±0.02	1.13±0.02	1.10±0.02
P value (within group)		.07			.02*	
P value (between group)			< .0001**			
Available Zn	0.23±0.01	0.20±0.01	0.22±0.01	0.26±0.01	0.23±0.01	0.25±0.01
P value (within group)		.04*			.03*	
P value (between group)			.003*			

Note: The values represent the mean of 20 random observations and the standard error of the mean
***Significant at 1 per cent level; *Significant at 5 per cent level*

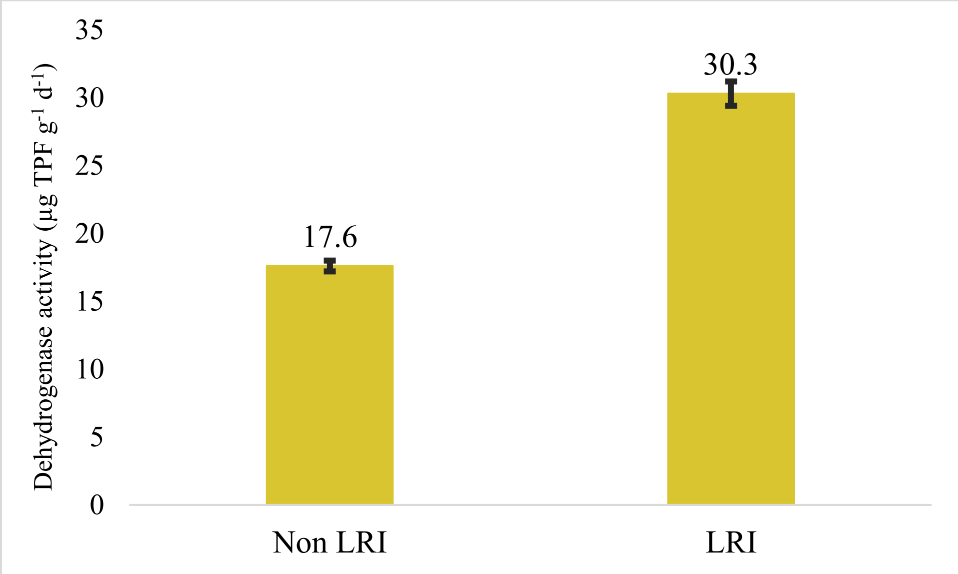

Fig. 1. Effect of LRI based fertilizer recommendation on dehydrogenase activity (during peak crop growth period – 60 DAP)
Error bars indicate standard error of mean (SEM)

Table 6. Effect of LRI based fertilizer recommendation on economic parameters in cotton fields

Economic parameters	Non LRI	LRI
Cost of cultivation (₹ ha^{-1})	28885	35369
Gross returns (₹ ha^{-1})	62065	92132
Net returns (₹ ha^{-1})	33180	56763
B:C ratio	2.2	2.6
Fertilizer recommendation (N: P_2O_5: K_2O kg ha^{-1})	72.5: 50: 12.5	133: 75: 25
Quantity of fertilizers applied (Urea: DAP: MoP kg ha^{-1})	115: 109: 21	226: 163: 42
Cost on fertilizers (₹ ha^{-1})	4215	6999
Expenditure on fertilizers (₹ ha^{-1})	2784	

4. CONCLUSION

LRI based fertilizer recommendations represent a sustainable nutrient management practice, as they help in preventing under or overuse of fertilizers while meeting soil and crop needs. For nutrient demanding crops like cotton, LRI cards provide more precise and timely guidance, enabling farmers to optimize input use for higher yields and better returns, even under high production costs.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that generative AI technologies such as OpenAI's ChatGPT (GPT-5) have been used during the editing of manuscript.

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COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Andersson, S., Simonsson, M., Mattsson, L., Edwards, A. C., & Öborn, I. (2007). Response of soil exchangeable and crop potassium concentrations to variable fertilizer and cropping regimes in long-term field experiments on different soil types. *Soil Use and Management, 23*(1), 10–19. https://doi.org/10.1111/j.1475-2743.2006.00058.x

Bhardwaj, G., Brar, P. S., Sharma, U., & Kaushal, R. (2024). Study on synergistic and antagonistic interactions of P and Zn fertilization on sweet pepper. *Journal of Plant Nutrition, 47*(17), 2930–2939. https://doi.org/10.1080/01904167.2024.2369088

Chu, H., Lin, X., Fujii, T., Morimoto, S., Yagi, K., Hu, J., & Zhang, J. (2007). Soil microbial biomass, dehydrogenase activity, bacterial community structure in response to long-term fertilizer management. *Soil Biology and Biochemistry, 39*(11), 2971–2976. https://doi.org/10.1016/j.soilbio.2007.05.031

Dhawan, A. S., Singh, J., & Deshmukh, M. S. (2005). Improving nutrient synergy through integrated nutrient management under rainfed cotton in vertical. *Journal of the Indian Society for Cotton Improvement, 25*(3), 132–140.

Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John wiley & sons.

Gudadhe, N. N., Khang, V. T., Thete, N. M., Lambade, B. M., & Jibhkate, S. B. (2011). Effect of different INMS treatments on growth, yield, quality, economics and nutrient uptake of hybrid cotton Phule-492 (*Gossypium hirsutum* L.). *Omon Rice, 18*, 137–143.

Gundlur, S. S., Rajkumara, S., Neelakanth, J. K., Ashoka, P., & Khot, A. B. (2013). Water and nutrient requirement of Bt cotton under Vertisols of Malaprabha command. *Karnataka Journal of Agricultural Science, 26*(3), 368–371.

Hosamani, V., Halepyati, A. S., & Vinodakumar, S. N. (2013). Yield and yield components, quality parameters, uptake of nutrients and economics of irrigated Bt cotton (*Gossypium hirsutum* L.) as influenced by macro nutrients and liquid fertilizers. *Ecology, Environment and Conservation, 19*(4), 1189–1193.

Kamara, E. G., Olympio, N. S., & Asibuo, J. Y. (2011). Effect of calcium and phosphorus fertilizer on the growth and yield of groundnut (*Arachis hypogaea* L.). *International Research Journal of Agricultural Science and Soil Science, 1*(18), 326–331.

Katharine, P., & Santhi, R. (2014). Soil test crop response correlation studies under integrated plant nutrition system for cotton through drip fertigation on Inceptisol. *Research on Crops, 15*(1), 226–231.

Kondapa, D., Radder, B. M., Patil, P. L., Hebsur, N. S., & Alagundagi, S. C. (2010). Effect of integrated nutrient management on growth, yield and economics of chilli (Cv. Byadgi Dabbi) in a Vertisol. *Karnataka Journal of Agricultural Sciences, 22*(2), 438–440.

Pawar, S. U., Gitte, A. N., Bhosle, G. P., & Suryawanshi, S. B. (2010). Effect of fertilizer levels and plant densities on yield, gross and net monetary returns of Bt cotton hybrids. *Journal of Cotton Research and Development, 24*(2), 182–185.

Ravi, K. N., Patil, S. L., Biswas, H., Ramesha, M. N., Naik, B. S., Ojasvi, P. R., & Morade, A. S. (2022). Land resource cards: An innovative approach to empower farmers for site-specific farm resource management. *Indian Journal of Extension Education, 58*(1), 106–110. https://doi.org/10.48165/IJEE.2022.58124

Sankaranarayanan, K., Praharaj, C. S., Nalayini, P., & Gopalakrishnan, N. (2011). Growth, yield and quality of Bt cotton (*Gossypium hirsutum*) hybrid under varied planting patterns, NPK levels and seasonal variations. *Indian Journal of Agricultural Sciences, 81*(9), 871.

Satishkumar, U., & Rajesh, N. L. (2021). Karnataka land resource inventory portal: One stop solution for optimal resource allocation and conservation at farm level for manoeuvring of agriculture. *Journal of Farm Sciences, 34*(5), 512–515.

Satpute, A. V., Patil, J. B., Phyto, S. M. S., & Gedam, V. B. (2020). Effect of inorganic and bio-fertilizers on nutrient (NPK) content, nutrient (NPK) uptake, and available nutrient (NPK) at harvest of summer groundnut (*Arachis hypogaea* L.). *International Journal of Chemical Studies, 8*(6), 1612–1616. https://doi.org/10.22271/chemi.2020.v8.i6w.10995

Singh, J., Blaise, D., Rao, M. R. K., Mayee, C. D., & Deshmukh, M. S. (2003). Assessment of agronomic efficiency of Bt cotton in rainfed Vertisol. *Journal of Indian Society of Cotton Improvement, 28*, 185–190.

Srinivasarao, C., Kundu, S., Venkateswarlu, B., Lal, R., Singh, A. K., Balaguravaiah, G., &

Rupendra Manideep, V. (2013). Long-term effects of fertilization and manuring on groundnut yield and nutrient balance of Alfisols under rainfed farming in India. *Nutrient Cycling in Agroecosystems, 96*(1), 29–46. https://doi.org/10.1007/s10705-013-9575-8

Stemmler, S. J., & Berthelin, J. (2003). Microbial activity as a major factor in the mobilization of iron in the humid tropics. *European Journal of Soil Science, 54*(4), 725–733. https://doi.org/10.1046/j.1365-2389.2003.00571.x

Upperi, S. N., & Kuligod, V. B. (2011). Effects of prolonged and integrated use of organics and inorganics on the performance of cotton. In *World Cotton Research Conference on Technologies for Prosperity–5*, November 7–11, 2011, Mumbai, India (pp. 359–363).

Veeramani, P., & Subrahmaniyan, K. (2012). Physical and economic optimum of response model for NPK application in irrigated groundnut (*Arachis hypogaea* L.). *Madras Agricultural Journal, 99*(7/9), 526–529.

Vidyavathi, G., Ravi, M. V., Yadahalli, G., & Shivaleela, S. (2014). Nutrient management in Bt cotton through STCR approach. *Ecology, Environment and Conservation, 20*(1), 337–340.

Vijaya, K. S., & Seethalakshmi, S. (2011). Response of eggplant (*Solanum melongena* L.) to integrated nutrient management amended soil. *International Journal of Scientific & Engineering Research, 2*(8), 2229–2238.

Wani, F. S., Ahmad, L., Ali, T., & Mushtaq, A. (2015). Role of microorganisms in nutrient mobilization and soil health – A review. *Journal of Pure and Applied Microbiology, 9*(2), 1401–1410.

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