NATIONAL SEMINAR

ON

DEVELOPMENTS IN SOIL SCIENCE – 2023

ABSTRACTS

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Abstracts

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ABSTRACTS: NATIONAL SEMINAR ON DEVELOPMENTS IN SOIL SCIENCE – 2023

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Correlation Studies of Different Soil Parameters of Selected Soil Series of Begur Micro Watershed of Gundlupet Taluk, Chamarajanagara District, Karnataka

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The present study was undertaken to characterize soils in Begur micro watershed located in the southern dry zone of Karnataka. The study revealed that the pedons were classified as upland to lowland categories in selected soil series *viz.*, Begur, Kamrahalli, Chikkamadure and Santhemarahalli were deep to very deep. The soil colour varied from brown to very dark gray in dry condition, very dark grayish brown to dark grayish brown colour when wet at surface layer. In sub-surface layers colour varied from brown to black both in dry and wet conditions. The texture of the soils were clayey, structure was moderate medium sub-angular blocky to strong medium angular blocky on surface and sub-angular to angular blocky structure in the sub-surface. The consistency of pedons were found slightly hard to hard consistency when dry, firm when moist and moderately to very sticky and moderately to very plastic when wet with moderate calcareousness in surface layers to highly calcareous at sub-surface layers. The pedons boundary were abrupt smooth and clear smooth boundary, strong to violent effervescence with dilute HCl. In the pedons, soil separates like clay was dominated over sand and silt, the clay content increased with depth. Soil pH of pedons was moderately to strongly alkaline in nature with non-saline, organic carbon content decreased with depth. The dominant cation found in the soil was Ca followed by Mg>Na>K with high CEC and it increased with depth. Base saturation was recorded higher with irregular trend with depth, higher ESP (>15%) indicated the sodic nature. The findings revealed that sand, silt, and clay content influence each other, and organic carbon has a significant relationship with various parameters such as sand, silt, clay, pH, Ca, and Mg. Additionally, electrical conductivity and exchangeable cations are related to pH and other cationic properties of the pedons.

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Land Resource Inventory and its applications for Watershed Planning-A Case Study of Dabarabad Sub-watershed of Semi-Arid Region of Kalaburagi District, Karnataka, India

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A case study was undertaken to evaluate land resources to classify soils to parcel level and to derive land capability and suitability classes of Dabarabad Sub-watershed located in North Eastern Dry Zone of Karnataka (Zone-2) in Semi-Arid Region of Kalaburagi district. A detailed land resource inventory was carried out at 1:8000 scale using IRS-P6 LISS-IV merged cartosat-I imagery overloaded with cadastral maps. The generated database thus mapped using Arc view 2.3 GIS software. The evaluation of land in terms of suitability classes were based on the method described in FAO guideline for land evaluation. The factors considered for evaluation of the land suitability were soil slope, soil drainage, soil texture, soil depth, soil fertility and the present land use of the study area. The analysis and interpretation of the spatial and non-spatial database generated has revealed that majority of the area suffer from major soil constraints. In most of the areas, very shallow (<25 cm) to shallow depth (25-50 cm), very gently sloping (1-3%) with moderate erosion and alkalinity affected even up to 60-80% of the sub-watershed area followed by gravelly (15-35%), thus reducing the production potential and crop choices. The fertility status of soils revealed that majority of soils were low in organic carbon content (<0.5%), medium (23-57 kg ha^{-1}) in phosphorus (P_2O_5) and high (>337 kg ha^{-1}) in potassium (K_2O). Zinc (<0.6 ppm) and Iron (<2.5 ppm) were below the critical limit and the soils are either moderately (S2) or marginally (S3) suited for growing most of the agricultural and horticultural crops. By interfacing land resource data with Remote Sensing, GIS techniques, different management scenarios were analyzed to arrive at the best management alternatives (optimum land use plans) that would be most suitable.

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Hyperspectral Remote Sensing Applications for Clay Mineral Detection in Soil

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Hyperspectral remote sensing technology can provide an alternate approach to the traditional clay mineral identification methods, saving time, money, and energy compared to conventional methods. In our study we were able to identify a variety of clay minerals using spectral data collected from different benchmark Vertisols of India. The minerals identified included Beidellite-nontronite, montmorillonite and illite. The spectral reflectance curves of the soil samples were generated using spectroradiometer data covering an electromagnetic spectrum range of 0.350-2.500 µm under laboratory conditions using controlled illumination. The results showed an increasing trend of soil reflectance with increase in wavelength of electromagnetic radiation for the studied soil irrespective to the nature of the soils. Result also revealed that although there is a steady increase in reflectance for all the soil samples with increase in electromagnetic wavelength but significant decreases in reflectance at 1.4 µm, 1.9 nm and 2.2 µm were observed. The USGS spectral library spectra of different minerals were compared to the soil sample extracted spectra of various soil series in order to determine the precise and true location of mineral absorption characteristics. It is observed that the USGS spectra of montmorillonite, and nontronite matches with the soil spectra of studied soils. The additional spectral bands were also found near 0.47 µm, 0.48 µm, 0.5 µm, 0.65 µm, 2.21 µm, 2.22 µm, 2.23 µm, 2.28 µm, 2.35 µm, 2.41 µm, 2.44 µm and 2.45 µm which are the characteristic features of montmorillonite, nontronite, beidellite and illite. The study shows that the hyperspectral spectroscopy is a useful tool for mineral identification in soils.

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Effect of Natural and Organic Crop Production on Soil Nutrient Availability and Enzymatic Activities under Soybean-Wheat Cropping Systems

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Natural and organic crop production techniques gaining popularity in India as an alternative to conventional farming. However, the long-term effect of natural and organic production system on crop productivity and soil properties lined with health of the soil has received little attention. Efficient nutrient management practices are the only way to sustain crop production, soil health and biodiversity. Therefore, soil properties in terms of available nutrients and enzymatic activities were evaluated under an ongoing three-year natural production system during the *kharif* season of 2021-22 and 2022-23 was conducted at Research Farm of ICAR-IISS (All India Network Program on Organic Farming-AINPOF), Bhopal. The experiment consisted of five nutrient management treatments with four replications. Result revealed that under organic farming practice had recorded lowest soil pH, EC and the highest soil organic carbon. In terms of soil available nutrients status, integrated crop management with need-based chemical pesticides had the highest available major and micro nutrients, followed by integrated crop management with natural farming. The maximum soil enzymatic and biochemical activity was found under the organic farming and enzymatic indices, including the biological activity index and the geometric mean of enzyme activities. As soil depth increased, nutrient availability and biological activity declined. All nutrients and enzymatic properties expressed a significant and positive correlation. As a result, implementing integrated nutrient management through organic and natural crop production systems can benefit soil fertility, biological activity, and overall production system sustainability.

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Comparative Studies on SQI Estimation of Ganjigatti Sub-Watershed of Karnataka

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Soil quality is a concept being developed to characterize the usefulness and health of soils. It is a key element in sustainable agriculture, which embodies the interrelationship between physical, chemical and biological fertility of soil that supports the plant growth. In agricultural research, soil productivity is analogous to soil quality. Three different SQI methods were used to estimate the SQI of the Ganjigatti sub-watershed by using the 27 soil profiles data: (1) assessment of horizon-wise SQI by subjecting the soil properties of every horizon to PCA followed by calculating the weighted averages of the SQI of each soil profile (SQI-1); (2) weighted averages of the soil properties of each soil profile subjected to PCA and followed by SQI assessment (SQI-2); and (3) considering the Ap horizon properties of each soil profile for the SQI assessment (SQI-3). Additionally, to validate SQI methodologies, correlation studies were done against major crop yields in the sub-watershed. Results showed that CEC has the most significant weight and contribution in the SQI determined by MDS, followed by porosity, ESP, OC, CN ratio and total N. SQI-1 was most strongly correlated with crop yield; the correlation coefficient ranged from 0.69** to 0.74**. Among all the three methodologies, SQI-1 and 2 are better methods for assessment of SQI compared to SQI-3 because using surface soil properties provides incomplete information as crop productivity is influenced by both surface and subsurface properties, which are later inherently linked to pedogenic processes. Furthermore, assessing the horizon-wise soil quality index (SQI-1) of a profile can provide more detailed and accurate information compared to using a weighted average (SQI-2). Weighted averages may provide an overall summary measure but can sometimes mask variations that occur at different horizons. By assessing the SQI horizon-wise, we can analyze the quality of the soil at each individual horizon separately. This approach allows for a more granular understanding of the profile's soil quality.

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Spatial Analysis of Soil Properties of Ganjigatti Sub-Watershed of Karnataka using GIS-based Geostatistics Models

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Accurate assessment of the spatial variability of soil properties is key component of the agriculture ecosystem and environment modeling. A study was conducted in Ganjigatti sub-watershed of Dharwad district, Karnataka, covering 4,324 ha area in the northern transition zone of Karnataka for investigating the spatial distribution of soil fertility parameters *viz.*, pH, EC, organic carbon and available macronutrients (AvN, AvP, AvK, ExCa, ExMg and AvS). Total 393 surface samples (0-30 cm depth) were collected using grid sampling method at 320 m interval and analysed for the soil properties. The geo-database was subjected to kriging through best-fit experimental semivariogram based on lowest root mean squared error. Circular model was found best fit for pH; exponential model provided the best fit to the semivariogram of EC, OC, ExCa and ExMg, whereas spherical model was best fit for AvN, AvP_2O_5, AvK_2O and AvS. The study concluded that the measured soil properties in regular gird sampling at given scale were enough to capture spatial dependence using ordinary kriging technique and in deriving thematic maps for efficient soil management strategies at sub-watershed level. The results of spatial dependence of each soil property, using ordinary kriging showed that there is medium spatial dependence of EC, OC, AvN, AvP_2O_5, AvK_2O, ExCa, ExMg and AvS with nugget-to-sill ratio [(C0/C0 + C)] between 0.25 and 0.75, whereas pH and AvN had a nugget/sill more than 0.75, displaying a weak spatial autocorrelation. Soil pH was positively correlated with EC (0.32**), ExCa (0.69**) and Mg (0.75**). Soil organic carbon had a significant and positive correlation with available N (0.52**) and P (0.18**). The distribution maps generated could be used as a guide to farmers and decision makers for precise and site-specific nutrient management in the study region.

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Effect of Biochar on Enhancement of Microbial Activity through Alleviation of Soil Metal Toxicity in Ultisol

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Metals like iron (Fe) and manganese (Mn) contents in lateritic soil (Ultisol) is one of the critical factors regulating soil organic carbon sequestration and crop yield. Application of soil amendment, biochar having high carbon content, could alleviate the toxic effects of iron and manganese on microbial functions and plant growth. So, the present study was taken up in *kharif* and *rabi* seasons continuously in rice-rice cropped lateritic soil with the addition of rice husk biochar (RHB). A combination of organic and inorganic sources *viz.*, FYM, glyricidia, *Artocarpus* sp. leaves and RHB mixed with urea at various levels of 35, 70 and 105 kg N ha^{-1} were used in the study. The results showed that RHB decreased the soil available Fe and Mn contents, increased organic carbon (>1%) and improved the microbial and enzymatic activity. Further, in *rabi* the soil metal contents were reduced to half compared to *kharif* season. The available Fe content reduced to 68.19 from 153.32 mg kg^{-1} with RHB and 35 kg N ha^{-1} while the available Mn content came to 2.67 from 3.54 mg kg^{-1} in RHB alone treated plots. This was coupled with an increase in microbial biomass carbon (MBC) content and the treatment with RHB showed an increase of 100 mg kg^{-1} in *rabi* season compared to *kharif*. The dehydrogenase and phosphatase activity were found to be maximum in RHB with 105 kg N ha^{-1} (218.07 µg TPF day^{-1} kg^{-1} and 478.72 µg PNP h^{-1} g^{-1}). The enzyme activity increased with increase in inorganic fertilisers which was a reflection of organic matter build up in the soil. Thus, it was proved that RHB decreased the adverse impacts of metals on soil properties through enhanced labile C for microbial assimilation and immobilization of metals.

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Taxonomical Classification of Soils of Asvaru Sub-Watershed, Hunsur Taluk, Mysuru District, Karnataka

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Pedological classification and characterization of the soils in a particular area gives an accurate and scientific inventory, its nature, kind and extent to which it is distributed, so that one can plan for a sustainable crop production by knowing its potentials and limitations. Soil classification is sorting of the soils into groups or classes with similar properties and potential which behave similarly. Keeping the importance of soil classification in view the soils of Asvaru sub-watershed in Mysuru district was classified and categorized into different soil order upto family level in order to enhance the productivity and profitability of the area. The profile pits were studied based on the soil heterogeneity and seventy two profiles were identified and studied for its different morphology, physical and chemical properties. The soil colour varied from 2.5YR (2.5/4-3/6) to 5YR (3/3-4/6) and 7.5YR (3/3-4/6) to 10YR (2/1-4/4) and soil depth was shallow (25-50 cm) to very deep (>150 cm) with texture varying from sandy loam to clay at both surface and sub-surface layers. The soil pH was strongly acidic to strongly alkaline in both red and black soil profiles and non-saline in nature. The exchangeable bases were in the order Ca^{+2}> Mg^{+2}> Na^{+}> K^{+}. Based on the data observed, 1983 ha area of sub-watershed was mapped into 75 phases comprising of 16 soil series of which Alfisols (87.5%) and Inceptisols (8.5%) were major soil orders. The major taxa identified at order level was *Alfisol* and *Incepitsols*, suborder-Ustalfs and Ustepts, Great group- Haplustalfs, Haplustepts and Rhodustalfs, Subgroup-Lithic, Inceptic and Typic and Family- fine loamy to clayey mixed isohyperthermic in accordance with Soil taxonomy.

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Taxonomical Classification and Soil-Site Suitability Assessment of Kondarajanahalli Micro-watershed of Kolar Taluk, Kolar District, Karnataka

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Land suitability assessment is the function of crop requirements, characteristics and a degree of fitness given to land for defined uses. Land suitability analysis done through Geographical Information System (GIS) provides a classification of urban and agricultural area into zones, each of which has a different likelihood or risk of experiencing specific land using processes. Thus, Soil Taxonomy serves as an important tool to classify the Land for its suitability. Keeping this in view, the soils of Kondarajanahalli micro-watershed (584 ha) was classified into different series and assessed for its suitability for growing crops by identifying the constraints. On a whole around 11 series were identified with 23 mapping units. Based on the morphological, physical and chemical properties, *Alfisols* and *Inceptisols* were found to be major soils of the area. Out of 11 series identified, majority of the area was dominant with 5 series *viz.*, Bidarakatte-BDK (45.5 ha), Chikka Madhure-CKD (67.8 ha), Hallikere-HLK (38.5 ha), Ranatur-RTR (41.2 ha) and Thimmasandra-TSD (42.7 ha) of the micro-watershed area. Soil-suitability for major crops grown in the area revealed that, about 200 ha was highly suitable for field crops (maize, redgram, minor millets and greengram) and horticultural crops (chilli, tomato, mango, pomegranate, papaya, sapota, coconut and custard apple). Remaining 70-90 ha area was moderately suitable and 20-40 ha area was marginally suitable for these crops with soil depth, gravels, slope, texture and drainage as major limitation and by following suitable strategies including management varietal selection which helps in enhancing overall soil and crop productivity.

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Soil Suitability Assessment for Sustainable Production of Cereals and Fruit Crops in Algali Micro Watershed

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Soil suitability evaluation of Algali micro-watershed in the Northern dry zone zone of Karnataka was undertaken to define the soil fitness for sustainable production of major cereals and fruit crops that are being extensively grown in the area. The micro-watershed covers an area of 508 hectares in Athani taluk of Belagavi district. An inventory of land resource of Algali micro-watershed was done by interpretation of world view satellite data, physical traversing, surface composite soil sampling and profile studies. Based on all the field and laboratory investigations, land resource of the micro-watershed area was grouped into seven mapping units. Land suitability for maize, cotton, sorghum, grapes, mango and amla was worked out based on the soil-site database and crop requirement as per FAO guidelines. In all eight soil phases were identified in the area. Majority of the land was marginally suitable followed by moderate suitability and the least was not suitable. Predominant land/soil constraint in moderately and marginally suitable area were low nutrient availability, surface gravalliness and non-suitable soil texture. Appropriate and integrated soil fertility, crop and water management approach should be applied to address these limitations as their lack of attention could affect the availability and uptake of nutrients by these crops in the study area. Only 26 per cent of the area is suitable for crop cultivation and remaining 63 per cent of the area is not suitable for cultivation of crops due to the constrains like steep slope, gravelliness and shallow depth.

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Assessment of Soil Constraints in Artal-1 (4D5E3b01) Micro-watershed, Belagavi, Karnataka using Geospatial Techniques

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Soil constraints limiting crop production and land capability classification of Artal-1 Micro-watershed (4D5E3b01) of Belagavi district, Karnataka were assessed and evaluated using geospatial techniques (RS & GIS). A detailed soil survey of Artal-1 (876.75 ha) was carried-out using Worldview 2-50 cm SR image and cadastral maps. The soils were classified up to series and further of phases of series based on surface features. Land capability classification was worked out for fifty one soil phases which showed II, III, IV and VI classes. The class IV occupied major area (490 ha) followed by class II (175 ha), class III (100 ha) and class VI (71 ha) of the study area. Soil constraints were evaluated by analyzing the soil surface features, physico-chemical properties and correlating them with interpretation of satellite imagery. The indicators used to assess their impact on crop productivity were soil erosion, surface slope slope, soil graveliness, soil depth and soil pH. Mapping of results on the GIS platform revealed that 628 and 209 ha are subjected to moderate and severe erosion, respectively indicating immediate need for soil conservation measures to reduce the soil loss. The land slope ranged from very gently sloping (1-3%, 606 ha) to gently sloping (3-5%, 136 ha) and moderately sloping (5-8%, 19 ha). Nearly 139 ha has 15-35 per cent gravels limiting its production potential. The very shallow (71 ha), shallow (490 ha) soils in this micro-watershed limit the choice of crops. Further, 436 and 35 ha of land which registered moderate and strong alkalinity, respectively need special attention for crop management and amelioration. From this study, it can be concluded that the present status of land resources in Artal-1 micro-watershed demands proper land use planning and management for its sustainable development.

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Studies on Potassium Dynamics under Central and Southern Dry Zones of Coconut Growing Areas of Hassan District of Karnataka

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The research work was conducted in an order to get an insight about the potassium dynamics in central and southern dry zone of coconut growing areas of Hassan district, Karnataka during 2022-23. The soil samples from surface (0-30 cm) and sub-surface (30-60 cm) were collected under central and southern dry zones of Hassan district for the study. Potassium exists in soil in different forms such as water soluble K, hot water soluble K, exchangeable K, non-exchangeable K, lattice K and total K. The average water soluble K, hot water soluble K, exchangeable K, non-exchangeable K, lattice K and total K in surface soils of coconut gardens of central dry zone of Hassan district was 2.76, 9.25, 54.65, 555.35, 5896.00 and 6509.00 mg kg^{-1}, respectively. Whereas that of sub-surface soil recorded was 2.67, 7.70, 47.36, 699.66, 7282.00 and 8032.00 mg kg^{-1}, respectively. The various forms of potassium in surface soils of southern dry zone revealed that water soluble K, hot water-soluble K, exchangeable K, non-exchangeable K, lattice K and total K was 2.87, 8.85, 53.51, 546.61, 5603.00 and 6206.00 mg kg^{-1}, respectively. Whereas that of sub-surface soil recorded was 2.21, 7.20, 45.21, 709.20, 7431.00 and 8188.00 mg kg^{-1}, respectively. The results revealed that sub-surface soil recorded highest potassium fixation compared to surface soil in both the agro-climatic zones. Knowledge of different forms of potassium in soil together with their distribution has greater relevance in assessing the long-term K supplying power of soil to coconut palm and is important in formulating a sound fertilizer program for a given set of soil.

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Status of Available Micronutrient Cations in Soils of Kheda District of Gujarat

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A study was undertaken to assess the status of available micronutrient cations in soils of Kheda district of Gujarat. Total 160 surface (0-15 cm) soil samples were collected from cultivated farmer's fields of 8 talukas of Kheda district during April-May, 2016. The soil samples were analyzed for DTPA-extractable Fe, Mn, Zn and Cu. The DTPA-extractable Fe, Mn, Zn and Cu content in these soils ranged from 2.31 to 17.83, 3.93 to 18.17, 0.24 to 2.08 and 0.14 to 2.02 with their corresponding mean values of 8.02, 10.11, 1.0 and 0.95 mg kg^{-1}, respectively. Overall, nutrient index values for available Fe, Mn, Zn and Cu were 2.02, 2.44, 2.39 and 2.88 in soils of Kheda district which medium in Fe and high fertility of Mn, Zn and Cu status.

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GIS based Spatial Variability Assessment in Flower Crops Grown Soils of Horticultural College and Research Institute, Periyakulam, Tamil Nadu

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Sixty five surface soil samples were collected in the flower crops grown soils of Horticultural College and Research Institute, Periyakulam, Tamil Nadu. The geo-coordinates were recorded for each sample using GPS and field maps were digitized for its field number wise boundary and other features. Georeferenced soil samples were collected, processed and anlaysed for soil physico-chemical and soil fertility properties. Analytical results indicated that samples were acidic to alkaline in reaction, non saline and slightly calcareous to non calcareous in nature. Soil fertility groupings under per cent category indicated the dominance of medium organic carbon, low available nitrogen, medium to high available phosphorus, high available potassium and low available sulphur categories. Among the micronutrients, dominance of low DTPA-Fe, medium DTPA-Zn, high DTPA-Mn, medium DTPA-Cu and high HWS-B were observed. The nutrient index values were worked out and it indicated that low status for organic carbon and available N, medium for available P and K while very low for available sulphur. With respect to micro nutrients, the order of nutrient index values were B>Mn>Cu>Fe>Zn. Nutrient index values found to indicate for very low DTPA-Fe, Zn and Cu while marginal for DTPA-Mn and HWS-B. Thematic maps generated on the individual soil parameters. Thematic maps indicated the spatial variability of individual parameters in the flower grown soils of Eastern farm of Horticultural College and Research Institute, Periyakulam. It can be concluded that the low fertile areas have to be improved by the conjoint application of organic and/or inorganic sources for enhanced flower production and sustainable soil fertility.

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Land Capability and Crop Suitability Assessment using LRI Data to Mitigate Drought in Watershed Scale

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A critical step in planning for the increased food demands brought on by climate change, population growth and environmental risk involves evaluating the suitability of crops. The initial farm scale endeavor was to conduct a detailed soil survey (1:8000 scale) in the drought-prone area of Gauribidanuru taluk of the Chikkaballapura district of Karnataka. The study area consists of nine micro-watersheds that make up the Kudumalakunte sub-watershed (4032.41 ha). During the land resource inventory (LRI) assessment, 133 soil profiles were dug to analyze the soil characteristics including texture, depth, gravelliness and slope, which are essential for land capability classification (LCC). Results showed that the most significant area, 1121 ha (27.8%), was classified as LCC-IIes (with limitations on erosion and soil factor), followed by LCC-IIs (739 ha) with limitations on soil factor depth, gravelliness, texture, erosion, and salinity/alkalinity. The major crops grown in the study area like ragi, maize, banana, and pomegranate were assessed for crop suitability using the soil characteristics and length of the growing period. Where, the ragi crop (2096 ha, 51.97%) was found to be highly suitable (S1) and the maize crop is moderately suitable with an area of 1285 ha (31.86%). Similar to agricultural crops, fruit crops like banana and pomegranate found their highest area under classes that were only moderately (S2) to marginally suitable (S3) with limitations on gravelliness, texture, drainage and rooting condition. Adaptation of Soil-based crop suitability evaluation helping to implementation in drought mitigation strategies in watersheds.

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Soil Site Suitability Evaluation of Turmeric Growing Soil of Marathwada Region Maharashtra

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Hingoli district is located in between 19°14′ to 20°01′ North Latitude and 76°16′ and 77°28′ East Longitude having 365 to 580 mt MSL and comes under the Deccan Plateau region of southern India. Ten soil profiles were characterized and classified and evaluated the soil site suitability. The turmeric growing soils were shallow to very deep, black to very dark grayish brown in colour, sandy loam to clay in texture. The bulk density varied from 1.29 to 1.81 Mg m^{-3}, HCs varied from 0.69 to 21.60 cm hr^{-1} and sand, silt and clay content ranged between 0.89 to 48.20, 8.89 to 45.65 and 29.02 to 73.89 per cent, respectively. The soils indicating neutral to strongly alkaline were non saline, very low to high in organic carbon and slightly to highly calcareous. The CEC of soils was varied from 27.37 to 69.97 cmol (p^+) kg^{-1}. The Vertisols (Typic Haplusterts and Calcic Haplusterts) were found highly suitable (S1) for turmeric cultivation. The Inceptisols (Vertic, Typic and Calcic Haplustepts) soils were found moderately suitable (S2) and Drainage, PAWC, Clay content, ESP and Soil depth are yield reducing factor. The Entisols (Typic Ustorthant) soils were found marginally suitable (S3) and Soil Depth, Coarse fragment, Clay content, PAWC, CEC and ESP are yield reducing factor. Sodic Haplusterts (Vertisols) soils were found currently not suitable (N1) to marginally suitable (S3) ESP is the strong yield reducing factor followed by drainage and texture for turmeric cultivation, its need to adopt the salinity-sodicity management practices for higher yield of turmeric.

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Assessment of Soil Quality Dynamics under Different Land Use Systems in Soils of Anand District

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A study was conducted in soils of eight talukas of Anand district of Gujarat to assess the soil quality dynamics under different land use systems. The representative soil samples were collected from major land use systems of the district *viz.,* agriculture land (rice-tobacco cropping system), problematic land (saline soil), forest land (mixed type), horticulture land (sapota orchard) and pasture land (grassland) using GPS coordinates. Soil samples were collected from different depths *i.e.,* 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 cm under each land use type. Then, samples were analyzed for various quality parameters *viz.,* physical (Soil texture, Densities of soil, Per cent pore space, Infiltration rate, MWHC, Hydraulic conductivity, Hydraulic diffusivity), chemical (pH, EC, CEC, Exchangeable Cations, Organic carbon, Available NPK & S and DTPA-Fe, Mn, Cu and Zn) and biological (Dehydrogenase activity, Phosphomonoesterase activity and Microbial Biomass carbon) properties of soil. The investigation resulted that texture varied from loamy sand to clay loam. The highest mean value of BD (1.45 Mg/m^3) was observed in saline soil. Whereas, PD (2.39 Mg m^{-3}) in R-T cropping system. The highest mean value of porosity (45.06 per cent) and MWHC (49.77 per cent) was observed in forest soil. The highest mean value of hydraulic conductivity (8.66 cm hr^{-1}), soil water diffusivity (2.38 cm^2/min) and infiltration rate (4.50 cm hr^{-1}) were observed in forest soil. The pH was alkaline in all the soils and EC was medium to high with respect to salt accumulation. The highest mean value OC (7.75 g kg^{-1}) was found in forest soil. The highest mean value of available N (159.41 kg ha^{-1}) and phosphorous (46.87 kg ha^{-1}) was observed in R-T cropping system whereas, available potassium (512 kg ha^{-1}) was observed in problematic soil and available sulphur (15.00 mg kg^{-1}) in forest soil. Further, highest mean value of CEC 12.00 (me 100 g^{-1}), exch. Ca (10.92 me 100 g^{-1} of soil), exch. Mg (10.20 me 100 g^{-1} of soil), exch. Na (2.16 me 100 g^{-1} of soil) and exch. K (0.182 me 100 g^{-1} of soil) were observed under saline soil. The highest mean value of available Fe in soil (3.19 mg kg^{-1}) was observed in R-T cropping system whereas, available Zn (1.32 mg kg^{-1}) under problematic soil. The highest mean value of Cu (0.60 mg kg^{-1}) and Mn (1.84 mg kg^{-1}) was observed in grassland. Among the different land use systems, the enzyme activity decreased with increase in soil depth. The highest mean value of dehydrogenase activity (937.00 g TPF/g min), acid phosphatase activity (29.50 µ moles g^{-1}) and alkaline phosphatase activity (112.96 µ moles g^{-1}) was observed under forest land.

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Effect of Organic Farming on Physical, Chemical and Microbiological Properties of Soybean Grown Vertisol

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The field experiment was conducted during *kharif* season 2021-22 at Ongoing long term Organic farming experiment during third cycle at Organic Farming Research and Training Centre (OFRTC) with thirteen treatments and three replications in randomized block design to study the effect of organic farming on physical, chemical and microbiological properties of soybean grown Vertisols and also the effect of organic farming on growth parameters, yield attributing characters and yield of soybean. The application of RDF + 5 t FYM ha^{-1} significantly improved the plant height, number of pods $plant^{-1}$, seed weight $plant^{-1}$, pod weight $plant^{-1}$, seed index of soybean crop, availability of NPK, and maximum monitoring return and B: C and followed by treatment T_3 (33% FYM + 33% Vermicompost + 33% Neem cake) of organic sources of nutrients. Whereas the application of 100% RDN through 33% FYM + 33% Vermicompost + 33% Neem cake enhanced organic carbon, DTPA extractable micronutrients, microbial population and enzymatic activity in soybean grown Vertisol. Among organic treatment, application of 100% RDN through 33% FYM + 33% Vermicompost + 33% Neem cake recorded highest soybean yield, gross monetary returns, net monetary returns and B: C ratio.

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Effect of Londax 60 DF on Soil Physico-Chemical Properties and Microbial Population in Lateritic Soil of West Bengal

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Londax 60 DF (Bensulfuron-methyl) is a member of the sulfonylurea group of herbicide. It has the ALS (Acetolactate synthase) inhibitor mode of action. A laboratory experiment was carried out twice in the year of 2021 to study the impact of londax 60 DF on physico-chemical properties and microbial population in lateritic soil of West Bengal, Department of Soil Science and Agricultural Chemistry, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal. The experiment was laid out in Completely Randomized Design (CRD) in air-dry soil with 4 treatments *viz.,* Control (T_1), Recommended dose of londax 60 DF @ 50 g ha^{-1} (T_2), Double the recommended dose of londax 60 DF @100 g ha^{-1} (T_3) & four times the recommended dose of londax 60 DF @ 200 g ha^{-1} (T_4) and replicated thrice. In air-dry soil the highest pH was recorded with treatment T_2 while lowest was recorded with the T_1 treatment. Highest EC (0.16 dSm^{-1}) was recorded with treatment T_3, highest OC (0.88%) was recorded with treatment T_4. Highest available N (205.70 kg ha^{-1}), available P (34.98 kg ha^{-1}), available K (138.61 kg ha^{-1}) were obtained in T_1 treatment whereas highest available Zn (2.37 ppm) was recorded with treatment T_3. The population of fungi, nitrogen-fixing bacteria& phosphorus-solubilizing bacteria were found to be increased with advancement of time after herbicide application. Maximum fungal population (1710^4 cfu g^{-1}), phosphorus solubilizing bacteria (27.67×10^5 cfu g^{-1}) and nitrogen fixing bacteria (26.67×10^6 cfu g^{-1}) were recorded with treatment T_4 at 150 Days after treatment application.

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Spatial Distribution of Nutrients in Soils of Nutri-Cereal Research Station Farm, Gokalpura, Bhiwani, CCS HAU, Hisar, Haryana

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Mapping the spatial variability of soil fertility by applying GIS provides an elicit information for current and future use. Fifty seven surface soil samples using grid and GPS system from Nutri-Cereal Research Station Farm Gokalpura, Bhiwani, CCS HAU, Hisar, Haryana were collected to evaluate the spatial distribution of nutrients. The soils of the study area were sandy to loamy sand in texture and neutral to slightly alkaline (6.90-8.20) in reaction and non saline (0.03-0.22 dS m^{-1}) in nature. Organic carbon was low and varied from 0.12-0.38 percent. The soils of farm were low in available nitrogen (62-160 kg ha^{-1}) low to high in available phosphorus (4-22 kg ha^{-1}) and medium to high in potassium (140-492 kg ha^{-1}). The DTPA extractable micronutrients were found low to high in Zn (0.80-3.27 mg kg^{-1}), low to moderate in Fe (0.42-8.98 mg kg^{-1}) & Cu (0.10-0. 35 mg kg^{-1}) and sufficient to High in Mn (2.43-4.80 mg kg^{-1}) Available N, P and K showed high variation as indicated by CV values (738.38, 31.14 and 7488.07 respectively). Organic carbon (0.08), zinc (0.19), iron (1.75), copper (0.003) and manganese (0.29) showed small variation as indicated by low variance. Organic carbon was significantly correlated with N and K suggesting synergistic effect. All the soils were low in available nitrogen, medium to high in phosphorus and potassium, therefore, the application of nitrogenous, phosphatic and potassic fertilizers are necessary to ameliorate nutrient deficiency and enhance crop production.The spatial variability maps of nutrients provide an insight of fertility status of the area and will help in easy monitoring of precision fertilizer management.

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Evaluation of Soil Fertility and Underground Water Quality of Dahod district of Gujarat

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An attempt has been made in the present study to evaluate the physical and chemical properties and fertility status of soils and quality of underground water by collecting 234 underground irrigation water samples and 234 surface soil samples from cultivated fields of Dahod district. The mean bulk density value of the soils of Dahod district was 1.35 Mg m^{-3} and it was ranged from 1.27 to 1.48 Mg m^{-3}. The mean particle density value of the soils of Dahod district was 2.45 Mg m^{-3} and it was ranged widely from 2.17 to 2.75 Mg m^{-3}. The porosity of soils ranged from 34.51 to 52.28 per cent with a mean value of 44.53 per cent. The overall range of MWHC was 33.57 to 60.10 per cent with a mean value of 43.24 per cent. The soils of Dahod district were medium in organic carbon content. It was ranging from 0.12 to 1.11 per cent with a mean value of 0.60 per cent. The soils are non-calcareous in nature (1.82 per cent $CaCO_3$) with alkaline in reaction (pH value ranging from 7.10 to 8.83 with a mean value of (7.82) in reaction. The mean EC2.5 value in the soils of Dahod district was (0.27 dS m^{-1}) and ranged from 0.08 to 0.68 dS m^{-1}. The CEC mean value was (26.10 cmol(p^+)kg^{-1}). The results further indicated the dominance of Mg^{+2} (6.11 cmol(p^+)kg^{-1}) and Ca^{+2} (3.97 cmol(p^+)kg^{-1}) among the exchangeable cations in soil, while among the water soluble ions Cl^- (6.90 me L^{-1}) and Mg^{+2} (1.61 me L^{-1}) were found in higher proportion. About 23.50 and 76.50 percent soil samples were found sodic and normal soil group, respectively. Overall the soils of Dahod district were low with respect to available N (247 kg ha^{-1}) and S (9.29 mg kg^{-1}). Medium in available P_2O_5 (32.15 kg ha^{-1}) and K_2O (205 kg ha^{-1}) status. The soils of Dahod district in DTPA extractable Fe, Mn, Zn and Cu with a mean values of 11.13, 16.60, 0.89 and 1.19 mg kg^{-1}, respectively. The result of quality of underground wells/tube wells water revealed that the EC values ranged 0.2 to 6.6 with a mean value of 2.3 dS m^{-1}. The overall RSC value ranged from 0.0 to 16.7 with mean value of 1.8 me L^{-1} and overall 68.38, 5.13 and 26.50 per cent samples fall under safe, marginal and unsafe classes of RSC, respectively. The overall mean value of SSP was found 54.75, which varied from 1.21 to 89.85 and overall 53.42 and 46.58 per cent samples fall under safe and unsafe classes of SSP, respectively. The SAR values ranged from 0.05 to 24.92 with a mean value of 6.88 and overall 79.06, 17.95 and 2.99 per cent samples fall under S1, S2 and S3 classes of SAR, respectively.

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Variability of Fe Under Various Land Use Systems in Lower Gangetic Plains of Bihar Using Geostatistical Modelling

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One of the main components of the lithosphere and pedosphere is iron. In the middle Gangetic plains of Bihar, the mean value of available Fe content was 11.4 ppm.In the Gangetic plains of Bihar, the quality of ground water is severely affected with various heavy metal contamination including Fe. Considering this fact, the variability of Fe fractions under four various land uses (Forest Land, Horticultural Land, Agricultural Land Barren Land and to map their spatial distribution, a study was conducted in the lower Gangetic plains of Bihar during the year 2021-22. The results showed that distribution of Total Fe under these land uses was found in following sequence: Forest Land> Horticultural Land>Agricultural Land >Barren Land respectively because of low pH and high organic matter content in Forest land and comparatively higher pH and less organic matter content in Barren Land. The distribution of Water-soluble Fe, Exchangeable Fe, Carbonate bound Fe, Manganese bound iron and Residual Fe followed similar sequence. In this study, the prediction modeling like Circular model, Spherical model, Gaussian model and Exponential model were used to validate the semivariogram model for Fe under various land uses developed by using different algorithms. Geostatistical methods aim to predict a soil variable at unknown location using a property measured at a given place and time. The model could accurately confirm for every soil property based on Mean Error (ME), Mean Standardize Error (MSE) and Root mean square error (RMSE) respectively. Moreover, the exponential model was the most suitable model to predict Organic matter bound Fe and Residual Fe with a good level of accuracy level. The correlation study revealed that the variability of total Fe ranged from 12-64 percent, which was mainly controlled by three key soil parameters such as soil acidity, clay content and $CaCO_3$ content. Therefore, this study confirms that the growing amount of sophisticated remote sensing data, particularly proximal sensing, enables agricultural planners to bridge the data-decision gap, ultimately leading to better decision-making processes for soil iron nutrition.

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Soil Charcterisation and Land Use Estimation with an Advanced, Accurate, Less Time Consuming and Cost Effective Method for Soil Fertility Assessment

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Soils are one of the world's most important resources. But it's protection, maintenance and improvement is critical for the continuation of life on earth. It provides the most important material to survive on earth; Food. Hence, soil fertility is one of the important factors in controlling yields of the crops. The soil fertility evaluation is the most basic decision making tool in order to do an efficient plan of a particular land use system. In this study we assessed soil fertility by a more advanced, accurate, less time consuming and cost effective tools of soil surface charge estimation. For this purpose, 25 soil samples were collected from East and North-east India. We did estimation of physio-chemical properties, net charge, variable charge and % base saturation on these soil samples by chemical analysis, potentiometric titration and ion retention methods. On estimation and analysis it was established that if the amount of net charge in soil is >40, that soil is considered as high fertile, whereas if the amount of net charge in soil is in between 10-40, it can be considered as medium fertile soil and soils with amount of net charge <10 are non fertile.

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Web GIS-Based DSS for Land Use Planning by Using Geospatial Techniques for Hingoli District of Maharashtra

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The web GIS based decision support system (DSS) for Hingoli district of Maharashtra by characterizing, classifying and evaluating the soils. High resolution IRS-P6-LISS-III (23.5 m) satellite data, SRTM-DEM (30 m) and SOI toposheet (1:50000) were used to interpret landforms. Ten representative pedons from different landform units, 50 soil surface samples and 20 ground water samples were collected and analyzed. As per the soil-site suitability criteria of NBSS and LUP (1994) the major factors of soils that reduces yield of commonly grown crops in Entisols are soil depth, PAWC, Clay, CEC, HC and drainage, in Inceptisols are drainage, Ca:Mg ratio, HC, $CaCO_3$ and in Vertisols are HC, drainage, soil pH, $CaCO_3$ and ESP. As per criteria of FAO (1983) the soil site suitability of study area were varied from highly (S1) to moderately suitable (S2) for sorghum and soybean crop whereas, highly (S1) to marginally suitable (S3) for turmeric, cotton and pigeonpea. Soils were grouped into nine land capability sub classes *viz*. IIs, IIes, IIIs, IIIes, IIIws, IVes, IVws, IVew and Ves, whereas into six land irrigability sub classes *viz.* 1, 2t, 2st, 3s, 3st and 4st. The fertility status of surface soils samples was found low to high. The ground water classified into C_2S_1 and C_3S_1 category. From this dataset however, developed web-based DSS as a web-map project in QGIS which was further uploaded on GitHub page to generate web link which includes soil map, suitability maps, irrigability map, land capability map and spatial variability maps of macro and micro nutrients. The suggestive interventions were included in attribution of each map. This web-GIS based DSS can easily assessed by end user for crop selection and soil specific management practices to overcome the limitations and improve soil health as well as to achieve sustainable yield.

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Digital Soil Mapping for Predicting Soil Organic Carbon in Bhopal district of Madhya Pradesh

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Soil organic carbon (SOC) is a key indicator of soil health and is critical for maintaining the fertility and productivity of soil. SOC plays a crucial role in regulating soil's physical, chemical, and biological properties, such as water-holding capacity, nutrient cycling, and soil structure. Therefore, monitoring and managing SOC levels are essential for sustainable agricultural and forestry practices. Digital soil mapping (DSM) is an effective tool for predicting and mapping soil organic carbon (SOC) levels. This information can assist farmers and land managers in making informed decisions regarding soil health management. In our study, we utilized a comprehensive approach that combined laboratory data, field data, and satellite data to develop a detailed digital SOC map for the Bhopal district of Madhya Pradesh. A total of 210 soil samples were collected randomly at depths of 0-15 cm for testing and a validating dataset. Remote sensing (RS)-derived vegetation indices such as NDVI, EVI, soil-adjusted vegetation index etc. and field-measured SOC and DEM-derived variables were used to generate DSM. The results showed that the multivariate model developed from vegetation index, topographical variables and field-observed data yielded a lower root-mean-square error (RMSE = 0.14) and higher R^2 (0.70). The study indicated that DSM can be used satisfactorily for predicting SOC in the Bhopal district of Madhya Pradesh.

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Assessment of Spatial Variability of Soil Properties in Chikkumbi-3 Micro-watershed using Geospatial Techniques for Farm Level Nutrient Management

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The primary impediment to achieving optimal land productivity is the degradation of soil resulting from inappropriate land management practices. For agricultural productivity, food safety, and environmental modelling, spatial variability in soil properties is necessary. The current investigation was carried out in the Chikkumbi-3 micro-watershed, located in Karnataka, India. The objective of the research was to examine the spatial heterogeneity of surface soil parameters via the use of a geostatistical model. A total of 51 soil samples (0-20 cm) were collected from the research area using a regular grid design with a sampling interval of 320×320 m^2. Measurements were taken for soil pH, electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulphur (S). The preparation of surface maps depicting soil attributes was conducted using the semivariogram model and Kriging methods. The findings of the study indicate that there might be variations in the geographical distribution and spatial dependence of soil characteristics, regardless of whether the scale of analysis is small or vast. Ordinary kriging was used to evaluate the geographic variability of the parameters. Gaussian, Circular, Exponential, and Spherical models were employed for mapping pH, EC, OC, N, P_2O_5, K_2O, Ca, Mg and S. The selection of these models was based on their respective Root Mean Square Error (RMSE) values. The research region exhibited widespread instances of multi-nutrient deficits, with a particularly severe deficiency in nitrogen (N). The maps developed in this research provide valuable information on soil characteristics, namely soil nutrient status, throughout the study area. These maps have the potential to assist farmers and decision-makers in implementing site-specific nutrient management strategies. This work further highlights the efficacy of geostatistics and GIS approaches as robust tools for regional nutrient management.

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Land Evaluation of Chikkumbi-3 Micro-Watershed in Northern Transition Zone of Karnataka

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A study was undertaken to evaluate three soil series belonging to Chikkumbi-3 micro-watershed in Belagavi district in Northern Transition Zone of Karnataka for sustainable land use planning. The soil series were Chikkumbi (CKB), Hanchinal (HNL) and Chulki (CLK) mapped into five mapping units and soil map was generated using GIS technique. The soils were evaluated for land capability classification and categorized as land capability classes III and IV based on limitations of erosion, drainage and physicchemical properties. The crop suitability is the process of assessing the appropriateness or ability of a given type of land on the basis of growing conditions of a particular crop. According to the established criteria for soil site suitability, an assessment was conducted on the mapping units to determine their suitability for cultivating cereal crops in the region. The results of the suitability assessment indicated that the region exhibited a moderately suitable (S2) for cultivating cereals such as sorghum with moderate limitations of drainage and fertility and a marginally suitable (S3) for crops such as maize, wheat, rice, and pearl millet with limitations of climate and drainage. Therefore, improved levels of agricultural production can be achieved by cultivating crop in highly and moderately suitable areas; and practicing diversification of marginally suitable areas to crops other than that for which it is low suitable.

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Residue Retention Effect on Soil Carbon and Nitrogen Dynamics in 6 Years of No-till Soybean-wheat Cropping System in Vertisols of Central India

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Residues decomposition in field and subsequent mineralization/immobilization of nutrients is an important process having large influence on soil quality and organic matter formation. To investigate the impact of 6 years of different levels of residue retention on dynamics of carbon and nitrogen in soil, samples were collected from ongoing conservation agriculture experiment on soybean (*Glycine max* L.), wheat (*Triticum aestivum* L.) cropping system in a Vertisols of central India. Soil samples were randomly collected from each treatment plots from two depths (0-10 cm and 10-20 cm). The treatment consists of T1: 0% residue, T2: 30% residue, T3: 60% residue and T4: 90% residue of preceding cropping sequence (soybean-wheat) under No-tillage (ZT). After six years of experimentation, 30, 60 and 90 % of retention of residue resulted in buildup of 8.75, 22.5, and 38.75% improvement in oxidizable carbon concentration as compared to nil residue retention treatment. The highest concentration of 11.1 and 15.9 g kg^{-1} of OC and TOC was recorded in 90% of residue retained plot. Retention of residue significantly (Pd≤0.01) impacted soil total carbon stock in 0-10 cm of soil depth. In 0-10 cm of soil depth, retention of 30, 60and 90% residue of previous crops resulted in 3.7, 16.7 and 26.9% improvement in soil carbon stock in comparison to no residue retained plot. Retention in 90% of residue of previous crops over a period of six years resulted in an increased POM-C by 54.5% and POM-N by 47% in the 0-10cm layer compared to the nil residue retained treatment. It was observed that with increase in quantity of residue retention, there was gradual increase in POM-C concentration. Retention of 30 and 60% of residue also resulted in 22 and 39.7% improvement in POM-C concentration. Similarly, retention of 30 and 60% of residue retention resulted in 72 and 18% improvement in N mineralization potential of soil in comparison to control.

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Resource Conservation Technologies for Enhancing Yield and Water Productivity of Maize-sunflower Cropping System in Eastern India

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The field experiment was laid out in a randomised block design involving ten treatments viz., permanent broad-bed furrow irrigation (PBBF), permanent broad-bed furrow irrigation with residue (PBBF + R), permanent narrow-bed furrow irrigation (PNBF) (30 cm bed width), permanent narrow-bed furrow irrigation with residue (PNBF + R) (90 cm bed width), zero-till surface drip irrigation (ZTDI), zero-till surface drip irrigation (ZTDI + R), zero-till sub-surface drip irrigation (ZTSDI), zero-till sub-surface drip irrigation (ZTSDI + R), zero-till flatbed flood irrigation (ZTFBF), conventional till flatbed furrow irrigation with residue (CTFBF + R). In sunflower, ZTSDI + R resulted in 13%, 27%, 41% and 47% higher seed yield as compared to ZTDI + R, PBBF + R, ZTFBF + R and CTFBF, respectively. In ZTSDI+R, the soil moisture content was highest at 15-30 cm depth which was 6-8% lower in 0-15 and 30-45 cm depths. The highest soil moisture content in 0-15 cm depth was found in ZTDI+R. Overall, among drip irrigation treatments, the uniform horizontal and vertical soil moisture distribution was observed in SDI. In PBBF+R, the highest soil moisture content was found 15 cm from the plant row zone towards the furrow side which was reduced 16% at 15 cm from the plant row zone opposite to the furrow side and 23% at the middle of the bed. In NBF+R, ZTFBF+R and CTFBF, the soil moisture content at 0-15 cm was 12%, 17%, and 22% lower, respectively, than that of ZTSDI+R. The ZTSDI + R resulted in 49% saving in water use as compared to the CTFBF. ZTSDI + R resulted in 34%, 56%, 154% and 189% higher crop water productivity WP as compared to the ZTDI + R, PBBF + R, ZTFBF and CTFBF, respectively. The retention of the preceding maize residue increased the WP by 10.3-14.0% under various treatments. After sunflower, sweet corn was grown in the same field with sunflower residue. The ZTSDI, ZTDI, PBBF, and PNBF increased yield 15% compared to the CTFBF. The effect of sunflower residue on the crop yield of maize was non-significant. The ZTSDI, ZTDI, PBBF, and PNBF saved 8-25% water compared to the CTFBF. The ZTSDI, ZTDI, PBBF, PNBF had 24-46% higher water productivity compared to the CTFBF.

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Assessment of Carbon Dynamics and Sustainability of Conservation and Conventional Agricultural Practices in Kaithal district of Haryana

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A study was conducted in the Kaithal district of Haryana for assessing the carbon dynamics and sustainability of conservation (CA) and conventional (CT) agricultural practices. Sustainability index (SI) was calculated for Siwan and Malakpura villages for 0-15 cm of soil depth based on critical limits and relative weighing factors of soil health parameters. Different carbon pools were calculated and root growth parameters were determined in the wheat crop. Taking limitation to crop production into consideration, critical values for each indicator was decided and relative weighing factor was assigned. The SI was obtained by summing up critical values for each indicator within a depth individually for each field. Sustainability of each field was decided from the cumulative ratings (CR) proposed by (Lal, 1994). Scoring of each soil health indicator was done by techniques for order of preference by similarity to ideal solution (TOPSIS) which is a multi criteria decision analysis method. Results showed all the carbon pools were higher in CA than CT in both the villages. Labile pool was 10.5% higher in Siwan village and 23% higher in Malakpura under CA treatment whereas non-labile pool was around 35% higher in both the villages under CA. Cumulative rating of CA at 0-15cm soil depth was around 23 with SI sustainable with high inputs in both villages. In case of CT, CR ranged from 26-29 which indicated a SI of "sustainability with high input". Results of TOPSIS indicated that SOC had the highest score of 0.957, thus giving it rank 1. This indicates that SOC contributes maximum to sustainability. Similarly, other parameters like effective rooting depth (ERD), texture and bulk density (BD), and wilting point (WP) ranked 2, 3, 4 and 5, respectively indicating their corresponding weightage of contribution towards sustainability.

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Aggregate Size Distributions and Associated Carbon under Different Levels of Residue Retention in No-till Soybean-wheat Cropping System in Central India

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A trial site established on a Vertisol under sub-humid, dryland conditions to examine the impact of no tillage along with residue retention on soybean (Glycine max L.) and wheat (Triticum aestivum L) cropping system, which has now been in operation for over 8 years. Tillage along with residue retention significantly (P <0.05) influenced the distribution of aggregates in large macro-aggregates (>2 mm size). The proportion of large- (>2 mm) was significantly higher in the NT treatment than that in CT. In contrast, the proportion of small macro-aggregates (1-0.25 mm) was higher in the CT than that in NT. The proportion of large macro-aggregate fraction in the NTR90 treatment was significantly higher than that in NTR0 (P <0.05), while the proportion of micro-aggregates was higher in the CT and NT without residue retention treatments than for R90 although the difference was not significant in the other size fractions (P > 0.05). Retention of residue to the extent of 90% resulted in 20% improvement in WSA in comparison to CT system. The effect of no till system along with residue retention significantly impacted soil MWD. There was 5.5-77% improvement in soil MWD in no till system with different levels of residue retention in comparison to CT system. The highest improvement of 77% was recorded under no till system with 90% of residue retention. MWD of soil increased from 0.91 mm in CT system to 1.61 mm in no till system with 90% of residue retention. Retention of 30 and 60% residues of previous crops resulted in 32 and 55% improvement in MWD of soil. The highest concentration of soil carbon was recorded in 2mm size class and the concentration decreased as the size of aggregate decreased. Here also, the highest concentration of soil carbon was recorded in 90% of residue retained treatment in different aggregate size class. A trial site established on a Vertisol under sub-humid, dryland conditions to examine the impact of no tillage along with residue retention on soybean (*Glycine max* L.) and wheat (*Triticum aestivum* L) cropping system, which has now been in operation for over 8 years. Tillage along with residue retention significantly (P <0.05) influenced the distribution of aggregates in large macro-aggregates (>2 mm size). The proportion of large– (>2 mm) was significantly higher in the NT treatment than that in CT. In contrast, the proportion of small macro-aggregates (1-0.25 mm) was higher in the CT than that in NT. The proportion of large macro-aggregate fraction in the NTR90 treatment was significantly higher than that in NTR0 (P <0.05), while the proportion of micro-aggregates was higher in the CT and NT without residue retention

treatments than for R90 although the difference was not significant in the other size fractions (P >0.05). Retention of residue to the extent of 90% resulted in 20% improvement in WSA in comparison to CT system. The effect of no till system along with residue retention significantly impacted soil MWD. There was 5.5-77% improvement in soil MWD in no till system with different levels of residue retention in comparison to CT system. The highest improvement of 77% was recorded under no till system with 90% of residue retention. MWD of soil increased from 0.91 mm in CT system to 1.61 mm in no till system with 90% of residue retention. Retention of 30 and 60% residues of previous crops resulted in 32 and 55% improvement in MWD of soil. The highest concentration of soil carbon was recorded in 2mm size class and the concentration decreased as the size of aggregate decreased. Here also, the highest concentration of soil carbon was recorded in 90% of residue retained treatment in different aggregate size class.

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Influence of Conservation Agricultural Practices and Cropping System on Soil Properties in Vertisols of Central India

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This study was conducted in 2022-23 crop season to assess the effect of different conservation agriculture practices on soil physical and chemical properties in Vertisols. This field experiment was initiated during 2015 under soybean-wheat and maize-chickpea cropping systems with three different types of tillage practices along with two levels of crop residue and three levels of nutrients doses. Results revealed that the chickpea yield was significantly higher with 100% RDF. However, soybean yield was higher with soil test crop response (STCR) based nutrient dose. Chickpea and wheat yield did not respond to various tillage practices. The soil organic carbon (SOC) decreased with the depth of soil under both the cropping systems. The SOC content ranged between 0.70 and 0.99% at 0-10 cm soil depth under soybean-wheat cropping systems. However, SOC varied from 0.70 to 0.86% under maize-chick pea cropping system. Effect of tillage practices was not significant on soil pH. Similarly, there was no definite trend on available NPK under different tillage practices. Available N, P and K varied from 260 to 272; 24 to 31 and 511 to 594 kg ha^{-1}, respectively, under maize- chickpea cropping system and from 138 to151; 22 to 27 and 512 to 549 kg ha^{-1}, respectively, under soybean-wheat cropping system. Study results indicated that conservation tillage practices involving reduced tillage or no-tillage and crop residue retention coupled with appropriate nutrient management not only improved crop yield but also soil organic carbon and available nutrient status in a Vertisol.

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Distribution and Spatial Variability of Some Soil Physical and Chemical Properties of Soybean-wheat Belt of Madhya Pradesh

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Mapping spatial variability of soil properties in any region is crucial for development of site-specific management practices as this will enhance the sustain crop productivity and maintain good soil health. With this background, present study was conducted to quantify the spatial variability of different soil physical and chemical properties in soybean-wheat belt of Madhya Pradesh state, India. A total 258 geo-referenced composite surface soil samples were collected across the study area. These samples were analysed for different soil properties *viz*: pH, EC, soil organic carbon (SOC), available phosphorous (Av-P), available potassium (Av-K), soil texture (sand silt and clay), water content at field capacity (0.33 bar) and permanent wilting point (15bar), MWD, water stability aggregate (WSA) and percent size distribution (macroaggregate, microaggregate and silt & clay) used standard laboratory method. The result showed that range of chemical properties: pH, EC, SOC, Av-P, Av-K, in the study region were varied from 5.97 to 8.56, 0.04 to 0.47 dSm^{-1}, 0.15-1.26%, 1.87-62.94 kg ha^{-1}, 62.16-987.11 kg ha^{-1}, and similarly range value of soil physical properties: sand, silt, clay, FC, PWP, MWD, WSA, macroaggregate, microaggregate and silt & clay 33.21 to 66.96%, 9.28 to 37.72%, 13.04 to 46.72%, 21.06 to 42.04%, 10.36 to 26.10%, 0.33 to 1.53 mm, 18.42 to 86.27%, 5.32 to 66.93%, 15.57 to 87.56% and 0.89 to 35.53% respectively. Further the spatial variability was quantified by constructing semi-variograms and ordinary kriging techniques. We have also quantified the spatial dependences for different soil properties (vary from moderate to strong) using nugget/sill (C_o/C_o+C) ratio. Best- t models for measured soil properties were Exponential, Spherical, Circular, Stable. The distribution maps of soil attributes could be utilized as a guide for sustainable soil management practices such as variable rate of fertilization. Further, this study demonstrates the usefulness of geo-informatics technology in soil variability studies.

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Effect of Tillage Systems and different Nutrient Doses on Soybean Crop Yield and Soil Properties in Vertisols of Central India

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A field experiment conducted at ICAR-Indian Institute of Soil Science, Bhopal under CRP on CA project. There were three tillage systems *viz.* no-tillage (NT), reduced tillage (RT) and conventional tillage (CT) and three nutrient doses namely 100% RDF, 75% RDF and STCR dose were tested in soybean crop. Soil samples were analyzed of 0-15 cm depth after 4th cycle of cropping system. The results showed that the pH and Electrical conductivity (EC) did not show significant difference among the tillage systems and nutrient doses. Soil organic carbon, available NPK were significantly higher under NT and 100% RDF as compared to other treatments, while the lowest was under CT with STCR dose. The soil moisture content (SMC), mean weight diameter (MWD) andwater stable aggregate (WSA) was significantly higher under NTand 100% RDF and lowest was under CT with STCR dose. The bulk density (BD) was found significantly higher in NT with 100% RDF in 10-15 cm soil depth as compared to other treatments, while the lowest BD was observed in CT with STCR dose in 0-5 cm soil depth. The soil penetration resistance (SPR) and soil water retention (SWR) did not show any change due to tillage systems and nutrient doses. The soil penetration resistance was slightly higher under NT and 100% RDF over CT and STCR dose. The NT resulted greater soil water retention over RT and 100% RDF dose as compared to CT and SCTR dose. The crop yield did not differ by tillage systems and nutrient doses of 75 % and 100 RDF. Based on data, it can be concluded that the tillage systems and nutrient doses can be saved the energy in form of fuel charge and labour, fertilizer and improve the soil properties under conservation agriculture in vertisols of central India.

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Sustainable Soil Health Management in India, Challenges and Remedies

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Soil health is the soil's fitness to support crop growth without resulting in soil degradation. The ideal NPK ratio is 4:2:1 but currently it is followed at the ratio of 10 :2.7: 1 which is much higher than recommended. Sustainable soil health management is important in current scenario especially in India to fulfill the increasing food demand for future generation without soil degradation. India is the seventh largest country in the world with an area of 328.72 million hectares (Mha), out of which 147 Mh is under soil degradation (Mha), including 94 Mha from water erosion, 16 Mha from acidification, 14 Mha from flooding, 9 Mha from wind erosion, 6 Mha from salinity and 7 Mha from combination of factors. Among the major soil degradation processes are accelerated erosion, depletion of the soil organic carbon (SOC) pool and loss in biodiversity, loss of soil fertility and elemental imbalance, acidification and salinization. Soil degradation trends can be reversed by conversion to a restorative land use and adoption of recommended management practices. The strategy is to minimize soil erosion, create positive SOC and nutrient budgets, enhance microbial activity and species diversity of soil biota, improve structural stability and pore geometry. Improving soil quality (*i.e.*, increasing SOC pool, improving soil structure, enhancing soil fertility) can reduce risks of soil degradation (physical, chemical, biological and ecological) while improving the environment. Increasing the SOC pool to above the critical level (10 to 15 g kg^{-1}) is essential to set-in-motion the restorative trends. Site-specific techniques of restoring soil quality include conservation agriculture, integrated nutrient management, continuous vegetative cover and controlled grazing at appropriate stocking rates. The strategy is to produce "more from less" by reducing losses and increasing soil, water and nutrient use efficiency.

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Effect of Organic and Inorganic Amendments on Soil Properties, Growth and Yield of Black Gram (*Vigna Mungo* L.) in Red and Black Soils

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A pot experiment was conducted with sixteen treatment combinations to study the "effect of organic and inorganic amendments on soil properties, growth and yield of black gram (*Vigna mungo* L.) under pot culture conditions in both red and black soil" at the College of Agriculture, Raichur during the summer season of 2021. The details of the treatments are control (without crop), control with crop, green manuring, FYM @ 5 t ha^{-1}, FYM @ 10 t ha^{-1}, FYM @ 25 t ha^{-1}, vermicompost @ 2.5 t ha^{-1}, Pusa hydrogel @ 0.05%, starch hydrogel @ 0.05%, humic acid (12%) drenching with 5 ml L^{-1}, straw mulch, seaweed extract @ 25 kg ha^{-1}, waste decomposer (NCOF), gypsum @ 500 kg ha^{-1}, SSP @ 100 kg ha^{-1} and $CaCl_2.2H_2O$ @ 0.15%. Growth and growth attributes (plant height, number of primary branches per plant, number of leaves per plant, leaf area, and leaf area index per plant) were significantly higher with the application of vermicompost @ 2.5 t ha^{-1} which was closely followed by FYM @ 25 t ha^{-1} and seaweed extract @ 25 kg ha^{-1} in red and black soils at 30, 60 DAS and at harvest stages of the growth while control with crop treatment recorded lower values of these growth parameters at all the growth stages studied. Yield attributes (number of pods, pod yield and stover yield per plant and 100 seed weight were significantly higher with the application of vermicompost @ 2.5 t ha^{-1}, which was closely followed by FYM @ 25 t ha^{-1} and seaweed extract @ 25 kg ha^{-1}. Comparing the red and black soils during the pot culture production system and after harvest of the crop, the black soil showed higher growth, yield attributes and improvement in soil physical, soil chemical, soil fertility, and soil biological properties.

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Quantifying the Impacts of Soil Physical Processes under Different Climatic Scenarios by Modelling Approaches

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In order to better understand the mechanisms governing field water dynamics, optimise agricultural water management practises, and evaluate regional water resources, it is crucial to evaluate the field water cycle under changing climatic conditions. Therefore, in this study, the field water cycle for a wheat-maize double cropping system in Bhopal, Madhya Pradesh, has been studied using the agro-hydrological Soil-Water-Atmosphere-Plant (SWAP) model under various fertiliser and tillage treatments. The SWAP model was calibrated assuming an upper boundary described by the potential ET, irrigation, and daily precipitation and a lower boundary condition for water flux of 2 m depth in the soil. Daily weather data from 2020 to 2022 was collected, and ET was estimated using the Hargreaves Equations Simulation Period 2020-2022. The observed data set of soil profile water content and temperature through the bottom of the root zone was used to validate the SWAP model. The root mean square error (RMSE) is 0.22 and 0.78 for soil temperature at 5 and 10 cm depth, respectively, and 0.53 for hydraulic conductivity. The maximum soil moisture storage month is shifting from mid-June to August in RCP 4.5 and 8.5 compared to the present scenario. This study indicates that the SWAP model can be used as a tool to simulate the field water cycle and evaluate soil water storage under changing climate conditions.

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Spatio-temporal Trend Analysis of Long-term ESA CCI Surface Soil Moisture Content Across different Agro-ecological Regions of India

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Soil water content (SWC) is pivotal in understanding and modelling various aspects of terrestrial climatology, hydrology, ecology, and agriculture. Studying the spatio-temporal variation of soil moisture is crucial as it directly impacts agricultural productivity, water resource management, and climate modelling, providing essential insights for informed decision-making in agricultural, environmental and economic sectors. Analysing the spatio-temporal patterns of SWC in various agro-ecological regions is vital to tailor agricultural practices and ensure sustainable water management specific to each region's unique climatic, soil, and topographic characteristics. This research delves into studying the spatio-temporal patterns of near-surface soil moisture and their temporal trends across different agro-ecological regions of India using the European Space Agency Climate Change Initiative (ESA CCI) surface soil moisture data spanning from 1979 to 2021 (43 years). The non-parametric Mann-Kendall trend test was applied to detect the presence of monotonic trend, and Sen's slope estimator to compute the magnitude of trend at 5% level of significance on grid basis at monthly and seasonal time scale. Our findings revealed that the 'Warm per-humid ecoregion with red and lateritic soils' registered the highest SWC average at 0.30 m^3 m^{-3}. In contrast, the 'Hot arid ecoregion with desert and saline soils' had the lowest SWC with mean of 0.15 m^3 m^{-3}. The 'Cold arid ecoregion with shallow skeletal soils' exhibited the broadest range of SWC fluctuation, between 0.15% to 53.5%. However, the 'Warm perhumid ecoregion with brown and red hill soils' demonstrated the least variation, from 5.7% to 26.2%. Interestingly, a vast majority of India (94.09%) did not show significant temporal trend ($p < 0.05$) in SWC. Only 2.75% indicated a declining trend, and 3.16% showed an increasing trend with a slope of 0.0002 m^3 m^{-3} $year^{-1}$. This research can assist in delineating areas based on soil moisture patterns during various seasons and months, aiding policymakers in agricultural and water resource management.

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Modeling SOC Sequestration Potential under Climate Change Effects in different Agroecosystems of India

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Soil organic matter (SOM) is vital for enhancing soil fertility and sustaining crop productivity. Worldwide, the largest pool of terrestrial carbon (C) is contained in soils, and under best management practices, soils may also have great potential to act as C sinks and assist in climate change mitigation. However, historic cultivation practices, including tillage, fertilization, and other management, have exerted significant pressure on agricultural soils' capacity to store and cycle organic C, leading to reduced soil organic carbon (SOC) stocks. Complex interactions between various factors such as climate, soil, and agricultural management practices control the SOC dynamics in soil. We utilized a process-based model, RothC, to simulate long-term SOC dynamics for rice-based cropping systems under 100% NPK and farmyard manure management (FYM) practices using the LTFE experiment dataset. The RothC model was parameterized and validated to predict SOC stock. The validated model was then used to evaluate the impacts of different management practices on SOC dynamics under different climatic scenarios. The results demonstrated that management practices with FYM have great potential to increase SOC sequestration in the rice-based cropping system. The equilibrium SOC concentration is higher with an integrated application of N with FYM. Climate change decreases the rate of SOC sequestration in all the studied agroecosystems, with higher decreases reported under RCP 8.5, followed by RCP 6.0, RCP 4.5, and RCP 2.6.

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Simulation of Green House Gas Emissions during Wheat Growth under different Tillage and Residue Management Practices

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Greenhouse gas emissions, particularly carbon dioxide (CO_2) and nitrous oxide (N_2O), are major contributors to climate change under upland ecosystems. Agricultural practices, such as tillage and residue management, significantly influence these emissions. Understanding the impact of different tillage and residue management techniques on greenhouse gas emissions in wheat production is essential for developing sustainable crop management strategies to mitigate climate change. A study was conducted in this view during the year 2020-21 and 2021-22 in a long-term field experiment being conducted in a Typic Haplustept at the Indian Agricultural Research Institute, New Delhi since 2014 to observe the effect of tillage and crop residue mulching on CO_2 and N_2O emissions and simulations of the emissions of these GHGs using Denitrification and Decomposition (DNDC95) model during wheat (cv HD 2967). The experiment was laid out in split–split plot design with two levels of tillage (Conventional tillage (CT) and No tillage (NT)) as main plot factor, two levels of mulching (with (R+) or without (R0) maize crop residue mulch @ 5t ha^{-1}) as sub plot factor. In this study, DNDC95 model was used to simulate greenhouse gas emissions in wheat fields subjected to two tillage practices (CT and NT) along with two levels of mulching (R+ and R0). DNDC95 was calibrated with the field experiment data on wheat for the year 2020-21 and validated for prediction of temporal variation in CO_2 and N_2O emissions along with final grain and biomass yield under different tillage and residue management for the year 2021-22. Results showed that the CO_2 emissions decreased under NT as compared to CT while the N_2O emissions were found to be greater under NT compared to CT. Residue mulching under CT increased CO_2 and N_2O emissions but NT with residue mulching had lesser emissions as compared to CT with residue mulching. However the overall global warming potential (GWP) value was lowest for NT than under CT. The evaluation of DNDC95 model with respect to prediction of CO_2 emissions showed that the prediction error ranged from 15.8% ($NTR_0N_{100\%}$) to 43.3% ($CTR_0N_{100\%}$). The nRMSE between observed and simulated CO_2 emissions was 32.21%, which was greater than 30% and hence this showed that the prediction of CO_2 emissions by DNDC95 model was poor. The Coefficient of residual mass (CRM) value was -0.30, which indicated that the model over predicted the CO_2 emissions. With respect to prediction of N_2O emissions, the prediction error

ranged from -4.0% ($CTR_+N_{100\%}$) to 1.0% ($NTR_+N_{100\%}$). The nRMSE between observed and simulated N_2O emissions was 2.20% which was <10% indicating excellent prediction. Thus from this study it can be concluded that DNDC95 model could satisfactorily simulate N_2O emissions but over-predicted CO_2 emissions under different tillage and residue management practices and it is recommended that wheat may be grown under no tillage with residue to reduce greenhouse gas emissions as well as GWP in sandy loam soil of Indogangetic Plain region.

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Development of Tillage and Residue Mulching Module in InfoCrop V2.1 Model for Simulating Yield, Water, and Nitrogen Productivities of Wheat

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Tillage and crop residue mulching have profound influence on soil properties, crop productivity, and input use efficiencies. Indigenous generic crop simulation model InfoCrop V2.1 model has limited capacity to simulate the effects of various tillage and residue mulching. In this study, an attempt was made to develop the tillage and residue mulching module in InfoCrop model V 2.1 to simulate its effect on crop growth, water productivity (WP) and nitrogen productivity (NP) of wheat. The degree to which soil properties and processes are affected by tillage mainly depends on the tillage intensity, which is a combination of tillage efficiency and mixing efficiency. Over the time, soil properties reconsolidate after tillage, eventually returning to pre-tillage states. The speed of reconsolidation depends on soil texture and the kinetic energy of precipitation. The tillage implementation mainly focuses on the bulk density and the subsequent effects of changed soil water properties in surface and subsurface soil layers. In order to limit model complexity and associated uncertainty, tillage effects that are not directly compatible with the original model structure are not taken into account in this initial tillage implementation, despite acknowledging that these processes can be important. While implementing the residue mulch module, the focus was on the effect of mulch on soil evaporation and the subsequent effects of changed soil water properties by employing the parameters like time and amount of residue application, and the extent of residue mulching coverage. These concepts were used to develop the tillage and residue module of the InfoCrop V2.1 model. The developed model was calibrated using field experiment data of a long-term tillage experiment on maize-wheat system for the year 2019-20 and validated with the independent data of the field experiment for the year 2020-21 at ICAR-Indian Agricultural Research Institute, New Delhi. The evaluation of modified InfoCrop-Tillage and Residue Mulching module showed that the model could account 84% variation in the observed grain yield with an RMSE of 382 kg ha^{-1} and nRMSE of 8.6%. The InfoCrop model also showed satisfactory result for validation of Water productivity and Nitrogen productivity with R^2 0.82 and 0.97, RMSE of 0.11 and 4.67, and nRMSE of 7.5 and 10.7%, respectively. Thus, the incorporation of tillage and residue mulching module to InfoCrop opens up opportunities to assess the impact of different agronomic management practices especially conservation tillage and conventional tillage practices on yield, water and nitrogen productivity of wheat and assist in taking critical decisions for optimization of input use for achieving higher resource use efficiency under the present and future climate change scenarios.

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Characterization and Mapping of Groundwater Quality of Rai block of Sonipat District, Haryana, India

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A survey of groundwater quality for irrigation of different crops was conducted at different villages of Rai block of Sonipat district, Haryana during 2020-2021. A total 76 water samples were collected and analyzed for various haydro chemical parameters pH, EC, (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) and anions (CO_3^{2-} , HCO_3^{-}, Cl^{-} and SO_4^{2-}) by using standard procedures. Irrigation indices such as SAR, RSC, were calculated for these samples. The pH, EC, SAR and RSC in groundwater ranged from 6.83 to 8.97, 0.24-14.86 (dSm^{-1}), 1.38 to 25.90 $(mmoll^{-1})^{1/2}$ and 0.00-5.26 (mel^{-1}), respectively. The trend among the average ionic concentration of cations and anions were Na^{+}> Mg^{2+} > Ca^{2+} > K^{+} and anions were Cl^{-}>HCO_3^{-} >SO_4^{2-} > CO_3^{2-}. According to AICRP, 1989 in Rai block of Sonipat district In Rai block of Sonipat district 22.39, 32.84, 20.89, 10.45, 5.97 and 7.46 per cent samples were found in good, marginally saline, high SAR saline, marginally alkali and highly alkali categories, respectively Spatial variability maps of EC, SAR and RSC of irrigated ground water were also prepared in the Rai block of Sonipat distric were Prepared.

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Impact of Clay Types, Dosages, and Sesquioxides on Carbon Stability

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Recent attention has been directed towards understanding soil organic carbon (SOC) stabilization mechanisms due to their impact on the global carbon cycle. Phyllosilicate minerals play a crucial role in stabilizing SOC through mechanisms like electrostatic attraction, H-bonding, ligand exchange, polyvalent cation bridging, and van der Waals forces. While earlier research mainly explored interactions between clay and organic matter from geological sources, the behavior of pedogenic clay minerals is distinct due to their formation in diverse soil environments. Consequently, their ability to stabilize carbon in the presence or absence of oxides and external carbon input remains inadequately understood. Addressing this gap, we conducted an incubation experiment with different soil clay fractions (SCFs) alongside external wheat residues in a sand-clay mixture. SCFs underwent sequential sesquioxide removal with varied dosages. Results demonstrated that Alfisol-SCFs yielded the highest cumulative C mineralization, trailed by Mollisol-SCF and Vertisol-SCF. Microbial biomass carbon (MBC) and enzymatic activities mirrored this trend but MBC displayed declining values with longer incubation. Stepwise regression analysis identified specific surface area (SSA), cation exchange capacity (CEC), MBC, and enzymatic activities as critical factors in carbon stabilization. This study underscores the significance of 2:1 clay mineralogy in sequestering SOC within natural pedogenic environments.

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Vertical Distribution of Soils Properties in Soils of Bansdih (Bankawa and Seriya village) Block of Ballia district (U.P.)

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Two pedons were exposed for collection of soil samples from two village *viz.* Bankawa (P1) and Sheria (P2) of Bansdih block of Ballia district from 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105,105-120, 120-135 and 135-150 cm depths during *ravi* season of 2020-2021 to study the depth wise distribution of soil properties were analyses for soil pH, EC, bulk density, WHC, sand, silt, clay, organic carbon, available N, P, K and S, and $CaCO_3$. The percentage of sand, silt, and clay in both pedon varied their value of P-1 showed sand 32 to 41%, silt 31 to 41% and clay 22.0 to 31.0% and P-2 sand 27.3 to 42.0%, and silt 32.5 to 40.2% and clay 23.0 to 36.0% respectively. EC of soil under study was ranged from 1.001 to 1.049 dSm^{-1} indicated very small variation. Soil pH range from 6.4 to 8.2 showed very small variation towards alkaline from top soil (105-120 cm) to the bottom (135-150 cm) were found in both pedons. Bulk density was ranged between the values of 1.321 to 1.607 Mg m^{-3} of both P1 and P2 pedon, respectively. The water holding capacity measured in P1 and P2 were ranged from 35.31 to 60.65% among the soil depth respectively. Maximum organic carbon content 0.704% was found at 0-15cm depth in P-1, whereas in P-2 was showed 0.812% at the similar depth. Available nitrogen content were showed decreasing ranged from 328.4 to 321.95 kg ha^{-1} throughout the depth of both pedons. However, available N content was found, maximum (328.4 kg ha^{-1}) in surface horizons and decreased regularly with soil depth in P-1 upto lower depth. The P-2 soil was showed for available nitrogen value 390.9 to 41.7 kg ha^{-1}. The P-1 was showed greater value of available phosphorus (12.19 kg ha^{-1}) in 0-15 cm depth. The similar pattern was found in P-2 also. The greater amount of available phosphorus was found of profile 2.0 of 14.48 kg ha^{-1}. Available potassium in P-1 was varied from 537.6 to 336 kg ha^{-1} and in P-2 was ranged from 515.2 to 313.6 kg ha^{-1} on 135-150 cm depth of horizon. There was great difference of available potassium content in Bansdih block soil between the both pedon of Bankawa and Sheria village. The greater amount of available sulphur was found in surface soil was varied with the horizon depth values were varied from 4.5 to 10.75 mg kg^{-1} soil than in sub surface soil.

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Impact of Crop Residue and Nutrient Levels on Soil Properties and Nutrient Dynamics under Conservation Agriculture in Vertisols of Central India

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Soybean-wheat cropping system is the most widely adopted cropping system in M.P., producing massive volumes of nutrient-rich residue. However, intensification of cropping systems leads to a smaller sowing window between two crops and increased mechanical harvesting of wheat resulted in huge biomass leftover in the field. Farmers prefer in-situ burning of crop residues in the field, and thus residue management becomes one of the most daunting tasks in modern mechanised agriculture threatening the long-term sustainability of agricultural production systems and soil health. Crop residue management coupled with adoption of zero-tillage system in vertisols can improve soil quality and help safeguard the land from degradation. Field experiments were carried out in the zero-tillage based soybean-wheat cropping system involving different levels of crop residue retention and nutrient doses. The experiment was laid out in a Factorial Randomized Block Design (FRBD) comprised of 16 treatments combinations involving 4 residue level (0%, 30%, 60% and 90%) and 4 nutrient doses (N_1-RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}), N_2-75% N+100% P_2O_5 and K_2O ha^{-1}, N_3-75% P_2O_5+100% N and K_2O ha^{-1}, N_4-75% K_2O+100% N and P_2O_5 ha^{-1}) with 3 replications under ongoing CRP-CA project at ICAR-Indian Institute of Soil Science, Bhopal (M.P.) since 2015. The study was conducted with an objective to evaluate the impact of residue levels and fertiliser doses on soil properties, nutrient dynamics and their subsequent effect on crop performance. The result revealed that the soil bulk density and porosity were not affected by nutrient doses but were affected by residue levels, which were shown to be lowest when crop residue levels were at higher level and inversely associated to porosity. Soil parameters pH, EC, OC, available and total N P K were considerably influenced by residue levels, while nutrient doses had no effect except on available N, P, K content. All the levels of crop residue retention treatments improved soil physical and chemical properties significantly as compared to no residue retention treatment. However, it has been observed that higher level of crop residue retention has pronounced effect on soil properties. The crop yield was also significantly influenced due to retention of higher level of crop residues as compared to no residue retention treatment. The current study indicates that retaining greater amounts of crop residue (90%) results in considerable improvements in soil characteristics and can potentially help in economizing the fertilizer requirement by 25% particularly phosphorus and potassium without compromising on crop yield.

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Assessment of Soil Properties in Different Textured and Salt affected Soils under Rice-Wheat Cropping System in Punjab

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Rice-wheat is the most predominant cropping system in Punjab due to considerable increase in area and high yielding varieties. However, due to intensive cultivation and imbalanced application of chemical fertilizers, soils have become deficient in most of macro and micronutrients. The declining organic matter content in soil has reduced nutrient availability, thereby decreasing the productivity potential of rice-wheat cropping system. Therefore, the study was conducted to assess the variation in soil properties in different textured and salt affected soils under rice wheat cropping system of Punjab. Soil samples were collected and categorised in coarse, fine and salt affected soils and analyzed for the basic properties such as- pH, EC (electrical conductivity), OC (organic carbon), CEC (cation exchange capacity), ESP (exchangeable sodium percentage), nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, sodium, iron, zinc, manganese, copper, boron, chlorides, carbonates and bicarbonates. Among these properties the first 5 principal components (PC's) influencing the availability of other nutrients resulted from the principal component analysis (PCA) obtained from R studio are pH, EC, OC, CEC and ESP. The salt affected soils had pH from 7.83 to 9.31, EC 0.44 to 10.82 dS m^{-1}, OC 0.33 to 1.14 %, CEC 3.01 to 5.72 meq 100 g^{-1} soil and ESP 7.19 to 19.86%. The coarse textured soils had pH from 7.4 to 8.55, EC 0.23 to 1.10 dS m^{-1}, OC 0.31 to 1.01%, CEC 2.13 to 4.88 meq 100 g^{-1} soil and ESP 7.54 to 21.96%. The fine textured soils had pH from 8.02 to 8.63, EC 0.31 to1.12 dS m^{-1}, OC 0.74 to 1.38 %, CEC 3.43 to 7.88 meq100g-1 soil and ESP 5.88 to 14.63%. The survey was carried to study the availability of the nutrients as it is affected by the variations in soil biochemical properties which are dependent on the texture and salts present in soil.

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Long Term INM Effects in a Cereal-Vegetable-Pulse Cropping System on Phosphorus Sorption Characteristics in an Acid Inceptisol of Coastal Odisha

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The bioavailability of P to crop plants is insufficient due to the strong adsorption and fixing behaviours in acid soils. P adsorption-desorption characteristics with detailed isotherm studies were investigated in an acid soil following 12 years of INM practices under AINP on Soil Biodiversity and Biofertilizers, spontaneity of the sorption reaction, and the impact of soil physico-chemical properties on adsorption-desorption behaviour. The experiment was performed in RBD with 3 replications and 8 treatments *viz.*, T1: Absolute Control, T2: STD (Soil test-based dose), T3: STD+ FYM (5.0 t ha^{-1}), T4: STD + VC (Vermicompost 2.5 t ha^{-1}), T5: STD+FYM (5.0 t ha^{-1}) +BF (Biofertilizer consortia of *Azotobacter* + *Azosprillum*+ *PSB* @ 1:1:1 *i.e.* @ 12 kg ha^{-1}), T6: STD +VC+BF, T7: STD+FYM+BF+L (Lime @0.1 LR), T8: STD+ VC+ BF+L. The adsorption and desorption of applied P were found inversely related. The soils applied continuously with inorganic fertilizers exhibited the maximum amount of adsorption [adsorption maxima(b): 526.3 μg g^{-1}] whereas the soils under INM+lime treatment showed maximum amount of desorption (b for desorption: 102.04 μg g^{-1}). Long-term balanced fertilization reduced P bonding energy and adsorption capacity in soil while increasing P desorption potential. Higher Langmuir "b" values found in soils with larger Langmuir "k" values (STD). Langmuir "b" and Freundlich K values followed a similar pattern in desorption study. This comprehensive knowledge on P adsorption-desorption mechanism can provides insights to future researchers and open up novel avenues in devising sound P management models for sustainable productivity.

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Soil Properties of a Vertisols affected by Long-term Application of Soil Test and Targeted Yield based Nutrient Management on Vertical Variability under Rice-wheat Cropping Sequence

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Present investigation was carried out during rabi season of 2020-21 to assess the vertical variability in properties of post-harvest soil under rice-wheat cropping system in an on-going research programme of AICRP on STCR initiated during 2008 at the Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. The study was consisted of six treatments of nutrient management practices based on soil test and targeted yields of rice and wheat (T_1: Control; T_2: GRD; T_3: T.Y. 50 and 45 q ha^{-1} for rice and wheat; T_4: T.Y. 60 q ha^{-1}; T_5: T.Y. 50 and 45 q with FYM 5 t ha^{-1} for rice and wheat and T_6: T.Y. 60 q with 5 t FYM ha^{-1}) at different soil depths (0-15, 15-30 and 30-45 cm) which were replicated four times in a randomized block design. Results revealed that STCR based nutrient management practices significantly affected the variability of physico-chemical properties of soil at different soil depths except soil pH. Highest values of EC, SOC, available N, P, K and S and CEC were obtained under treatment T_6 having highest yield target of 60 q ha^{-1} along with FYM 5 t ha^{-1}, while content in calcium carbonate of soil was obtained highest under control. It was further revealed that the values of different soil parameters were decreased with increased soil depths except soil pH, calcium carbonate and CEC of soil.

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Impact of Tillage, Crop Residue Addition, Nutrient Doses on Soil Organic Carbon

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A field experiment was conducted to study the impact of tillage, crop residue addition and nutrient doses on soil organic carbon after five crop cycles. Results indicated that tillage system and nutrient doses had a significant impact on SOC at end of *kharif* season. Significant higher value of SOC (0.78%) observed under T1 and T2 (NT with 30 and 60 cm residue height) at 0-10 cm soil depth; Lower value (0.66 and 0.52%) of SOC was found under T5 (Conventional tillage) at both of the soil depths, respectively. Among the nutrient doses the higher values of SOC (0.80 and 0.82%) were recorded under N2 (100% RDF) and N3 (STCR) than N1 (75% RDF). The interaction of tillage system × nutrient dose, nutrient dose × depth and tillage system × nutrient dose × depth have not shown significant effect on SOC in the end of *kharif*. The monitoring the changes in active C can be particularly useful to farmers who are changing practices with the goal of building up soil organic matter. This fraction of C is often termed as active or labile fraction of C, which is very sensitive to management practices. The labile or active C; which is readily available to microbes which are different from a highly recalcitrant or passive C, that is only very slowly altered by microbial activities. The active C fraction (835.7 and 780.7 mg C kg^{-1}) was found significantly higher under RT with 60 cm residue height compared to NT and CT practices in the end of *kharif* and *rabi* sampling. This was mainly due to better mixing of residue with minimum soil disturbances under reduced tillage, which provided more substrate for microbes to decompose the fresh residue resulting in higher labile carbon under these treatments. Lower values of active C under NT over RT was due to less opportunity for mixing of crop residue. Minimum active C content was recorded under CT (682.8 and 662.2 mg C kg^{-1}) at both study stages. Nutrient management practices had significant ($P < 0.05$) effect on labile carbon at both of the samplings. Among the all nutrient levels compared, STCR dose was significantly higher active C content at all stages. The value of active C recorded under STCR at end of *kharif* (824.86 mg C kg^{-1}) and end of *rabi* (782.5 mg C kg^{-1}) followed by 75% and 100% RDF. The interaction effects between tillage system and nutrient dose was non significant ($P < 0.05$) on active C at both of the study stages.

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Evaluation of the Spatial Variability of Physico-chemical Properties in the Malwa belt of Madhya Pradesh

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Knowledge of the soil variability of any region is crucial for the development of site-specific nutrient management practices (SSNMP) for good soil health and to enhance crop productivity. The present study was carried out on a total of 150 geo-referenced surface soil samples collected from Ujjain Tehsil, Ujjain District, Madhya Pradesh State, India. These soil samples have been analyzed in a laboratory using standard methods for properties like pH, electrical conductivity, soil organic carbon, particle size distribution (sand, silt, and clay), and available nitrogen, phosphorus, and potassium. The results showed that the soil's pH, EC, SOC, available N, P, and K, as well as its sand, silt, and clay, ranged from 7.01 to 8.15, 0.10 to 0.79 dSm^{-1}, 0.30 to 0.60%, 139.00-235.00 kg ha^{-1}, 8.00-25.60 kg ha^{-1}, 301.00-463.00 kg ha^{-1}, 9.15 to 24.06%, 24.00 to 41.55%, and 40.20 to 58%, respectively. The data were analyzed using classical statistics and geo-statistics by constructing semi-variograms and mapping them using ordinary kriging techniques. Semi-variograms were calculated for soil characteristics, and their spatial distributions were mapped. The nugget/soil (Co/Co+C) ratio was used to determine the best-fit models involving exponential, spherical, circular, and gaussian functions. We also assessed the spatial dependence of different soil properties, ranging from moderate to strong. These maps will be helpful for farmers when deciding how much fertilizer to apply to the soil to improve soil fertility for future crop production and environmental protection. Further, this study demonstrates the usefulness of GIS applications in soil variability studies.

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Effect of Low PH, High Exchangeable Aluminium (Ex Al), Exchangeable Acidity (EX Acidity) and Poor Soil Nutrient Conditions on Plant Aluminum (Al) Content and Growth of Rubber (Hevea Brasiliensis) Seedlings

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Plant aluminium (Al) content and growth of rubber seedlings grown in soil with low pH, high Exchangeable aluminium (Ex. Al) and Exchangeable acidity (Ex. Acidity) were compared with those grown in soils with pH 5.5 and pH 7.5. Study was conducted in an open air condition at Rubber Research Institute of India, Kottayam, Kerala, India. Sprouted seedlings were planted in polybags filled with three different soils *viz*. extremely acidic soil (pH 4.4), strongly acidic soil (pH 5.5) and neutral soil (pH 7.4) with varied soil nutrient conditions. Initial soils were analysed for soil pH, Ex Al, Ex Acidity and soil nutrients. Growth of plants in terms shoot, root and total biomass was recorded at two stages *viz*. 3 months and 8 months after planting. Aluminium (Al) content in shoot and root and total Al uptake in plants were also determined. Results of the study indicated that in low pH soil with high Ex Al and Ex acidity, the shoot and root Al was high in rubber seedlings and the growth of plants was less at 8 months. But in pH 7.4 soil, root Al was high with less Al in shoot along and the growth of rubber seedlings was comparatively superior also. It can also be observed that even in acidic soil with pH 5.5, the growth of plants was not affected. Hence, it was inferred from the study that the extremely acidic low pH (4.4) soil having higher Ex Al, Ex acidity with poor soil nutrients is a constraint for the growth of rubber seedlings and the acidic soil pH 5.5 with less exchangeable Al & acidity was found to be favorable for rubber seedlings for early growth of plants. The neutral pH 7.4 with rich soil nutrients is very congenial for growth of rubber seedlings. Though rubber is widely cultivated in acidic soil, the initial growth of seedlings in neutral soil (pH 7.4) was comparable with that of soil pH 5.5, indicating the tolerance of rubber plants to a wide soil pH range.

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Comparison between Extraction of Potassium with Difference in Shaking Time, Soil: Solution Ratio in Vertisols and Inceptisols

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The supply of potassium from soil depends on the forms present and rate at which the exchangeable K is replenished from non-exchangeable K sites. Extraction in soils with 1 *N* NH_4OAc is a successful method adopted so far. Both the release and fixation of K by lattice minerals during weathering is the basis for recommending fertilization for growing plants. So, it is important to study the extracting power of K with acid and evaluate the rate of release with successive soil/solution ratios with different shaking time as it can avoid over fertilization and moreover can save millions expended to buy muriate of potash from other countries. The study aimed at evaluating extraction technique by noting the relationship between different extracting procedures. The K release was observed with different soil/solution ratios and shaking time. The results showed that K release pattern maximum with 30 minutes of shaking > 10 min> 5 min. the correlation coefficients of equation was noted ($R^2 = 0.99$) between 5 and 10 min; ($R^2 = 0.98$) for 10 and 30 min and ($R^2 = 0.98$) for 30 and 5 min. Soil/solution ratio taken as 1:5 showed greater extraction than 1:3. When compared with Whatmann filter paper 2 and 42, WFP 2 extracted more K as well as took less time to filter. Concluding, 1 N NH_4OAc extracted K maximum with 30 minutes shaking, WFP 2 and 1:5 soil/solution ratio well described the release rate of soil K in Vertisols and Inceptisols of Madhya Pradesh, India.

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Nutrient Release in Alfisols and Inceptisols Amended with Biochar

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Biochar, a recalcitrant form of carbon, is gaining importance in agriculture for improving soil health and enhancing crop production. An incubation study was carried out on Alfisols and Inceptisols of Odisha with the objective to assess the nutrient release on application of biochar in these soils. Treatment combinations included were three levels of biochar (0, 2 and 4%) and two levels of manures (0 and 2%) *viz.* T1- No biochar no manure; T2- No biochar with 2% FYM; T-3 Biochar 2% without manure; T4- Biochar 2% and manure 2%; T5- Biochar 4% without manure and T6- Biochar 4% with manure 2% (w/w basis). 100 g soil was incubated at 27°C for 84 days and sampled periodically. The sampled soil was analyzed for soil properties *viz*. pH, electrical conductivity, NO_3^-- N, available N, and available K as per standard procedures of estimation. Addition of biochar with and without manure showed impact on nutrient release and changes in soil properties in both the types of soils. The soil of Belpada was normal in reaction while that of Nuapada was acidic in reaction. The soil pH was increased by about two units with application of 4% biochar. Application of biochar alone did not affect nitrate and phosphorus release to a significant level when applied alone, however, when applied with manure it showed pronounced effect on nitrate-N and available P release in soil. Available K release was consistently increased gradually with biochar as well as manure application and reached to a level as high as 535 mg ka^{-1}. In alfisols of Odisha i.e. soils from Nuapada the increase in soil pH was very significant. It varied between 5.15 and 7.43 indicating an increase of 2.3 units showing its potential to be a better amendment for acid soils. A corresponding increase was also observed in soil electrical conductivity. Biochar application along with manure at both the levels increased the release of nitrate N in soil from 37 to 85 mg kg^{-1} in 84 days of incubation. This improvement was increased to as high as 143 when biochar was applied with manure (2%). Highest available P was observed with manure application @2 per cent, which was slightly decreased with application of 2 and 4 per cent biochar application indicating that it would help in controlling the P release for plants. Available potassium content in soil improved significantly with biochar application in acid soils from 55 to 168 and 285 mg kg^{-1} with application of 2 and 4 per cent biochar. Thus biochar hold promise to retain and release plant available nutrients in soil and moderate the soil properties.

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Effect of Long Term Nutrient Management on Carbon Pools and Indices in Rice-rice Cropping System in Lateritic Soils of Humid Tropics

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Being a crucial component of the carbon cycle, soil organic carbon serves a vital role in sustaining environmental quality and supporting agroecosystems. The present study evaluated the effects of long-term manure and fertilizer application on soil organic carbon pools in a rice-rice cropping system in the lateritic soils of central plain, Kerala, India. Soil samples from a randomized block design with twelve treatments and four replications were used to determine the organic carbon pools. Under integrated nutrient management treatments, results reveal a considerable improvement in the WBC contents in soil. The WSC, $KMNO_4$-C and WBC forms 0.7, 5.4 and 94% of the total organic carbon respectively. The $KMnO_4$-oxidizable carbon ranged from 0.092 to 0.158 percent. It was proven to be a more accurate indication for assessing how agricultural management techniques affect the quality of soil organic carbon. The management practices were found to greatly influence microbial biomass carbon in the soil with values 195.55 to 298.2 μg g^{-1} soils. The treatments had a significant effect on total polysaccharides and glomalin, that are strongly connected to aggregate stability. Application of graded doses of NPK from 50 to 150% improved Walkley and Black carbon, water soluble carbon and microbial biomass carbon by 7.69, 22.22 and 27.94% respectively. With the integrated supply of mineral fertilizers and organic manures, the SOC stocks under the rice-rice system were reported to be significantly greater at $p < 0.05$. The carbon management index, an indicator predicting the sustainability of soil management systems increased by 72.89% in 100% NPK + FYM over the control and 41.48% over the sole application of fertilizers. It was superior in one receiving integrated nutrient sources than one receiving prescribed levels of nutrition using only mineral fertilizers

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Effect of Long-term Application of Inorganic and Organic Fertilizers on Basic Soil Properties under Soybean-wheat Cropping Sequence in Subtropical Vertisols

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Soil health encompasses the physical, chemical, and biological properties of the soil, which are crucial for plant growth and as a buffer against hazardous compounds. Long-term experiments are the primary source of information to determine the effect of cropping systems on soil quality attributes. An experiment was carried out at the Research Farm of, JNKVV, Jabalpur with aim to study changes in soil quality, crop productivity, and sustainability in Soybean-Wheat cropping system. The experiment consists of 10 treatments, *i.e.*, T1 50% NPK, T2 100% NPK, T3 150% NPK, T4 100% NPK + HW, T5 100% NPK + Zn, T6 100% NP, T7 100% N, T8 100% NPK+FYM, T9 100% NPK-S, and T10 control, with four replications in a randomized block design. Continuous application of varying amounts of fertilizers, either alone or in combination, did not alter the soil pH and EC. However, a positive change was observed in soil organic carbon, available N P K and S content with the use of balanced fertilizers and manures, as compared to the imbalanced and unfertilized treatments. A positive correlation was observed among most of the soil properties, indicating an interrelationship among them. The yield of soybean-wheat also showed a positive relationship with the various soil properties. The improvement in soil properties enhanced the nutrient storage capacity, thereby improving the soil health, which may ultimately lead to an increase in crop productivity on Vertisol.

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Efficiency of Phosphorus as Influenced by Sources (DAP and Superphosphate) on a Pearl Millet Crop in an Alluvial Soil

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A study was conducted to investigate the efficiency of diammonium phosphate (DAP) and single superphosphate (SSP) as phosphorus sources for pearl millet crops in alluvial soil at the RVSKVV research farm in Gwalior. Soil samples were collected from the topsoil horizon (0-15 cm) of all 4 replications, which included eight treatment combinations: T_1 - 30 kg P_2O_5 ha^{-1} through SSP, T_2 - 60 kg P_2O_5 ha^{-1} through SSP, T_3 - 30 kg P_2O_5 ha^{-1} through SSP + 5 tonne FYM, T_4 - 60 kg P_2O_5 ha^{-1} through DAP, T_5 - 30 kg P_2O_5 ha^{-1} through DAP, T_6 - 60 kg P_2O_5 ha^{-1} through DAP, T_7 - 30 kg P_2O_5 ha^{-1} through DAP + 5 tonne FYM, T_8 - 60 kg P_2O_5 ha^{-1} through DAP + 5 tonne FYM. Standard protocols were used to analyze soil samples for pH, electrical conductivity, soil organic carbon, available nitrogen, phosphorous, potassium, and sulphate The findings indicated that all the treatments had a significant impact on the soil properties. Among two sources (DAP and SSP), treatment with SSP's 60 kg P_2O_5 + 5 t FYM, had received significantly higher grain and stover yield than DAP and increased with the increasing level of phosphorus application. The study found that the application of various phosphorus sources, along with the integration of farmyard manure, led to the highest grain and straw yield in pearl millet grown in alluvial soil. The soil's nitrogen, phosphorous, potassium, and sulfur status followed similar trends, with the highest values observed.

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Nitrogen Dynamics under different Tillage Systems and Crop Management in a Vertisol of Central India

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Maintaining healthy soil is crucial for agriculture, and the key to achieving this lies in the cropping system, tillage techniques, and nitrogen management practices. These factors greatly influence the soil's physical, chemical and biological properties, so it's important to implement the right strategies to ensure optimal soil management. A field experiment was conducted in Vertisols of central India at the research farm of ICAR-IISS, Bhopal, with two tillage treatments *viz.*, No-tillage (NT) and Conventional tillage (CT) as main plot, two cropping systems *viz.*, Maize-Wheat and Maize-Chickpea as subplot and four nitrogen (N) levels *viz.*, N150%, N100%, N50% and N0% of GRD as sub-sub plots to study the effects of these treatments on soil physical and chemical properties. The soil samples were collected after the collection of seven crop cycles. The NH_4-N concentration in the 0-5 cm soil layer was significantly affected by tillage. However, the cropping system and its interaction effect did not have a significant impact. The highest concentration was observed in the no-till system with a value of 19.08 mg kg^{-1}, while the lowest concentration was observed in the conventional tillage system, with a value of 12.67 mg kg^{-1} for the same soil layer. The concentration of NO_3-N in the 5-15 cm soil depth was significantly influenced by tillage practices. The study indicated that NT systems had higher NO_3-N concentrations compared to CT systems. The NO_3-N concentration was not significantly affected by the cropping system and nitrogen levels. However, the highest NO_3-N value was observed in the Maize-Wheat cropping system with a nitrogen dose of 150%. Although tillage had a significant impact on the total nitrogen concentration, cropping systems and their interaction had no effect on the 0-5 cm soil layer. The mean total N value ranged from 0.107% to 0.134% in the 0-5 cm soil layer, from 0.104% to 0.132% in the 5-15 cm soil layer, and from 0.086% to 0.131% for the 15-30 cm depth of soil. It indicates that reducing soil disturbances and leaving residues improves soil quality, and retention of water and nutrients, leading to better crop growth and sustainability.

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Carbon Fractionation in different Tillage Systems and Crop Management Practices in a Region of Central India

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Soil organic carbon and nitrogen (SOC and N) are the two primary factors that impact crop growth. A field experiment was conducted in Vertisols of central India at the research farm of the ICAR-India Institute of Soil Science, Bhopal with two tillage treatments *viz.*, No-tillage (NT) and Conventional tillage (CT) as the main plot, two cropping systems *viz.*, Maize-Wheat and Maize-Chickpea as subplots, and four nitrogen (N) levels *viz.*, N150%, N100%, N50% and N0% of GRD as sub-sub plots to study SOC dynamics. The soil samples were collected after the completion of seven crop cycles. At depths of 0-5 cm, the average value of SOC data ranged from 0.61% to 0.77%. At depths of 5-15 cm, the average value of SOC data ranged from 0.55% to 0.70%. Finally, at depths of 15-30 cm, the average value of SOC data ranged from 0.52% to 0.66%. In terms of soil organic carbon (SOC) concentration, the tillage treatments had a significant impact at depths of 0-5 cm and 5-15 cm. Specifically, the no-tillage treatment (NT) had the highest SOC concentration (0.77%) while the conventional tillage treatment (CT) had the lowest (0.61%) within the 0-5 cm soil layer. Surface layer had higher SOC concentration that decreased with depth. DOC values ranged from 10.36 to 23.58 at 0-5 cm, 9.77 to 17.04 at 5-15 cm, and 9.74 to 16.19 at 15-30 cm depth. Total carbon ranged from 0.8% to 0.986% at 0-5 cm, 0.783% to 0.979% at 5-15 cm, and 0.783% to 0.975% at 15-30 cm depth. By minimizing soil disturbance and leaving residues on the ground, soil physical and chemical properties are improved. This also helps retain water and nutrients, creating a better soil environment for crop growth over longer periods of time.

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Assessment of Biological Soil Health under Conservation Agriculture based Rice-wheat System in Indo-Gangetic Plain

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Conservation agriculture (CA) is one of the best options to sustain productivity by ensuring resource conservation as well as mitigation of adverse climatic impact. To assess biological soil health, soil samples were collected from six treatments *viz.* (Zero till direct seeded rice (ZTDSR) - zero till wheat (ZTW), ZTDSR+ wheat residue (WR) – ZTW + rice residue (RR), ZTDSR + WR + sesbania brown manuring (SBM) - ZTW + RR, ZTDSR - ZTW - zero till mungbean (ZTMB), ZTDSR + mungbean residue (MR) - ZTW + RR – ZTMB + WR, Transplanted rice (TPR) -conventional till wheat (CTW) - conventionally tilled mungbean (CTMB)) from 0-5 cm soil depth of 10 years old CA based experiment with rice-wheat system situated at ICAR-IARI farm, New Delhi. The soil samples were analysed for different labile fractions of organic carbon, soil enzyme activities and microbial population by using standard protocol. Molecular based qPCR technique was used to quantify the abundances of different phylogenetic groups and nutrient cycling genes. PCA analysis was done to screen out key indicators of biological soil health and â-glucosidase (PC1), *Bacterial amoA* (PC2), *Archaeal* 16S (PC3), *Bacteroidetes* 16S (PC4), *Bacterial* 16S (PC5), mineralizable C (PC6) were selected. The highest biological soil health index (BSHI) was found in triple ZT with residues (ZTDSR + MR - ZTW + RR - ZTMB + WR) treatment. Therefore, this practice may be recommended for CA based rice-wheat cropping system in Indo-Gangetic plain.

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Effect of Biomass on Total Carbon Sequestrations under Pearl Millet-mustard Cropping Sequence in Typic Ustochrepts

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The study was carried out between experimental period of *kharif* 2017 to *rabi* 2019 with sixteen fertility treatments, combinations of inorganic and organic fertilizers to quantify effect of biomass on carbon sequestrations. The management practices such as application of fertilizer and organic amendments together plays an important role in maintaining total carbon sequestration under the pearl millet - mustard cropping sequence. The pearl millet-mustard cropping system indicated that there was always gain in value of total carbon sequestration (TCSQ) at the end of study period compared to initial stage of study period. In all the treatments a regular and higher build up of TCSQ was recorded. The maximum build up of TCSQ by 5.8 Mg ha^{-1} under treatment 100% NPK + FYM @ 10t ha^{-1} yr^{-1} +Azotobactor +PSB followed by 100%NPK + FYM @10 t ha^{-1} yr^{-1} (5.5 Mg ha^{-1}) over all fertility treatments and control, may be the result of higher biomass production through the application of FYM along with inorganic fertilizer, which can build up of SOC in soil additionally. Major contribution in carbon sequestration was made by biomass production rather than changes in SOC pools. The data very clearly indicated that even if a small portion of biomass could be recycled to soil then only crop production itself can enrich SOC content and stop its further deterioration. Lal (2004a) summarized the results of a number of studies and concluded that improved fertility management can enhance the SOC content at the rate of 0.05 to 0.15 Mg ha^{-1} yr^{-1} to the soil through only crop roots.

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Carbon Sequestration Potential of Tasar Host Plantations and Exploitation of Fungi to Improve soil C Turnover

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Tasar sericulture is an agriculture allied activity in which tasar silk is produced by rearing the wild silkworm *Antheraea mylitta* on suitable host plants. The tasar host plants are trees maintained in systematic plantations through a prescribed set of cultural practices. The tasar host plantations may be good candidates for promoting C sequestration at the same time provide a means of income to the poor tribal populations living at the fringes of the sal forests in tasar sericulture states. *Terminalia arjuna* and *Terminalia tomentosa* are the preferred host plants to establish systematic tasar sericulture plantations and the biomass C sequestration was studied in both the species in >30 year old plantations. The biomass carbon sequestration of Arjun is 28.6 t ha^{-1} at a tree spacing of 10' × 6' and Asan is 23.9 t ha^{-1} at 12' × 12' spacing. An increment of ~0.15% was observed in SOC during a period of 3 years. Although leaf litter of 0.6 to 0.7 t ha^{-1} is generated during the autumn leaf fall, the increment in the soil organic carbon content is not proportional which is due to the low C turnover rates. The soils are acidic and are favourable for the growth of fungi and thus the fungal consortia may be exploited to improve the C turnover rates in tasar ecosystems. The cellulase producing fungi and white rot fungi with high cellulose degradation and lignin degradation efficiency respectively were isolated from decomposing leaves of arjun, asan and sal and are being explored to bring about the *in situ* litter degradation and carbon turnover of tasar plantations during the humid months of the year.

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Impact of Secondary Ecological Succession on C-Sequestration in Sub-tropical and Sub-Humid Region of Bihar

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To examine the secondary succession of any management practices to test the applicability of different land use systems for improving biological activity in restored ecologies, soils were sampled from 0-15, 15-30 and 30-45 cm deep layers of Napier, Litchi, Mango, Guava, Grassland -based silviculture systems. These were compared with samples from fallow land (F). To assess soil physical, chemical and biological properties that can be used as quantitative indicators of soil health have assumed crucial significance. the experiment was conducted in different land use management system with random block design. Secondary ecological succession is 3-fold higher in horticultural and pastoral land use management systems as compared to cycling ecological system in terms of enzymatic activities and Ecological restoration. Grasses tree-based DLUS, such as Litchi, Mango, Guava, fodder and Napier may be advocated as these practices improved soil biological quality compared to fallow. The Napier had 2.14-, 1.82- and 1.38-time higher CMI than fallow in sampled soil layers. CMI is a valuable tool for explaining soil quality since it examines the ability of various management activities to determine the long-term efficacy of mineral nutrient availability, efficiency and soil C pools. Biological activity index (BAI) ranging from 2.20-2.93 in upper depth of soil. Organic amendments significantly improved the activities of C, N, P and S cycling enzymes and SOC concentrations in surface and subsurface soils. it is ecological succession that for improvement of secondary and vertical ecological succession for improvement of pasture and horticultural development is more useful option and soil test crop response management in general further studies is required.

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Impact of Long-term Fertilizer and Manure Application on Soil Microbial Community Structure and Elemental Stoichiometry

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Sustainable soil management is crucial to achieve optimum crop productivity and to maintain soil health. In this regard application of fertiliser is a critical requirement for sustaining crop productivity. Thus, the long-term fertiliser experiment serves as a focal point for research on the function of microbial interaction in nutrient-supplying capacity. Despite extensive research, we are still unsure of how long-term applications of fertiliser and manure will affect the soil microorganisms and in turn soil ecosystem services. Therefore, the present study was conducted to find out the alteration in elemental stoichiometry, microbial biomass ratio and corresponding shift in microbial community structures under different fertilizer and manure application regimes in long term fertilizer experiments (LTFE) of Inceptisol (Barrackpore) and Vertisol (Parbhani). Treatments comprised of control, Fallow, 100% N (imbalanced fertilizer application), 100% NP (imbalanced fertilizer application), 100% NPK (balanced fertilizer application), 100% NPK + farmyard manure (FYM) at 5t ha^{-1} (Integrated nutrient management; INM). Significantly higher C limitation on soil microbial community has been found under imbalanced fertilizer application based on vector length calculation and it decreased in 100% NPK and 100% NPK + FYM treatments. Similarly, higher P limitation as compared to N under was noticed in imbalanced fertilizer application based on vector angle calculation in both LTFE Barrackpore and LTFE Parbhani. Likewise, significantly lower ratio of Cyclo/Monounsaturated precursor analysed through Phospho Lipid Fatty Acid (PLFA) in 100% NPK + FYM indicated lower stress on soil microbial community; on the contrary significantly higher Cyclo/Monounsaturated precursor ratio in control, 100% N, 100% NP indicated higher stress on soil microbial community in both LTFE Barrackpore and LTFE Parbhani. Similarly, highest soil enzymatic diversity indices such as Shannon diversity index (H) and Simpson Yule index (SYI)) have been noticed in 100% NPK + FYM treatment in LTFE Barrackpore and LTFE Parbhani.

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Synergistic Impact of Microbial Inoculation and Nitrogen Supplementation on Crop Residue Recycling: Implications for Soil Properties and Field Pea Productivity

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Disposal of crop residues is a major problem now days which leads to its burning, and subsequent atmospheric pollution. Therefore, a field experiment was undertaken at research farm of ICAR RCER FSRCHPR Ranchi to study the effect of crop residue sources and microbial culture application on field pea yield and soil properties. The experiment was designed in factorial RBD with 15 treatments consisting of three crop residue sources (C1 - Paddy straw, C2 - black gram straw and C3 - ragi straw) and five microbial treatments to crop residue (T1 - control l, T2 - CR treated with *Aspergillus niger* culture, T3 - CR treated with *Trichoderma Viridi* culture, T4 - CR treated with *Aspergillus niger* culture along with 1.0% nitrogen T5- CR treated with *Trichoderma Viridi* culture along with 1.0% nitrogen) with 2 replications. The study showed that the highest grain and straw yield, (16.12 q ha^{-1} and 24.97 q ha^{-1}), was recorded under the treatment application of paddy straw@ 5.0 t ha^{-1} while among the microbial inoculation treatment, T5 treatment registered significantly higher grain yield (16.18 q ha^{-1}) and straw yield (24.92 q ha^{-1}) of field pea over control treatment. The treatment application paddy straw @ 5.0 t ha^{-1} and inoculation of *Trichoderma spp.* culture along with 1.0% nitrogen increased the crop yield, total nutrient uptake and also improved soil nutrient status. Thus application on crop residue along with microbial inoculation and nitrogen supplementation can be an effective approach for *insitu* residue management.

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Potential of Endophytic Fungi Isolated from Municipal Solid Waste Dumping Site for Toxic Trace Elements Tolerance and Plant Growth Promotion

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Endophytic fungal species has been found to be resistant to toxic trace elements and have potential role in bioremediation of trace elements contaminated soil. Manmade anthropogenic activities release wide range of toxic trace elements in the environment, which adversely affect the soil, water and surrounding living organisms. In the present study, the endophytic fungi were isolated from dominant plants growing near municipal solid waste dumping site. Total 14 endophytic fungi were isolated from ten different plant roots, 12 isolates were of morphologically distinct. In toxic trace elements tolerance study, few isolates could tolerate Pb and Cr in the range of 150 to 200 ppm concentration, while others could tolerate Cd and Hg up to 50 ppm concentration with their biomass growth. Identified fungal isolates belong to genera *Fusarium* and *Curvularia* show highest tolerance against Pb, Cr, Hg, and Cd elements with tolerance index more than 100%. These isolates with higher tolerance can be used as potential partner of hyper accumulator plants in microbe-assisted phytoremediation of trace elements contaminated soil. Some of the endophytes isolates namely *Aspergillus, Fusarium* and *Alternaria* sp has great potential for phosphorus solubilization and Indole Acetic-acid production whereas the *Curvularia, Fusarium* and *Paecilomyces* has great potential for siderophore production.

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Effect of Co-inoculation of Biofertilizers on Growth, Soil Fertility and Productivity of Soybean (*Glycine Max* (L) Merrill) in Vertisol

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A field experiment was conducted during the *kharif* season 2019-20 at the research farm of R.A.K. College of Agriculture, Sehore (M.P) India. The experiment was laid out in randomized block design with three replications and seven treatments with the plot size 4.2 m × 3.5 m. The treatment included Absolute control (T_1), 100% RDF (T_2), 50% RDF + *Glomus geosporum* (AMF culture) (T_3), 50% RDF + PGPR (*Paenibacillus polymyxa*) (T_4), 50% RDF + *Rhizobium japonicum* (T_5), 50% RDF + *Glomus geosporum* (AMF) + PGPR (*Paenibacillus polymyxa*) (T_6), 50% RDF + *Glomus geosporum* (AMF) + PGPR (*Paenibacillus polymyxa*) + *Rhizobium japonicum* (T_7). This experiment was conducted to investigate the effect of biofertilizer co-inoculation on soybean growth, yield, Soil Fertility and Productivity. The combination of 50% RDF + *Glomus geosporum* (AMF) + PGPR (*Paenibacillus polymyxa*) + *Rhizobium japonicum* (T_7) was found to be the most advantageous for soybean growth symbiosis characteristics, yield-attributes, and productivity in vertisol. This was followed by 50% RDF + *Glomus geosporum* (AME) + PGPR (*Paenibacillus polymyxa*) (T_6) and 50% RDF + *Rhizobium japonicum* (T_5), in that order. T_7, T_6, and T_5 treatments yielded 14.60, 13.99, and 13.44 q ha^{-1} of grain, respectively. Balance of N,P,K and S after harvest of the crop was found better under the treatment of the combined application of 50% RDF *Glomus geosporum* + (AMF) + PGPR (*Paenibacillus polymyxa*) + *Rhizobium japonicum* (T_7) over the other treatments. Thus, the treatment T_7 produced maximum total biomass (grain + straw upto 30.55 q ha^{-1}), total uptake of nutrients upto 111.1 kg N ha^{-1}, 12.82 kg P ha^{-1}, 52.57 kg K ha^{-1} and 8.45 kg S ha^{-1} by soybean along with improved available N,P,K and S *i.e.* 240.29, 12.51, 413.32 kg ha^{-1} and 9.88 ppm, respectively in the post-harvest soil. The second best treatment was T_6 having 50% RDF + *Glomus geosporum* (AMF)+ PGPR (*Paenibacillus polymyxa*) and then T_5 having 50% RDF + *Rhizobium japonicum* (T5). On the basis of investigation, it may be concluded that the combined application of 50% RDF + *Glomus geosporum* (AMF) + PGPR (*Paenibacillus polymyxa*) + *Rhizobium japonicum* (T_7) proved beneficial for soybean growth, symbiotic traits, nutrients uptake and its productivity in vertisol. Followed by 50% RDF + *Glomus geosporum* (AMF) + PGPR (*Paenibacillus polymyxa*) (T_6).

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Enzymatic Profiling and Pigeon pea (*Cajanaus cajan*) Response on Plant Growth Promoting Potential of Thermophilic Bacterial Isolates from Central India's Hot Springs: An in-depth Study

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This study aimed to uncover stress-tolerant bacterial isolates or consortia from the hot springs of Central India that possess the ability to promote sustainable crop productivity and soil health. Sixty thermophilic bacterial isolates were obtained from the Choti and Badi Anhoni Hot springs, and they were subsequently screened for their enzymatic activities, including cellulolytic, lignolytic, proteolytic, lipolytic, amylase, phosphatase, siderophore, and Indole Acetic Acid (IAA) production. Based on their plant growth-promoting potential for pigeon pea (*Cajanus cajan*), six isolates were selected for further investigation. A pot culture experiment employing a Completely Randomized Design (CRD) with eight treatments (T1: BAM3, T2: BAS11, T3: BAS17, T4: CAM1, T5: CAM-29-3, T6: CAS-5, T7: consortia, T8: control) and three replications was conducted. The results revealed that the CAM1 isolate displayed the most significant enhancement in crop growth, followed by BAS 11 and CAS5. Moreover, the bacterial culture treatments exhibited substantial improvements in both root and shoot growth compared to the control group. This study demonstrated the heat tolerance and plant growth-promoting properties of the identified bacterial isolates, establishing them as promising candidates for effective biofertilizers to enhance pigeon pea growth and production under stressful conditions. In conclusion, the findings of this research identify stress-tolerant bacterial isolates with plant growth-promoting properties that can serve as an efficient biofertilizer, enhancing crop productivity and soil health under stress conditions

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Isolation and Purification of Methanotrophic Bacteria

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Methanotrophic bacteria are ubiquitous in nature and found in freshwater, marine and terrestrial environments where they serve as crucial biological sinks for methane. Methanotrophs importance in reducing methane emission is widely studied. The broad substrate specificity of soluble form of methane monooxygenase (sMMO) is of special interest in methanotrophic bacteria. Methanotroph enrichment and isolation using nitrate mineral salt (NMS) standard medium. Isolation, cultivation of natural methanotrophs from paddy field or from natural habitats is a perspective to resolve global warming. Methanotroph's significantly reduce CH_4 emissions through oxidation, contribute to 10-15% global CH_4 eradication. The sample were collected from paddy field for isolation. The plant sample and soil sample were collected separately from experimental farm of dapoli, where soil is acidic in nature (sandy loam). One gram of soil for enumeration of colony were diluted 1:9 in distilled water (soil: water) contain in the test tubes. The supernatant was serially diluted upto 10^{-6} to 10^{-7} and then the 1 ml supernatant from test tube transfer into petri plates, before this the NMS media was pour in petri plates. The plates were placed in gas tight jar and 20% methane is flushed into it and also some plates are prepared by pouring media contain methanol 2% in which methane are not flushed. From some of plates, cells from different colonies were incubated on new plates or slants. In first purification step, colonies from the old plats and again incubated on an Petry plates. The paddy field were all described and tested for presence of methanotrophs. The soil had medium to high organic carbon possessed a potential for methane oxidation. The incubation in a methane atmosphere supported the formation of a significant number of visible colonies on the petri dish or slants, reaching the maximum number after 7 to 10 days.

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Bio-chemical Characterization of Organic and Natural Supplements used in Agriculture

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Excessive use of agrochemicals in agriculture for increasing productivity that may have adverse consequences on food quality and soil environment. Alternative to agrochemicals like natural supplements are essential as a plant nutrient for enhancing crop and soil productivity in sustainable manner. Therefore, a lab study was conducted to characterize chemical and microbiological properties of locally produced supplements based on cow dung, such as vermicompost, farmyard manure, *Beejamrit*, *Jeevamrit*, and *Ghanjeevarmrit*. The *Jeevamrit* and farmyard manure had the lowest pH and electrical conductivity, whereas *Ghanjeevamrit* and *Jeevamrit* observed highest values. Vermicompost had the highest concentrations of total nitrogen, phosphorus, potassium, iron, manganese, copper, and zinc. The total carbon content of was found highest (35.9%) under *Ghanjeevamrit* followed by farmyard manure (34.5%) and vermicompost (24.1%). The soil heterotrophic microbial counts and beneficial microbial diversity such as phosphorus solubilizers, and nitrogen fixers found highest in vermicompost. However, in *Jeevamrit* there was no growth was visible for actinomycetes and N-fixers whereas in *Beejamrit* preparation there was only no growth of actinomycetes. Organic supplements in solid form with *Ghanjeevamrit* showed the highest production of indole acetic acid whereas in farmyard manure showed the lowest. The liquid formulation such as *Beejamrit* and *Jeevamrit* indicated more levels of indole acetic acid than the farmyard manure. The application of organic supplements has great role in supplying available nutrients modulating microbial diversity and plant growth hormone production.

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Soil Biological Activities and Nutrient Availability under Pearl Millet as Influenced by IPNS on Vertisol

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The study on soil biological activities influenced by integrated plant nutrient supply under pearl millet grown on vertisol was conducted at Bajara Research Scheme, College of Agriculture, Dhule. The experiment was laid out in Randomized Block Design with eight treatments replicated three times. Treatments comprised of RDF, 100% RDN through FYM, vermicompost and poultry manure, 50% RDN through chemical fertilizer and 50% RDN through organic manures and one control. Soil biological properties were estimated at 45 days of sowing and at harvest of crop, while, soil chemical analysis was done at harvest only. The significantly maximum soil microbial biomass C (157.01 µg C g^{-1} soil), soil microbial biomass N (48.12 µg N g^{-1} soil), C and N mineralization (18.20 µg C g^{-1} soil d^{-1} and 1.06 µg N g^{-1} soil d^{-1}, respectively), dehydrogenase enzyme activity (81.36 µgTPF g^{-1} soil 24^{-1}), fungal (28.00×10^4 cfu g^{-1} soil), bacterial (57.00 10^7 cfu g^{-1} soil) and actinomycetes (48.00×10^6 cfu g^{-1} soil) populations were recorded at 45 days of sowing with the application of 50% RDN through fertilizer + 50% RDN through FYM followed by 100% RDN through FYM. At harvest of crop, significantly maximum available N, P and K were noted under 50% RDN through fertilizer + 50% RDN through FYM *i.e.* 201.79, 24.64 and 282.16 kg ha^{-1}, respectively. However, organic C was found higher with the application of 100% RDN through FYM (4.67 g kg^{-1}). The highest availability of micronutrients *viz.*, Fe, Zn, Mn and Cu (5.97, 0.76, 14.12 and 3.82 mg kg^{-1}, respectively) were recorded in 50% RDN through fertilizer + 50% N through vermicompost followed by 100% RDN through vermicompost. Maximum protein percentage in grains were recorded where FYM is applied while, Fe and Zn contents were higher under vermicompst treatments. The highest grain (26.51 q ha^{-1}) and stover yield (38.05 q ha^{-1}) was obtained with the application of 50% RDN through fertilizer + 50% RDN through FYM.

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Effect of Weedicides on Nitrification and N_2O Production in Vertisol of Central India

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Greenhouse gas (GHG) emission from agricultural fields, particularly nitrous oxide (N_2O), is an increasing concern for climate change. Global warming potential of N_2O estimated to be about 296 times that of CO_2. Present experiment was undertaken to evaluate N_2O production, and nitrification, under the influence of different concentration of weedicides. An experiment was conducted under controlled conditions with three weedicides (pendimethalin, imazethapyr and atrazine) amendedto soil at six concentration (0, 5, 10, 20, 50 & 100 ppm). Soil was amended with 10m M NH_4^+. Vials were incubated with three replications and maintained at 60% moisture holding capacity for evaluating nitrification and N_2O production. Both N_2O production (ng g^{-1} soil), 5.92±0.190 and nitrification rate (mM NO_3^- produced g^{-1} soil d^{-1}), 0.35±0.011 were low in control soil (0ppm weedicide) and highest in 100ppm imazethapyr amended soil, 11.62±0.422 (ng g^{-1} soil) N_2O and 0.65±0.021 (mM NO_3^- produced g^{-1} soil d^{-1}) respectively. Production of N_2O increased with the weedicides concentration. N_2O production ranged from 5.92 ng g^{-1} soil to 11.62 ng g^{-1} soil. The potential nitrification rates were in the range of 0.35 to 0.65 mMNO_3^- produced g^{-1} soil d^{-1} irrespective of weedicides. Copy number of amoA gene significantly ($P<0.05$) increased with wedicides application. Study highlights that weedicides stimulated both nitrification and N_2O production by enhancing CO_2 induced autotrophic metabolism of nitrifiers.

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Spectral Characterization and Elemental Composition of Humic Substances Extracted from different Organics using Various Extractants

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Utilization of organic residues holds considerable promise for innovation in nutrient recycling. In view of the considerable importance of nutrient cycling through efficient management of crop residues, the present experiment was conducted to prepare enriched compost by using crop residues and rock phosphate. The prepared composts were extracted for humic substances for spectral characterization and elemental composition. The fully decomposed compost were subjected to alkaline extraction for isolation of various humic substances (HS). These HS were subjected to FTIR for spectral characterization and analyzed for their total element and functional group. The results indicated that, compost prepared from various combinations of crop residues and different ingradients were yielded quite high recovery of HS. The significantly highest value of total nitrogen, phosphorus and sulphur content was observed in humic substances extracted from compost prepared by 25% wheat straw + 25% shredded cotton stalk + 25% gliricidia leaves + 25% sorghum stubbles followed by 30% wheat straw + 30% shredded cotton stalk + 20% gliricidia leaves. Among the functional group, the total acidity and phenolic OH was higher in humic acids and humin extracted from compost prepared by same combinations of crop residues and gliricidia leaves. The carboxylic OH was higher in humic acids extracted from compost prepared by 30% wheat straw + 30% shredded cotton stalk + 20% glyricidia leaves + 20% sorghum stubbles. The presence of peaks on the basis of FTIR, at around 3000 and 3500 cm^{-1} for fulvic acid, peaks at 1000 to 1500 cm^{-1} for humic acid and humin indicating strong absorption bands attributed to vibration of OH, aliphatic C-H, carbonyl (C=O) and carboxyl groups in COO^- form.

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Soil Types Influencing Endorhizospheric Bacterial Diversity of Corn

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Microbes associated with root of crop plant greatly influence crop performance. Corn (*Zea mays* L.) is cultivated worldwide under varied agro-climatic conditions. Being highly adaptive and versatile food and feed crop, corn is responsive to both organic and inorganic sources for the required nutrients, which makes it suitable plant for examination of endophytic flora and possible role of bacterial partner in growth promotion of the crop. As the soil vary in microbial composition, the role of soil in shaping microbial diversity of a crop rhizosphere is least studied. In present study, Corn (cv Proagro4212) was grown in three different soil *viz.* Vertisols, Inceptisols and Alfisols, and the bacteria were isolated form root tissues and rhizoplane to study their PGPR attributes and diversity using BOX PCR fingerprinting technique, as influenced by soil types. Form threes soil orders, total 30 isolates were obtained of which, 11 could grow on nitrogen free medium, 3 solubilized P from tricalcium phosphate, 1 isolate solubilized potassium from glauconite (IME-1) and 9 had zinc solubilizing ability. Four isolate were positive for siderophore production, 3 isolate had fungistatic effect against *Sclerotium*, two isolates including IME-3 inhibited growth of *Fusarium* in pteriplate which also showed fluoerescence in King's B medium under UV light (Fluorescent Pseudomonads). Based on the fingerprint analysis, differences occurred in the endophytic bacteria of same host grown in different soil types suggesting influence of soil types in colonization of microbes in rhizoplane and endorhizosphere. Common organisms obtained from host grown in different soil types indicating host genotype driven assembly of bacteria.

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Comparison of different Jute Retting Methods on Water Quality

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Jute retting is a biochemical process carried out by the enzymatic action of retting microbes present in the water for biodegradation of pectin and hemicelluloses and production of lingo-cellulosic jute fibre. This study deals with the comparative assessment of three improved retting methods (free flowing water retting, in-situ retting, stagnant water retting in concrete tank) with universally followed conventional retting method of jute focussing post-retting water quality. A microbial retting accelerator "CRIJAF SONA" was used in the three improved retting methods; whereas no retting accelerator was used in conventional retting method. Among the four retting methods, free flowing water retting proved to be the best one for quality jute fibre production, with very low water requirement and maintenance of water quality compared to the conventional retting of jute. Fee flowing water retting requires only 7135 litres of water for 1 quintal jute fibre production compared to 25,840 litres in conventional retting. Except pH, all other water quality parameters like EC, BOD (biological oxygen demand), COD (chemical oxygen demand), Ca + Mg, bicarbonate, chloride and hardness values in post-retting water increased significantly compared to the pre-retting water in all the retting methods. Among the retting methods, the free flowing water retting recorded significantly very low BOD (45.1 mg l^{-1}), COD (157.6 mg l^{-1}), and hardness (65 ppm) content in post-retting water compared to other retting methods indicating the fact that it maintain water quality besides requiring less amount of water for per quintal jute fibre production.

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Assessment of Solubilization Capacity from Two different Insoluble Inorganic Phosphatic Sources for the Isolated, Characterized Phosphate Solubilizing Bacteria (PSB): An Incubation Study

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Phosphate solubilizing bacteria (PSB) is well-known to promote crop growth and yield. But the isolation of PSB, characterization and evaluation of solubilization capacity from insoluble phosphatic sources are rarely conducted from subtropical soils. Thus in an incubation study total seven bacterial isolates including two check isolated from subtropical soils of Bihar, India were effectively evaluated to solubilize P from Tri-calcium phosphate {TCP, Ca_3 $(PO_4)_2$} and ferric phosphate ($FePO_4$). Furthermore, phytohormones like indole acetic acid (IAA) and gibberelic acid (GA) production capacity of those isolates were also tested. The identification of isolates has been carried out by morphology, biochemical characterization and 16S rDNA sequencing. The used isolates effectively solubilized considerable amount of $Ca_3(PO_4)_2$ ranging from 53.93 to 414.62 mg (soluble P) L^{-1} and ($FePO_4$) ranging from 5.93 to 28.33 mg (soluble P) L^{-1} under optimal conditions. *Pseudomonas putida* (D3) solubilized maximum tri calcium phosphate (414.62 mg L^{-1}) while *Pseudomonas sp.* (D2) was found to solubilize maximum (28.33 mg L^{-1}) ferric phosphate when compared with other strains. All seven isolates were also observed to produce IAA ranging from 15.57 to 32.00 mg L^{-1} and GA ranging from 13.16 to 20.66 mg L^{-1}. *Pseudomonas sp.* (D2) recorded highest value in terms of IAA production (32.00 mg L^{-1}) and *Pseudomonas putida* (D3) was found most potent (20.66 mg L^{-1}) bacterial isolate to produce GA significantly higher than other bacterial isolates. Given this particular incubation study, both *Pseudomonas sp.* (D2) and *Pseudomonas putida* (D3) were found most superior bacterial isolates considering different evaluated attributes.

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Effect of Nano NP and Nano P Fertilizers on Growth Parameters of Wheat (*Triticum aestivum* L.)

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Nano fertilizers were produced as a potential solution to reduce fertilizer loss and increase fertilizer use efficiency for crop production, hence decreasing the recommended dose of traditional fertilizers. Nano fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility and productivity of agricultural produces. It is observed that seed treatment by nanoparticles can promote the crop growth, increase the yield and improve the quality of many crop products, including cereal crops and cash crops. The study entitled was carried out in two parts, (i) laboratory study for synthesis and characterization of nano NP and nano P fertilizers and (ii) optimization of nano NP and nano P fertilizers dose for wheat under in vitro at Anand Agricultural University, Anand, Gujarat during the years 2021-22. In laboratory, the nano NP and nano P fertilizers were synthesized of different concentrations *viz.*, 0, 500, 1000, 2000, 3000 and 4000 ppm by using direct precipitation method. The nanoparticles were characterized by Dynamic Light Scattering (DLS) and Fourier-Transform Infrared Spectroscopy (FTIR) for their particle size, count rate, poly dispersity index, zeta potential and absorbance spectra. The nano NP and nano P having the particle size 0 to 709 nm, count rate (kcps) 0 to 287, poly dispersity index 0 to 0.46 and zeta potential 0 to -57.88 mV were found in standard range. The FTIR spectrum of synthesized nano NP (pH 8) shows absorption bands at wave number of 3431.27, 3335.11 and 1027.86 per cm and in nano P absorption bands at wave number of 1647.37, 1212.63, 1123.28 and 1054.07 per cm. The in vitro experiment conducted in laboratory was comprised of six levels of nano NP (0, 500, 1000, 2000, 3000 and 4000 ppm) and nano P (0, 500, 1000, 2000, 3000 and 4000 ppm) with 36 treatment combinations laid out in factorial completely randomized design (FCRD) with three repetitions. The seeds were presoaked for 2 hrs in different levels of nano NP and nano P and thereafter the seeds were dried under shade and sown in plastic cup that's filled with cocopit. The seed application of nano NP @ 2000 ppm and nano P @ 1000 ppm differentially proved to be significantly superior in reducing the days to 50% germination; enhancing germination (%) at 4th and 8th day, shoot length, root length and vigour index. While interaction effect of nano NP and nano P showed that the seed treatment of NP_3 + P_2 (nano NP @ 2000 ppm + nano P @ 1000 ppm) was found significantly lower days to 50% germination; higher germination percentage at 4th and 8th day and higher vigour index of wheat.

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Effect of Nano NP and Nano P Fertilizers on Growth, Yield and Nutrient Content of Wheat

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The nano-fertilizer mainly controls and/or delays the release of the nutrients and prolongs effectiveness of the applied fertilizers. Nano fertilizers are the important tools in agriculture to improve crop growth, yield and quality parameters with increase nutrient use efficiency, reduce wastage of fertilizers and cost of cultivation. Nanostructure fertilizer exhibits novel physico-chemical properties, which determines their interaction with biological substances and processes. The application of nano technological formulation to agricultural crop inputs is one of the proposed tools for sustainable intensifications. The study entitled was carried out in three parts, (i) laboratory study for synthesis and characterization of nano NP and nano P fertilizers, (ii) optimization of nano NP and nano P fertilizers dose for wheat under *in vitro* and (iii) in green house study with using pots of 13 kg capacity of soil at Anand Agricultural University, Anand, Gujarat during the years 2021-22. The greenhouse experiment was carried out based on the *in vitro* study. The results of *in vitro* experiment were optimized and best treatments were taken for the greenhouse experiment. The experiment was comprised of five levels of nano NP (0, 500, 1000, 2000 and 3000 ppm) and nano P (0, 500, 1000, 2000 and 3000 ppm) with 25 treatment combinations laid out in factorial completely randomized design (FCRD) with two repetitions in greenhouse. The soil was loamy sand in texture comes under *Typic Ustochrepts*, having slightly alkaline pH 8.0, organic carbon, available N, K_2O and Fe were low in status. While available P_2O_5, Zn and Mn were medium, whereas Cu content was high in soil. The foliar spray of nano NP and nano P was done at 21, 35 and 60 DAS. The plant height, potassium content of wheat plant and available nitrogen, phosphorus and potassium content in soil found non-significant with the foliar application of different levels of nano NP and nano P fertilization. Foliar application of Nano NP @ 2000 ppm had significant effect on chlorophyll content, leaf area index, number of tillers, dry matter yield (3.43 g pot^{-1}) and potassium uptake by wheat. While N, P content and uptake by wheat were showed marked increase in foliar application of nano NP @ 3000 ppm over the rest of other treatment. The significant result on chlorophyll content, leaf area index, number of tillers, dry matter yield (3.12 g pot^{-1}), nitrogen, phosphorus and potassium uptake by wheat of wheat were found with foliar application of Nano P @ 1000 ppm. While N and P content was better in nano P @ 3000 ppm over rest of the treatments. Interaction effect between foliar application of nano NP and nano P fertilizers were found to be significant. Treatment combination $NP_4 + P_2$ (nano NP @ 3000 ppm + nano P @ 1000 ppm) was found significantly higher in terms of chlorophyll content, leaf area index, dry matter yield (3.92 g/pot), N and P uptake by plant over the rest of treatments.

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Impact of Silicon on the Productivity of Rice-wheat Cropping System in Vertisol of Central India

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Silicon (Si) is a beneficial element for the growth and development of graminaceous crops. This study aims to assess the impact of Si on plant growth and yield of rice-wheat cropping system in *Vertisols* of Central India. A comprehensive field trial was conducted during *Kharif* rice (PB-1) and *Rabi* Wheat (HI-1544), 2022 with seven treatments including control (No P and Si), phosphorus (soil application @ 60 kg P_2O_5 ha^{-1}), silicon (seed priming/foliar application/both @ 1%, Na_2SiO_3) and their combination applications (P + Si) with three replications. The plots were arranged in a randomized block design. Plant growth parameters like chlorophyll content, carotenoid, plant height and shoot biomass at different growth stages were significantly higher in P+ Si priming while the control was the lowest. However, the effective no of tillers, root biomass and test weight were non significant among the treatments. In rice crop, the yield increased over the control in the trend as follows: T4, P+ Si priming (72%) >T6, P+ Si priming + Si foliar (46%) e" T5, P+ Si foliar (44%)> T1, P (39%)> T2, Si priming (30%)> T3, Si foliar (21%). While in wheat, the yield increased over the control: T4, P+ Si priming (75%) > T6, P+ Si priming + Si foliar (63%)> T5, P+ Si foliar (54%) > T1, P (52%)> T2, Si priming (5%) e" T3, Si foliar (5%). The study indicates that using Si as seed priming, along with P fertilizer, can have a significant positive impact on rice-wheat cropping system in the *Vertisols* of Central India.

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Mapping of Available Nutrients Status in Agadi Micro-Watershed of Karnataka by GIS Technique

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Soil fertility mapping at cadastral scale is inevitable for economically feasible and environmentally sustainable management of natural resources. Modern geostatistical tools enable soil scientists to precisely map soil properties even in the unsampled areas and prescribe suitable precision nutrient management practices. Agadi micro-watershed with an area of 1055 ha in Dharwad district, Hubli taluk, Karnataka was chosen which lied between 75°08' and 75°10' East longitudes and 15°10' and 15°12' North latitudes. Composite surface (0-20 cm) soil samples collected at 320 × 320 m grid interval (to represent one sample per 10 hectare) were analyzed for available N, P, K, S, B, Zn, Mn, Cu and Fe and pH, EC and OC. Using the grid data, spatial maps were generated by ordinary kriging employing a spherical model in GIS environment. The micro-watershed was low in available nitrogen and boron whereas medium to high in organic carbon; medium to high status in phosphorus, potassium and sulphur. Micronutrients like manganese, copper and iron were sufficient in the entire micro-watershed, whereas nearly half of the micro-watershed area was sufficient and remaining was deficient in available Zinc. Ninety-five per cent of area remained either slightly acidic or neutral in reaction and the entire micro-watershed was non saline. Sever nitrogen, boron and phosphorus deficiency symptoms were observed in the important crops like maize, cotton, rice and soybean

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Effect of Zinc Application on Yield, DTPA-Zn and Zinc use Efficiency of Maize Crop Grown in an Acid Alfisol

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Zinc (Zn) is the most deficient soil micronutrient in the world as well as in India which adversely affects the yield, DTPA-Zn and zinc use efficiency (ZnUE) of maize crop. In this view, an experiment was conducted during *kharif* 2020 with four sets of zinc treatments (T_1: RDF without Zn; T_2: Zn @ 2.5 kg ha^{-1}, T_3: Zn @ 5.0 kg ha^{-1} and T_4: Zn @ 10.0 kg ha^{-1} in acidic soil of Himachal Pradesh. Treatments where Zn was applied as basal (T_2 to T_4) increased grain and stover yield of maize over no application of Zn. Grain yield of maize in T_4 treatment (Zn @ 10 kg ha^{-1}) significantly increased over T_3, T_2 and T_1 by 4.26, 6.94 and 11.83 per cent, respectively. The effect of different Zn treatments was significant on the maize stover yield. The T_4 treatment (Zn @ 10 kg ha^{-1}) significantly increased stover yield over T_3, T_2 and T_1 by 7.37, 10.98 and 21.54 per cent, respectively. DTPA- Zn content of soil after the harvest of maize was significantly affected by different treatments. All the treatments showed higher value of zinc over the initial status where Zn was applied (direct application), except T_1 where no zinc was applied. The highest zinc use efficiency (ZnUE) was recorded in treatment comprising application of Zn @ 2.5 kg ha^{-1} (2.62%) followed by Zn applied @ 5 kg ha^{-1} (1.73%) and lowest with Zn application @ 10 kg ha^{-1} (1.18%). The present study thus concluded that Zn application significantly influences yield, DTPA-Zn and zinc use efficiency (ZnUE) of maize crop with the best result registered with treatment T_4 (Zn @ 10.0 kg ha^{-1}).

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Effect of different Residue Management Practices on Physical, Chemical and Biological Soil Quality Indicators under Three Wheat based Cropping Systems of Subtropical India

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Assessing soil quality (SQ) is crucial to understand the impact of different soil management practices. SQ indicators, representing physical, chemical, and biological components of soil, help to define management goals and critical soil functions. In Resource Conservation Technologies (RCTs), residue management has emerged as a vital component, providing substantial carbon input and enhancing soil health. To extensively study the effects of residue management on soil quality, a long-term field trial was initiated at the Indian Agricultural Research Institute (ICAR-IARI) in the year 2010. The trial involved different residue management practices in three wheat-based cropping systems: rice-wheat, maize-wheat, and pearl millet-wheat. The residue management techniques included crop residue incorporation, open burning, conversion of crop residue into biochar, and complete removal of crop residues. Various SQindicators were examined in this study. For physical stability and water retention, parameters such as bulk density (BD), aggregate stability (AS), infiltration rate (IR), and maximum water-holding capacity (MWC) were measured. Nutrient cycling was assessed by analysing available nitrogen (N), phosphorus (P), micronutrient (Fe, Mn, Zn & Cu), and potential mineralizable nitrogen (PMN). Soil biological indicators e.g. dehydrogenase activity (DHA), soil respiration, and microbial biomass carbon (MBC), were also considered. Soil organic carbon (SOC) was used as an indicator of soil resistance, resilience, filtering, and buffering capacities. The results demonstrated that plots with residue and biochar showed a significant ($P<0.05$) increase in almost all the SQ indicators (N, P, Fe, Mn, C, Zn, DHA and PMN, soil respiration) as compared to plots with complete residue removal and open burning. Physical stability was also significantly ($P=0.05$) higher in plots where residues and biochar were applied. Among all the treatments, biochar-treated plots exhibited the highest SOC levels, indicating improved soil quality. Conversely, open burning of residues did not show significant benefits in terms of enhancing the recorded parameters. In conclusion, residue and biochar application significantly improved various soil quality indicators. These findings emphasize the importance of adopting sustainable residue management practices to enhance soil health and overall agricultural productivity.

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Potassium Fixation and Release Characteristics in Profile Soils of different Land use Systems in Southern Transect of Bengaluru, Karnataka

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Potassium fixation of soils is an important phenomenon affecting the status of soil K and its availability to crops. It is the process in which soils converting exchangeable or water soluble potassium to fixed form in the inter lattice position of clay minerals. Potassium releasing power refers to the inherent capacity of the soil to supply K to growing plant from its natural source. The present study was undertaken to know the potassium fixation and release characteristics in the profile soil samples of southern transect of Bengaluru. The results prevailed that the mean values of potassium fixation were 0.23, 0.17, 0.25, 0.18, 0.31, 0.24, 0.27and 0.41 cmol (p^+) kg^{-1} in all the profiles (1 to 8), respectively. The highest average potassium fixation was in profile-8 (0.41 cmol (p^+) kg^{-1}) which was under plantation land use and lowest was found in profile-2 (0.17 cmol (p^+) kg^{-1}) which was under agriculture land use system. The cumulative K released was irregular down the profile. The pattern of distribution of cumulative K release followed almost the same trend as in non-exchangeable K, step K and constant rate K. Major portion of cumulative K from all most all the profiles was released by the fourth extraction with the reagent *viz.*, 1N HNO_3. The total step potassium release from surface soils of mulberry, agriculture, vegetable and plantation land use profiles ranged from 143 to 578, 99 to 175, 83 to 106 and 63 to 139 mg K kg^{-1}, respectively. Constant rate K varied within the narrow limit of 3 to 20 mg kg^{-1} in spite of wide variations in step K contents of the soils.

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Quality Parameters of Mustard (*Brassica juncea* L.) as Affected by Nano Nitrogen and Nano Zinc

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The aim of this present investigation is to study the effect of foliar application of nano nitrogen and nano zinc on quality parameters of mustard (*Brassica juncea* L.) crop. The field experiment was carried out during October to March 2022 season at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur which lies in agro-climatic zone IV-A of Rajasthan, India. The field was designed in a randomized block design having 10 treatments which were replicated thrice. The treatments include the various combination RDF and nano fertilizers of N and Zn. The application treatment T6 (100% NPK Zn + 1st spray of Nano Nitrogen and Zinc at 30 DAS + 2nd spray of Nano Nitrogen and Zinc at 45 DAS) has significantly increased oil content, oil yield, protein content and protein yield of mustard crop over control.

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Effect of Agri-horti Systems on Soil Health, Carbon Sequestration and Crop Production

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A study was conducted to assess the effect of agri-horticultural systems on soil health and crop production. Four different orchard *viz.*, mango, guava, lime and aonla have been selected where three intercrops *viz.*, wheat, gram and mustard during winter were sown. Bulk density of soil was influenced by different fruit orchard and it is gradually increasing throughout the depth (0-45 cm). Soil organic content was highest at upper layer (0-5 cm) of soil which was highest in guava orchard (0.96%) and lowest (0.30%) at lower depth (45-60 cm) in lime orchard. Similarly, phosphorus and potassium content were highest at upper layer of soil (30.46 kg ha^{-1}, 612 kg ha^{-1}) in guava orchard. All micronutrients decreased with increasing soil depth. Maximum soil carbon stock was deposited at 5-15 cm depth in all the orchards. Irrespective of the soil depth, the highest carbon stock was observed in aonla orchard (15.13 t ha^{-1}) followed by guava (14.02 t ha^{-1}). Similarly, carbon sequestration by various fruit crops was assessed and found that aonla orchard sequestered 36.46 t ha^{-1} followed by the lime orchard 35.54 t ha^{-1} carbon dioxide from the atmosphere. The yield of mango was highest (12.54 q ha^{-1}) in mango + wheat model whereas lowest (11.76 q ha^{-1}) was found in mango + mustard model. Mango equivalent yield was highest (42.87 q ha^{-1}) with mango + gram model. In guava orchard, the yield of guava was highest (75.00 q ha^{-1}) with gram model and lowest (66.04 q ha^{-1}) with mustard model. Guava equivalent yield was highest (93.73 q ha^{-1}) with guava + gram model and lowest with mustard model. In aonla orchard, the yield of aonla was highest (554 q ha^{-1}) with gram model and lowest (490 q ha^{-1}) with mustard model. Aonla equivalent yield was highest (593 q ha^{-1}) with aonla + gram model.

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Effect of Gypsum and Zinc on Wheat (*Triticum aestivum*) Yield under Sodic Water Irrigation

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An experiment was conducted under field conditions during *rabi* 2021-22 at farmer field in Mahendergarh district, to study the "Effect of gypsum and zinc on soil properties and wheat (*Triticum aestivum*) yield under sodic water irrigation." The experiment was laid out in a randomized block design with three replications and treatments comprised four levels of gypsum (G_0, G_{50}, G_{75} and G_{100}) and four levels of zinc (0, 5, 10 and 25 kg Zn ha^{-1}). The test weight, seed yield, straw yield and number of grains per spike of wheat crop significantly increased with the application of gypsum and zinc up to G_{100} and Zn_{25} treatment respectively. The seed (39.18 q ha^{-1}) and straw yield (58.93 q ha^{-1}) of wheat crop significantly increased due to the application of gypsum and zinc treatments. Interaction effect of gypsum and zinc was found significant in plant height, number of tillers, seed yield, straw yield and number of grains per spike. Economic analysis was done to found the economic feasibility of the treatments and the higher net monetary returns Rs. 91487 ha^{-1} with B:C ratio (2.39) under the treatment combination $G_{100}Zn_{25}$. It is concluded from the present study that the application of gypsum and zinc at G_{100} (100% neutralization of RSC of irrigation water) and Zn_{25} (25 kg ha^{-1} zinc) was found optimum in term of improvement of soil physical properties, available nutrients, plant parameter, crop yield, nutrient content and uptake, microbial activity and economics of a sodic water irrigated soil.

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Impact of Balanced Fertilizer Application on Soybean Productivity in Tribal Areas of Madhya Pradesh

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Soybean (*Glycime max* L) is a major leguminous crop in Madhya Pradesh which is the largest producer accounting for about 50% of the total production in our country. Moreover, soybean contributes by about 10% of the domestic oil production in India. Soybean is one of the predominant crops of Madhya Pradesh. In terms of grain quality, it has rich nutritive value. It is good source of proteins and a decent source of both carbohydrate and fat. It also plays a role to supply vitamins, minerals and is considered better than another oilseed. The present study indicates the results obtained from sixty-six field demonstrations conducted on soybean in the tribal villages of Barwani district (MP) under STC (TSP) project of ICAR during 2020-22. There were two interventions *i.e.* (i) Farmers' Practice (FP) (Variety: Local; Fertilizer @ 9:23:0 kg N: P_2O_5: K_2O ha^{-1}) and (ii) Improved practices (IP) (Improved variety cv RVG-202) with balanced recommended dose of fertilizers (RDF) @ 20:60:20 kg N: P2O5: K_2O ha^{-1} with package of practices and plant protection measures followed in soybean. Result from these 66 trials revealed that average soybean yield ranged from 1590 to 1860 kg ha^{-1} under Improved Practice (IP), on the contrary, it was lower 1110 to 1320 kg ha^{-1} under Farmers' Practice. Altogether, soybean yield with IP was much higher (1730 kg ha^{-1}) as compared to FP (1220 kg ha^{-1}). Thus, improved variety with balanced nutrient application recorded 41.6% higher soybean yield over farmersâ•™ practice. Therefore, balanced fertilizer application along with improved varieties proved as the best agronomic practice in order to enhance crop productivity of soybean in tribal areas of Barwani in Madhya Pradesh.

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Residual and Cumulative Effect of Phasing and Levels of Zinc Application on Zinc Fractions and Crop Productivity under Cotton Soybean Rotation

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The investigation was carried out to study the effect of different levels (0, 2.5, 5.0, 7.5 and 10.0 kg Zn ha^{-1}) of zinc application on seed yield, yield attributing characters, quality parameters, nutrient content, uptake and soil fertility and zinc pools in soil after harvest of cotton and soybean. The seed and stalk yield of cotton and grain and straw yield of soybean was significantly increased with the soil application of 7.5 kg Zn ha^{-1} in alternate year application through $ZnSO_4$. The quality parameters viz. boll weight, numbers of boll of cotton, oil content and oil yield of cotton, test weight, oil and protein content in soybean seed, nutrient content, uptake of nitrogen, phosphorus, potassium, sulphur and micronutrients (Zn, Fe, Cu, Mn, B) by cotton and soybean and availability of nutrients were recorded significantly higher with soil application of 7.5 kg Zn ha^{-1} through $ZnSO_4$ but statistically at par with the soil application of 10 kg Zn ha^{-1}. Water soluble plus easily exchangeable-Zn, carbonate bound-Zn, Fe-Mn oxide bound-Zn, organically bound-Zn, residual-Zn were recorded highest with soil application of 10 kg Zn ha^{-1} followed by 7.5 kg Zn ha^{-1} in every year. Thus, it can be concluded that soil application of zinc @ 7.5 kg Zn ha^{-1} along with recommended dose of fertilizers found beneficial for seed yield, yield attributes and quality of soybean along with improvement in soil fertility while zinc fractions were recorded highest with every year application of zinc @ 10 kg ha^{-1}.

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Effect of Emplacement of Arundo Donax Mats on Soil Organic Carbon Sequestration in a Maize-based Cropping System in the Indian Himalayan Region

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Despite of agrogeotextiles (AGT) has potential for soil conservation, limited information is available on effect of Arundo donax as AGT on C sequestration and soil aggregation in Indian Himalayan region (IHR). A study conducted in Selakui, Dehradun, utilizing Arundo donax mats within a maize-based system on a 4% slope to investigate its effects on carbon sequestration and soil aggregation. Soil sampling was done in December, 2021 after vegetable pea harvest and results indicated that in the 0-15 cm soil depth, Maize + Arundo donax mat (10 cm thick) on 0.5 m vertical interval - vegetable pea-wheat (M+A10D0.5-V-W) had ~23% higher total soil organic C (TSOC) in bulk soils than the control (M-W) plots. Plots with Arundo donax mats exhibited ~12% higher TSOC than plots without the mats. Plots under M+A10D0.5-V-W and maize-vegetable pea-wheat under bench terracing (M-V-W) B showed similar impacts on C sequestration. In 0-15 cm depth, M+A10D0.5-V-W plots had ~36% greater macro aggregate and ~35% higher mean weight diameter (MWD) than M-W plots. Mean annual soil loss value of 2017-2021 ranged from 0.78 t ha^{-1} yr^{-1} to 10.39 t ha^{-1} yr^{-1} which was correlated with carbon management index (CMI) value. The CMI was ~38% higher in M+A10D0.5-V-W plots than M-W due to emplacement of Arundo donax mats, resulting better soil aggregate stability. We observed that CMI, proportion of macro aggregates, aggregate-associated C, labile C, total SOC concentration (thus SOC accumulation rate) ($P < 0.01$) and mean annual C input ($P < 0.05$) were strongly correlated with mean annual soil loss from 2017 to 2021. Thus, soil aggregation and SOC accumulation are the major mechanisms of soil conservation. Thus Arundo donax application potentially improve soil stability and carbon storage in the IHR.

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Soil Test Crop Response based Fertilizer Prescription Equation for Foxtail Millet (*Setaria italica*) under Alfisols of Southern India

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Balanced crop nutrition will be rewarding to profitable sustainable yield and soil quality. In this regard, studies on development and validation of fertilizer prescription equation for foxtail millet under rainfed condition by encompassing the Soil Test Crop Response approach (STCR), were conducted at University of Agricultural Sciences, Bangalore. The experiments were conducted in three phases *viz.,* Fertility gradient experiment, Main experiment and Validation trial. Initial soil analytical data, yield and NPK uptake by foxtail millet in main experiment were used for obtaining four important basic parameters, *viz.,* nutrient requirement (NR), nutrients contribution from fertilizers (CF%), soil (CS%) and organic manure (%C-OM). From these basic parameters, the STCR fertilizer prescription equations through NPK alone and NPK + FYM were developed and these equations were evaluated through validation trial in comparison with soil test laboratory (STL) approach and general recommended dose (GRD). The results of main experiment revealed that an amount of 4.30, 3.13, and 3.61 kg of N, P_2O_5 and K_2O, respectively were required for producing one quintal of foxtail millet grain through NPK alone whereas 4.20, 2.87, and 4.19 kg of N, P_2O_5 and K_2O, respectively through NPK + FYM. The STCR approach, with or without FYM, at the target yields 13 and 10 q ha^{-1} enhanced the grain yield over general recommended dose and soil test laboratory approach. Further, STCR treatments also exhibited a higher NPK uptake and use efficiency. Similarly, the better profit was recorded (VCR: 4.05) in STCR-targeted yield of 13 q ha^{-1} through NPK alone. The per cent achievement at both the yield target levels (13 and 10 q ha^{-1}) was within ± 10 per cent variation, proving the validity of equations.

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Soil Test Values Prediction and Fertilizer Calibration Equations for Aerobic Rice (*Oryza sativa* L) under Integrated Plant Nutrition System in Alfisols of Southern India

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The Soil Test Crop Response (STCR) approach is unique as it provides the scientific basis for balanced fertilization not only among the fertilizers but also with soil available nutrients and manures. Field experiments *viz.*, fertility gradient experiment and main experiment were conducted to develop a targeted yield equation for aerobic rice with graded levels of NPK and poultry manure. The basic data required for developing the targeted yield equations *viz.*, the nutrient requirement (NR), the contribution of nutrients from soil (CS), fertilizer (CF) and organic manure (C-OM) were computed for NPK using the main experimental data. Using basic parameters, the fertilizer prescription equations were developed for the desired yield targets for a range of soil test values. The results revealed that an amount of 1.85, 1.14 and 2.70 kg of N, P_2O_5, and K_2O, respectively were required for producing one quintal of grain through NPK nutrients alone whereas an amount of 1.77, 1.09 and 2.88 kg of N, P_2O_5 and K_2O, respectively through integrated approach (NPK + FYM). The STCR approach, with or without FYM, at the target yields of 65 and 55 q ha^{-1} enhanced the grain yield over the general recommended dose and soil test laboratory approach. Post-Harvest Soil Test Values prediction equations (PHSTVs) were developed by using the plot-wise initial test values, fertiliser doses and grain yield or uptake of NPK by aerobic rice in the main experiment. Significant R^2 values were recorded for these regression equations which could be used with confidence to predict post-harvest N, P_2O_5 and K_2O.

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Assessment of Soil Properties in Natural Forest Converted Land use Systems of Biligirirangana Hills, Chamarajanagar, Karnataka

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Land management practices play a major role in enhancing soil fertility and carbon sequestration in the process of sustainable agriculture in the tropical ecosystem. In order to increase soil and crop production, the dynamics of soil properties (bulk density, % porosity, available major and minor nutrients) in soil must be understood at a greater depth. In this context, soil samples from six prominent land-use systems (LUSs), including natural forest, forest plantation, pure coffee system, coffee multi-storeyed system, agriculture mono and mixed cropping systems were collected and assessed for soil physico-chemical properties. The results revealed that the soil was sandy loam to sandy clay loam in texture. The mean bulk density of the soil ranged between 1.08 and 1.45 g cm^{-3}, and the mean total porosity between 45.80 to 66.31 per cent. In all the land use systems, the soil pH was slightly acidic, and electrical conductivity was normal. The percentage base saturation (76.56%) and the cation exchange capacity [28.22 cmol (p^+) kg^{-1} soil] were both significantly greater in the natural forest and lower in agriculture mono-cropping [13.83 cmol (p^+) kg^{-1} soil and 39.50%, respectively]. Natural forest soil recorded significantly highest mean value of organic carbon (37.09 g kg^{-1}) and the lowest mean value was observed in agriculture mono-cropping system (8.5 g kg^{-1}). The highest mean available N, P_2O_5 and K_2O was recorded on the pure coffee plantations (415.02, 97.64 and 665.60 kg ha^{-1}). The exchangeable calcium, magnesium, available sulphur and DTPA extractable micronutrients were recorded higher in natural forest and tree based LUSss compared to agriculture LUSss. The correlation analysis revealed that soil SOC had positive effect on availability of available major, secondary and DTPA extractable micronutrients in soils. The findings of this study helps in soil quality assessment, enabling farmers in implementing appropriate land use and nutrient management practices for sustainable soil-crop productivity.

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Prediction of Soil Physical and Nutrient Properties using Regression and Classification Algorithm from Vis-NIR Spectroscopy

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Nutrient management is one of the important factor that have a direct impact on crop growth, yield and quality. The nutrient recommendations are normally suggested to the farmers based on nutrient classes rather than obsolete values of properties. Soil test based fertilizer recommendations are based on chemical analysis, which is expensive and time-consuming. Vis-NIR spectroscopy has proven to be rapid, non-destructive and effective technique for many soil properties. The present study aims to predict nutrient classes using Vis-NIR spectroscopy and compared with prediction of obsolete values. A total of 127 soil samples were collected in Bagepalli Taluk, Karnataka and analysed for eight soil properties (Texture, pH, OC, available phosphorous (P_2O_5), available potassium (K_2O), extractable Mn, Fe and Zn). We used Partial least square regression (PLSR) for regression analysis and Support vector machine (SVM) coupled with Synthetic Minority Oversampling Technique (SMOTE) for classification analysis with balanced class distribution. The models were calibrated using 80% of total observations and validated using 20% of observations. PLSR model successfully predicted pH, clay and sand content (R2val = 0.9-0.78) and moderately predicted Fe, Mn, Zn and OC (R2val = 0.48-0.44) and poorly predicted silt content, P_2O_5 and K_2O (R2val< 0.4). SVM model classified successfully for pH, K_2O, Mn, Fe and Zn (overall accuracy (OAval) = 0.84-0.93, Kappa index (Kval) = 0.78-0.53) and poorly predicted for textural class, OC and P_2O_5. Finally, we compared the performance of classification by direct SVM classification with classification of predicted PLSR values. Our study concluded that direct classification of nutrient classes is better than PLSR prediction (pH, OAval = 0.77 & Kval = 0.69; K_2O, OAval = 0.77 & Kval = 0.54; Fe, OAval = 0.74 & Kval = 0.48; Mn, OAval = 0.87 & Kval = 0.27) for many physical and nutrient properties for assessing the soil fertility parameters and can be used for recommendation of fertilizers.

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Effect on Soil Productivity by Application and Utilization of Distillery Byproducts as Organic Manures in Dryland Regions of Northern Karnataka

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A field experiment was laid out to know the "effect on soil productivity by application and utilization of distillery byproducts as organic manures in dryland regions of northern Karnataka, the experiment was carried out at the Regional Agricultural Research Station (RARS), Vijayapura, during *rabi* seasons of 2019-20. The experiment comprising 11 treatments was laid out in recommended complete block design with three replications. The treatments were consisted of T_1: FYM @ 3 t ha^{-1}; T_2: Pressmud @ 3 t ha^{-1}; T_3: Spentwash @ 5 ml kg^{-1} of soil (1:10 dilution spentwash: water); T_4: 3 t ha^{-1} (Spentwash + FYM (1:3 mixing and curing for 25 days)); T_5 : 3 t ha^{-1} (Spentwash + Pressmud (1:3 mixing and curing for 25 days)); T_6 : T_1 + 100% RDF; T_7 : T_2 + 100% RDF; T_8 : T_3 + 100% RDF; T_9 : T_4 + 100% RDF; T_{10} : T_5 + 100% RDF and T_{11} : Absolute control. Significant build-up of soil fertility in terms of alkaline $KMnO_4$-N, Olsen-P, NH4OAc-K; soil organic carbon pools namely, total organic carbon, labile organic carbon and non-labile carbon; and soil organic carbon indies like carbon pool index, lability index and carbon management index; N fractions (Amino acid-N (mg kg^{-1}), Amino sugar-N (mg kg^{-1}), Ammonia-N (mg kg^{-1}), Hydrolysable-N (mg kg^{-1}), Total hydrolysable unknown-N (mg kg^{-1}), Acid insoluble-N (mg kg^{-1})) enzymatic activities (urease, dehydrogenase, acid phosphatase and alkaline phosphatase) and growth and yield of *rabi* sorghum were observed with spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers. Hence, the application of spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (50:25:15 kg N: P: $ZnSO_4$ per ha) and combined application of spentwash with FYM (both the combinations were cured and mixed at 1:3 ratio for 25 days) are the best options for dryland agricultural production for enhancing the soil as well as crop productivity.

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Effect of Basic Oxygen Furnace and Ladle Furnace Slags on Performance of Rice in Base Unsaturated Soil

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Soil acidity-related problems are well known and the elimination of its deleterious effects is commonly performed through liming. As landfill sites are limited for the slag disposal, huge volume of slag generation from steel industries drew researcher's attention to reuse it in an efficient way in agriculture due to its high nutrient composition. Hence, pot culture experiment was conducted to know the effect of Basic Oxygen Furnace (BOF) and Ladle Furnace (LF) slags in base unsaturated soil using rice as test crop. The experiment was set up in completely randomized block design with seven treatments and three replications, consisting of three levels (500, 1000 and 2000 kg ha^{-1}) of slags along with recommended dose of fertilizers (RDF) and one RDF alone as control. Grain and straw yield of rice increased linearly with both the sources of slag and had a positive linear relationship with BOF (R^2 = 0.417 and R^2 = 0.438, respectively) & LF slags (R^2 = 0.565 and R^2 = 0.460, respectively). Total uptake of nutrients by rice exhibited a strong positive linear relationship with grain yield. Increased soil pH, EC and available K_2O content in post - harvest soil was noticed with 2000 kg ha^{-1} of LF slag application while, the application of 2000 kg ha^{-1} of BOF slag out yielded for higher available P_2O_5 and acetic acid extractable-silicon over other treatments. As the slag level increased, DTPA extractable Fe^{2+} and Mn^{2+} in soil tend to decrease significantly. In conclusion, though application of 2000 kg ha^{-1} of BOF and LF slag enhanced the post-harvest nutrient availability status, higher yield & uptake of nutrients by rice was noticed at 1000 kg ha^{-1} and further increase in levels of either slag decreased the yield. Among the slags, LF slag performed better under base unsaturated soil compared to BOF slag and hence proved to be an optional substitute source for lime.

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Paddy Residue and Nutrient Management; Its Effect on Growth of Paddy and Soil Nutrient Balance

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Disposal of residue has turn out to be a huge problem in paddy growing areas, resulting farmers prefer to burn the residues in-situ. Burning biomass not only pollutes environment but also results in loss of appreciable amount of plant essential nutrients. The objective of the study is to reuse the residue in an efficient way without harming the environment. Hence, four season field experiment was conducted (kharif and rabi-summer seasons of 2019-20 and 2020-21) at Gabbur village of Raichur, a part North Eastern Dry Zone of Karnataka to study the effect of paddy residue along with different nutrient management approaches on growth & yield of paddy and soil nutrient balance. The study laid out in a spilt plot design which consisted of four residue managements [residue removal; residue incorporation (RI); RI + compost culture; residue burning] and five nutrient managements [absolute control; recommended dose of fertilizers (RDF); soil test laboratory (STL); soil test and crop response (STCR); site specific nutrient management (SSNM)] with three replications. Results of the study indicated that residue incorporation + compost culture (M_3), SSNM targeted yield of 80 q ha^{-1} (T_5) and their interaction (M_3T_5) was found to be more advantageous in enhancing growth, yield attributes and yield of paddy. Higher recovery efficiency (RE), agronomic efficiency (AE) of NPK was noticed under residue removal over other managements. Adoption of different management practices resulted in net loss of N in soil. Maximum net gain of P_2O_5 and K_2O are seen in SSNM with residue removal. Through residue incorporation showed maximum negativity over removal/burning, the magnitude of negativity was reduced with the addition of compost culture. In conclusion, the residue incorporation + compost culture along with SSNM targeted yield of 80 q ha^{-1} was found to be more effective and useful in increasing soil fertility yield of paddy.

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Modeling Soil Organic Carbon stocks under Permanent Manurial Experiment with Roth C Model under Maize-sunflower Cropping System

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Modeling plays important role in predicting long term manurial and fertilizers application influences the soil organic carbon status and crop yield to great extent. We assessed the effectiveness of the RothC model in simulating Soil Organic Carbon (SOC) dynamics after 112 years of organic and mineral fertilisation practises in *Alfisol* under maize-sunflower cropping sequence. The model performance was evaluated by Coefficients of RMSE and EF. Under the assumptions, the model was used to forecast SOC dynamics over a 25-year timeframe under similar pedoclimatic conditions with 18.5% clay contents are permitted to be predicted. The results of the RothC simulations demonstrated NPK+FYM increased SOC stocks at the 0-15 cm soil depth (RMSE = 1.36, EF = 0.66). The SOC stocks reached steady state for the treatments FYM (Every year) (RMSE = 0.99; EF = 0.49). Roth C clearly simulated SOC reductions in control plot (RMSE = 12.37; EF = 0.58) and inorganic fertilizers applied plot (RMSE = 1.17; EF = 0.64). The carbon sequestration potential of the treatment which received NPK+ FYM is 147 kg ha^{-1} yr^{-1} during 2032 and it showed an improvement over the future years. Similarly, FYM treatment plot showed a sequestration potential of 96 kg ha^{-1} yr^{-1} and it showed a static rate in the future trend. However, 100% NPK plot shows declining trend which was 59 kg ha^{-1} yr^{-1}. Therefore, the RothC model can successfully predict C dynamics in Permanent manurial experiment plot provided initialization and parametrization of the model is accurate.

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Role of INM in a 50-Years-Old Long-Term Fertiliser Experiment Using Finger Millet and Maize Cropping Sequence

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The long-term fertilizer experiments has been in progress since 1972 at Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore with finger millet-maize cropping sequence to monitor the changes in soil quality/health, crop productivity and sustainability under continuous application of plant nutrient inputs through fertilizers and organic sources. Results revealed that the balanced application of nutrients and also their conjoint application in an integrated manner through inorganic and organic sources sustained higher stable yields over the years and impacted positively the soil physical, chemical and biological properties. Increase in soil organic carbon content from 3.0 g kg^{-1} to 7.27 g kg^{-1} was observed in INM treatment. Nearly 50 years of LTFE results lead to a conclusion that the balanced and integrated application of nutrients sustains crop productivity, improves soil health with balanced organic carbon status and production potentiality of the soil for Finger Millet-Maize cropping sequence.

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Long Term Effect of Rubber (*Hevea brasiliensis*) Seedling nurseries on Soil Properties in North East India

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In order to prescribe suitable management practices for rubber and maintain optimum soil fertility, we have examined soil properties under rubber seedling nursery grown in two locations of North East India over a period of thirty years. Two representing Pedons of acidic soils viz. District Development Centre (DDC), Jenggichekgre, West Garo Hills, Meghalaya and District Development Centre (DDC), Darengiri, Goalpara, Assam of the North Eastern region were selected for morphological characterization, Physico-chemical properties and suggestions for sustainable management for *Hevea* seedlings in North Eastern region. The texture of pedons varies from sandy clay loam to clay loam. The structure ranges from fine to moderate, angular to sub-angular blocky loose to very hard consistency of dry surface horizons was observed. The density of the rooting zone was decreased with increasing contents of Ca and Mg. The ranges of soil pH varied from 4.58 to 5.15 of different horizons and showed very strongly acidic in nature. The Organic Carbon (OC) ranged from 0.52 to 1.12% (5.20 to 11.2 g kg^{-1}) in different horizons and decreasing trend was noticed with depth in both the nurseries (Pedons). Cation Exchange Capacity (CEC) ranged from 4.55 to 4.88 with mean value 4.73 cmol (p+) kg^{-1}. In general, the CEC decreased with increasing soil depth. The range of Bulk Density (BD) of different surface soil horizons was 1.31 to 1.73 Mg m^{-3}. The Bulk density was slightly increased in lower horizons compare with upper horizons in both the nurseries (Pedons). The available N, P, K, Ca, Mg and S (kg ha^{-1}) in upper horizons were 298 to 354, 30.8 to 86.9, 201.6 to 232.9, 130.2 to 290.6, 22.6 to 78.4 and 9.1 to 10.5 and lower horizons 281 to 308, 1.3 to 10.5, 241.5 to 275.5, 158.2 to 315.6, 30.6 to 98.3 and 14.1 to 14.2, respectively. Similarly, ranges of Zn, Fe, Cu, Mn, B and Mo (mg kg^{-1}) in upper horizons were 0.93 to 1.05, 140.8 to 162.2, 0.87 to 0.92, 25.36 to 32.33, 0.03 to 2.12 and 0.19 to 0.21 and in lower horizons from 0.78 to 0.85, 85.3 to 101.3, 0.63 to 0.69, 27.63 to 34.32, 0.58 to 0.62 and 0.14 to 0.16, respectively. Available N was in medium range, P, K were low to medium and Ca and Mg were very high in all the depths of horizons, respectively. Suggestions should be given to the Growers to maintenance of organic matter strictly followed the Rubber Board's recommendations of annual addition of 2.5 tones of organic manure as basal dose and mulching plant bases before the onset of Summer/Winter since organic carbon is declining with the depths in both the nurseries. Since, soil pH is also declining in both the nurseries; maintenance of soil pH can be achieved by adding liming materials. Similar, application of nutrients for crops for sustainable production system is recommendation as per soil test for both the nurseries.

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Characterization and Transformation of Lignin and Holocellulose of different Crop Residues during Residue Management

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Incubation and pot culture studies were conducted during *rabi*, 2021-2022 in College of Agriculture, Rajendranagar, Hyderabad to determine the Characterization and Transformation of Lignin and Holocellulose of different crop residues during residue management. The incubation and pot culture studies were conducted in Completely Randomized Design (CRD) with 9 and 13 treatments, respectively and replicated thrice. The proportion of cellulose, hemicellulose and lignin were determined according to the method of Goering and van Soest, 1970. Total phenol content in different crop residues was determined by the Folin-Ciocalteau method (Singleton et al. 1999). The results of the incubation experiment revealed that maximum loss of lignin content (%), cellulose content (%), hemicellulose content (%) and protein content (%) was recorded at the end of 120th day of incubation in crop residues *viz.*, redgram stalks, maize stover, rice straw, cotton stalks and sorghum stover. In other crop residues *viz.*, sunhemp residue, blackgram residue, greengram residue and soyabean residue, maximum loss of lignin content, cellulose content, hemicellulose content and proteins content were recorded at the end of 60th day of incubation. The results of the pot culture experiment showed that lignin, cellulose, hemicellulose and proteins degradation increased with the duration of decomposition. At the end of 120th day of decomposition, the lignin, cellulose, hemicellulose and proteins degradation were found to be higher in crop residue + microbial consortium followed by crop residue + single super phosphate and crop residue only. Among the treatments, Crop residue + Microbial Consortium recorded increased soil organic matter, available nutrients, ammonical, nitrate nitrogen and biological parameters. Addition of crop residues along with microbial consortium will increase the rate of decomposition and make the soil active to facilitate crop growth when compared to crop residues alone.

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Assessment of Soil Test based Fertilizer Recommendations for *Kharif* Black Gram under Red and Lateritic Soils of Purulia District in West Bengal

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Black gram (*Vigna mungo* L.) is one of the most popular pulse crop, grown throughout the Purulia district of West Bengal in the unbunded upland situation. The soils of Purulia district having lower fertility status. Total area and productivity of *Kharif* Blackgram in Purulia District is 1512 ha and the average yield is 5.6 q ha^{-1}. Among the various constraints for low productivity of Kharif Blackgram, less and imbalance use of fertilizers is one of the main reason related with lower productivity of Blackgram. Farmers of this district apply only the ash and they are not following neither blanket recommendations given by the State Agriculture Department nor as per the recommendations done by Soil testing of a particular plot. Therefore, a field experiment was conducted to increase the yield of black gram and to maintain the soil health as On Farm Trial (OFT) during Kharif season at village level through Krishi Vigyan Kendra, Kalyan, Purulia, West Bengal for the year 2019-20, 2020-21 and 2021-22 to assess the soil test based fertilizer recommendations for Kharif Blackgram under red and lateritic soils of Purulia District of West Bengal. The experiment was laid out in a Randomized Block Design (RBD) having three (03) treatments with ten (10) replications, the treatments were comprises of T1: Application of Ash @ 60 q ha^{-1}; T2: T1 + FYM/Compost @ 4 t ha^{-1} + Inorganic Fertilizers (N:P:K; blanket/general recommendations); T3: T1 + FYM/Compost @ 4 t ha^{-1} + Soil test based fertilizer recommendations (N:P:K). The growth and yield attributing characters *viz.* plant height, No. of branches per plant, no. of pods per plant, no. of seeds per pod, test weight and seed yield (cm) were recorded at 25, 55 and 65 DAS. T3 recorded highest plant height (46.9 cm) in 65 DAS, No. of pods per plant (27.56), No. of seeds per pod (6.04) and seed yield (8.41 q ha^{-1}). Hence it is clear from the present experiment that soil test based fertilizer recommendation is one of the best option to maximize the yield of black gram and improve the available nutrient status enhancing soil organic matter content and increase in soil microbial activities.

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Enhancing Potassium Availability from Waste Mica using Indigenous Potassium Solubilizing Bacteria

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With intensive agricultural practices, many reports of K deficiency in Indian soils has been brought into limelight. As entire K fertilizer requirement in India is met through imports, the need to develop strategies to explore the K reserves in low grade K bearing indigenous mineral like mica is gaining importance. In this regard, an initiative was taken to consider mica mining areas as a potential site for isolation of K solubilizing bacteria which can facilitate K release from these minerals. The effect of isolated potential K solubilizer on K release from mica waste in presence of crop residues was studied under an incubation experiment wherein different fractions of potassium was analyzed. Results reveal a new strain of potential K solubilizer (*Acinetobacter* sp.) isolated from mica mines with K solubilizing ability slightly less than standard K solubilizer. Upon its inoculation with soil along with mica (@ 50 mg kg^{-1} soil) and rice residue (@ 2 g kg^{-1} soil) there has been significant increase in water soluble K and exchangeable K fractions (almost 2 times) over control (no KSB) after a period of 120 days of incubation. Pot experiment revealed that combination of mica along with KSB and rice residue could increase wheat biomass yield by 40% and K uptake by 56.2% over control but could not exceed the impact of MOP. The study brings out the importance of a new strain of K solubilizer on improving K availability from mica waste and thus open avenues for better utilization of this mineral waste into wealth.

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Effect of a New Strain of Potassium Solubilizer Isolated from Mica Mines of Jharkhand on Release of Potassium from Waste Mica

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Presently, the entire demand of potassic fertilizers in India is met through imports of costly K-fertilizers like muriate of potash (MOP). Use of low-grade K-bearing mineral could be an alternative for supplementing K in soils. However, it is not popular as a K fertilizer source due to its poor solubility. In this regard, new strains of indigenous K solubilizing bacteria (KSB) should be explored which could be used with some organic supplementation like crop residue incorporation. The present study was conducted to isolate KSB from soils of mica mining area and explore its potential in improving K availability from waste mica. The KSB (JHKSB4) isolated from mica mines of Koderma, Jharkhand was identified as *Acinetobacter* sp. and was used in improving solubility of waste mica along with incorporation of rice residue. Both incubation and a pot culture study was conducted. Laboratory incubation study revealed that addition of indigenous KSB (JHKSB4) and rice residue significantly increased the water soluble K and exchangeable K contents in soil by 100% and 91%, respectively as compared to mica alone over 120 days of incubation. Pot experiment revealed that combination of mica along with KSB and rice residue could increase wheat biomass yield and K uptake over control than mica alone but could not exceed the impact of MOP. Residual impact of JHKSB4 and rice residue incorporation on K recovery from mica was also observed in rice grown after wheat. Scanning electron microscopy and X-ray diffraction revealed changes in the surface of mica crystal which might be attributed to action of KSB and rice residue incorporation. This controlled experiment established the potential of treated waste mica as an alternative K source and established the role of *Acinetobacter* sp as KSB.

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Understanding Spatio-temporal Variability of Secondary and Micronutrients in Soils of a Hilly Region of Northern India

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Understanding the spatio-temporal variabilities of plant available nutrients in soils is important for precision nutrient management practices in order to maximize crop production and nutrient use efficiency. The present study was carried out to assess and compare the status and spatial distribution pattern of available sulphur (AS), available micronutrients, and some selected soil properties (soil pH, electrical conductivity (EC), and soil organic carbon (SOC) in cultivated soils of a hilly region of India, over a period of time. We collected altogether 2, 871 (1, 127 in 2015 and 1, 774 in 2021) georeferenced representative topsoil samples from cultivated areas of Uttarakhand state of India and analyzed. Soil properties, AS and available micronutrients exhibited moderate variability with coefficient of variation (CV) values ranging from 10 to 100%. The mean concentrations of AS (13.2 mg kg^{-1}), available iron (AFe) (36.5 mg kg^{-1}), available boron (AB) (0.92 mg kg^{-1}) and available molybdenum (A Mo) (0.40 mg kg^{-1}) in 2021 were significantly lower than the concentrations of AS (44.7 mg kg^{-1}), AFe (42.8 mg kg^{-1}), AB (1.46 mg kg^{-1}), and A Mo (0.94 mg kg^{-1}) in 2015. The significant positive correlation was observed in AS concentration with soil pH and significant negatively correlated with SOC in both the years. The exponential model was found to be best fitted for all estimated soil parameters with lower MSE values in both the years of estimation. The nugget/sill ratios indicated the moderate spatial dependence for all the soil parameters except AFe (nugget/sill ratio 0.14, strong spatial dependence) in 2015 and EC (nugget/sill ratio 0.24, strong spatial dependence) in 2021. The distribution patterns of AS, AB and A Mo changed to a greater extent over the period of time. This emphasized the need for adoption of revised site-specific AS and available micronutrients management strategies for higher crop production.

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Status of Plant Available Sulphur and Micronutrients in Soils of India

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Nutrient deficiencies in soil and crop system and inappropriate managements are the important factors for low crop productivity, nutritional quality and human malnutrition worldwide. The present investigation was carried out to evaluate nutrient deficiencies of sulphur (S) and micronutrients [zinc (Zn), boron (B), iron (Fe), copper (Cu) and manganese (Mn)] in agricultural soils of India for devising effective management strategies to achieve sustainable crop production, improved nutritional quality in crops and better human health. A total of 2,42,827 surface (0-15 cm depth) soil samples were collected from agriculture fields of 615 districts in 28 states of India and were analyzed for available S and micronutrients concentration. The study was carried out under the aegis of All India Coordinated Research Project on Micro- and Secondary-Nutrients and Pollutant Elements in Soils and Plants. The mean concentrations of available S, Zn, B, Fe, Cu and Mn were 27.0 ± 29.9, 1.40 ± 1.60, 1.40 ± 4.70, 31.0 ± 52.2, 2.30 ± 3.50 and 17.5 ± 21.4 mg kg^{-1}, respectively. The deficiencies (acute deficient + deficient) of S (40.8% of soils), Zn (36.5% of soils) and B (23.2% of soils) were higher compared to the deficiencies of Fe (12.8% of soils), Cu (4.20% of soils) and Mn (7.10% of soils). Out of 615 districts, > 50% of soil samples in 101, 131 and 86 districts were deficient in available S, Zn and B, respectively. Whereas> 25% of soils in 83, 5 and 41 districts had deficiencies of available Fe, Cu and Mn, respectively. There were occurrences of multi-nutrient deficiencies such S+ Zn (9.30% of soils), Zn + B (8.70% of soils), S+B (7.00% of soils) and Zn + Fe (5.80% of soils). The information could be used by various stakeholders for production, supply and application of right kind of fertilizers in different districts, states and agro-ecological regions of India for better crop production, crop nutritional quality, nutrient use efficiency, soil health and for tackling human and animal malnutrition.

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Effect of Different Sources, Levels and Methods of Zinc Application with Bio Inoculant on Growth and Yield of Maize in Alfisol

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A study was conducted to know the effect of different sources, levels and methods of zinc application with bio inoculant on growth and yield of maize in Alfisol during rabi season of 2021-22 at College of Agriculture, Hassan, UAS, GKVK, Bangalore, Karnataka. The field experiment was laid out in Randomized Block Design comprising nine treatments replicated thrice which includes, NPK + foliar application of Nano Zn (2 ml L^{-1} and 4 ml L^{-1}) and NPK + $ZnSO_4$ (0.25 and 0.5% at 45 DAS and silking stage), NPK + seed treatment of Zn solubilizer alone as well as various combinations of soil application of $ZnSO_4$ @ 5 and 10 kg ha^{-1}, NPK + $ZnSO_4$ @ 10 kg ha^{-1} and only NPK. Results revealed that significantly higher growth and yield parameter, kernel and stover yield were recorded in NPK + foliar spray of Nano Zn @ 4 ml L^{-1} compare to RDF. Similarly zinc content in kernel, total zinc uptake and crude protein in kernel record were significantly higher in NPK + foliar spray of Nano Zn @ 4 ml L^{-1}. Among different zinc fractions in soil, water soluble + exchangeable, organically complexed, manganese oxide bound, amorphous and crystalline sesquioxide bound zinc fractions and dehydrogenase activity were significantly higher in NPK + soil application of $ZnSO_4$ @ 10 kg ha^{-1} + Zn solubilizer at harvest. Higher gross and net returns cost of cultivation and B: C ratio were recorded in the treatment with application of NPK + foliar spray of Nano Zn @ 4 ml L^{-1}.

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Long-term Effect of Potassium Fertilization on Nitrogen Uptake and Yield of Sorghum (fodder) and Wheat Growing on Inceptisols

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To assess the long-term effect of potassium fertilization on nitrogen uptake and yield of sorghum (fodder) and wheat, a long-term fertilizer experiment was started in 1985 at Potash Research Institute of India, Gurgaon (Haryana)**.** Soil of experiment, in 1885, was loamy sand in texture, medium in 1*N* NH_4OAc-K and 1N boiling HNO_3-K status. There were seven treatments: $N_0P_0K_0$, $N_{120}P_{60}K_0$, $N_{120}P_{60}K_{60}$, $N_{120}P_{60}K_{120}$, $N_{240}P_{120}K_0$, $N_{240}P_{120}K_{120}$, $N_{120}P_{60}K_{60+\ 10tonnesFYM.}$ Sorghum (fodder) and wheat were cultivated with these treatments. Per hectare doses of N, P and K (P_2O_5 and K_2O), showed in subscript, were applied in sorghum and wheat. An equal dose of 25 kg zinc sulphate per hectare was also applied. Sources of N, P and K were urea, Diammonium phosphate, Murate of potash, respectively. The Experiment is continued till date. Results showed that after 34 sorghum and wheat cycles, (after year 2019), at recommended doses of nitrogen and phosphorus, application of 60 kg K_2O ha^{-1} and 120 kg K_2O ha^{-1} in wheat increased Nitrogen uptake by 14% and 35% respectively when compared to wheat grown without potassium application. Grain yield of wheat increased by 10% and 30% respectively. Nitrogen uptake by sorghum (fodder) increased by 9% and 19%, respectively. Fodder sorghum yield increased by 35% and 41% respectively. This increase in nitrogen uptake and yield was attributed by low Level of 1N NH_4OAc-K and 1N boiling HNO_3-K status of soils of plots which did not receive K application during the 34 crop cycles. At higher doses of Nitrogen and phosphorus, uptake of nitrogen by wheat increased by 38% and by sorghum fodder increased by 68% with application of 120 Kg K_2O ha^{-1}. This study showed that long term application of potassium in sorghum and wheat reduced losses of applied nitrogen and increased yield. It also reduced environment pollution caused by NH_3, N_2O emission and NO_3 leaching.

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Influence of different Levels of Seaweed Extract and Humic Acid Granules on Soil Properties, Nutrient Uptake and Productivity of Bengal gram (*Cicer arietinum* L.) in Alfisols

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A field experiment was conducted at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru during *Rabi,* 2021. Two species (*Ascophyllum* sp. and *Sargassum* sp.) of seaweed extract (SWE) and humic acid granules were applied to soil at three levels (20, 30 and 40 kg ha^{-1}) and two times (basal and 30 days after sowing) to assess the effect of seaweed extract and humic acid granules on growth and productivity of Bengal gram. The experiment was laid out in a Randomized Complete Block Design with twelve treatments replicated thrice. With increase in the rate of seaweed extract and humic acid granules, increased the yield and yield attributes *viz.*, pod weight per plant (g), seed weight per plant (g), 100 seed weight (g) and grain yield per hectare (q). Among different treatments, higher yield was recorded with soil application of 100% NPK (25: 50: 50 kg ha^{-1}) + SWE Granules (*Sargassum* sp.) @ 40 kg ha^{-1} followed on par with soil application of 100% NPK + humic acid granules @ 40 kg ha^{-1} and both were significant over control (100% NPK + FYM @ 7.5 t ha^{-1}) and soil application of 100% NPK + SWE Granules (*Ascophyllum* sp.) @ 40 kg ha^{-1}. Similarly, soil application of 100% NPK + SWE Granules (*Sargassum* sp.) @ 40 kg ha^{-1} recorded significantly higher nutrient uptake *i.e.,* macro and micro nutrients compared to control. Soil physical properties (bulk density and maximum water holding capacity) and chemical properties (pH, electrical conductivity and organic carbon) did not vary significantly with imposition of different treatments. Higher available NPK content, microbial biomass carbon and dehydrogenase activity in soil were recorded with application of 100% of NPK along with SWE Granules (*Sargassum* sp.) @ 40 kg ha^{-1} at 60 days after sowing and at harvest over all other treatments. Hence, treatment involving 100% of NPK along with SWE Granules (*Sargassum* sp.) @ 40 kg ha^{-1} was found to be superior in improving Bengal gram productivity over all other treatments.

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Effect of Continuous Application of Fertilizers and Manure on Productivity of Soybean-wheat Cropping Sequence in a Vertisol

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The present study has been conducted under the ongoing all India Coordinated Research Project on Long-Term Fertilizer Experiment (AICRP-LTFE) with soybean-wheat sequence since 1972, to assess the impact of continuous application of fertilizer on productivity of the crops grown in the Vertisol of Jabalpur agro-climatic condition. The experiment comprised optimal doses of N, NP, NPK, NPK without S and NPK with FYM. The data on grain yield of the crops revealed an increasing trend with the application increasing dose of fertilizer while continuous cropping without supplementing fertilizers invariably reduced both the crop yields. The results also indicated that long term application of N alone resulted a declining trend in yields with time assured as imbalanced nutrition. Further, the supplementation of P with N (100% NP) remarkably enhanced the yield while, application of K along with NP *i.e.* 100% NPK further increased the yield. Contrarily, the deficiency of S in DAP application manifested yield reduction, against the observation from SSP application. These findings indicated that integrated use of optimal doses of fertilizer and organic manure was superior. Thus, the balanced nutrition with and organic manure is ascertained for sustaining productivity of crops.

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Effect of Continuous Application of Fertilizer and Manure on Nutrients Uptake in Soybean-wheat Cropping Sequence

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The present study was conducted under the ongoing experiment under All India Coordinated Research Project on Long-Term Fertilizer Experiment (AICRP on LTFE) in soybean-wheat cropping sequence in a Vertisol. The experiment was composed with ten treatments in a RBD with four replication the result indicated that the increasing trend with uptake of N, P, K, S and Zn by soybean was observed with successive application of fertilizer over control and the maximum uptake of nutrients was recorded when 100% NPK with FYM applied. Hence, increasing rates of fertilizer addition resulted in successive increment in the uptake of nutrients. A similar, trend has also been observed with rabi wheat crop and the data indicated that highest uptake of N, P, K, S and Zn by wheat was observed in 100% NPK+FYM treatment followed by 150% NPK. Increasing rate of fertilizer application successively increased the uptake of nutrients by the crops. In general, higher uptake of nutrients N, P, K, S and Zn was recorded in grain rather than the straw at the harvest of the crop. It was also noticed that higher amount of nutrients was harvested by wheat crop in comparison to the nutrient content obtained in soybean.

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Influence of Some Traditional and Non-traditional Manures on Nitrogen Mineralization

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Nitrogen Mineralization rate (NMR) studies provide a means of determining plant available N resulting from traditional and nontraditional organic manures applications. Laboratory evaluation of nutrient release composts is important to estimate nutrients, and ultimately, to determine optimum application rates, timing and placements of composts. Accurate prediction of N mineralization under laboratory conditions would promote optimal N use. N use efficiency from both organic and inorganic sources. This study was conducted to assess the utility of N mineralization. Laboratory incubation and analysis were conducted to evaluate the mineralization rate and transformation of N in different traditional and nontraditional organic manures. Incubated soil sample was analyzed for KCL extractable NH_4-N and NO_3-N. Total N of the incubated samples was determined in the end of each incubation study. Organic N mineralization rates during the 30 days incubation were 7.4%, 7.4%, 7.5%, 14.2%, 7.2%, 3.6%, 10.1%, 11.7%, 48.2%, 39.2% and 42.1% of the total organic N in soil, Vermicompost, Poultry litter, Oil cake, Cow dung, Neem cake, Cabbage, waste, Tomato waste, Di ammonium sulphate, Urea and Ammonium sulphate, respectively as determine by the organic N decrease method. Mineralization was described better by consecutive (sigmoidal) reaction model. Potentially mineralizable organic N (N_0) to total N (N_0/TN) was greater in poultry litter and oil cake, and it is least for neem cake among other organic manures used in this study. It is nearly three times when soil is incubated with poultry litter. The mineral N(NH_4-N+NO_3-N) recovered from both the compost and underlying soil by KCL extraction accounted for at best 0.16, 0.18, 0.20, 0.38, 0.21, 0.08, 0.27, 0.19, 2.14, 1.54 and 2.44 of the total mineralized N determined from the organic N difference before and after incubation for the Soil, Vermicompost, Poultry litter, Oil cake, Cow dung, Neemcake, Cabbage waste, Tomato waste, Diammonium phosphate, Urea and Ammonium sulphate respectively. NO_3- N was dominant mineral throughout the whole incubation period for the tomato waste composts. In situ mineralization of N may contribute significantly to total inorganic N pool of the soil samples. Utilization of the organic wastes and/or byproducts acts as amendments to agricultural soils can be beneficial to crop production while simultaneously providing an efficient and cost effective method of disposal for these products. Application rates, timing and placement of composts. Which contain high N concentration, should be adjusted for high N release to minimize the risk of NO_3-N leaching into ground water. This finding may advance our ability to modal and account for residual N mineralization when developing N management recommendations.

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Yield and Nutrient Uptake by Brinjal as Influenced by Zinc and Boron Fortified Briquettes in Lateritic Soils of Konkan

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The field experiment was conducted during rabi, 2021-22 at Agronomy Farm, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. The soil of the experimental site was lateritic which was sandy loam in texture, moderately acidic in reaction (pH 6.47), low in salt content (0.13 dS m^{-1}), extremely rich in organic carbon (17.74 g kg^{-1}), low in available nitrogen (199.13 kg ha^{-1}) and phosphorus (11.47 kg ha^{-1}), and was moderate in available potassium (211 kg ha^{-1}). The experiment was laid out in Randomized Block Design with nine treatments and three replications. The treatments comprised of T_1: Absolute control, T_2: RDF (150:50:50 N:P_2O_5:K_2O kg ha^{-1}) through straight fertilizers, T_3: 100% N through Konkan Annapurna Briquette (KAB), T_4: 80% N through Konkan Annapurna Briquette (KAB), T_5: 60% N through Konkan Annapurna Briquette (KAB), T_6: RDF + 2 kg boron + 3 kg zinc ha^{-1}, T_7: 100% N through KAB fortified with 2 kg boron + 3 kg zinc ha^{-1}, T_8: 80% N through KAB fortified with 2 kg boron + 3 kg zinc ha^{-1} and T_9: 60% N through KAB fortified with 2 kg boron + 3 kg zinc ha^{-1}. The results indicated that the application 100% N through KAB fortified with 2 kg boron + 3 kg zinc ha^{-1} was recorded significantly higher brinjal fruit yield which was found at par with T_3, T_6 and T_8 treatments. The significantly highest nitrogen, phosphorous, zinc and boron uptake were also recorded in the treatment receiving 100% N through KAB fortified with 2 kg boron + 3 kg zinc ha^{-1}.

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Effect of Sulphur, Zinc and Boron on Yield and Quality of Watermelon in Vertisol

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A field experiment was conducted at Kamaknur village of Kalagi taluka in Kalaburagi district of North Eastern Dry Zone (Zone-2) of Karnataka during 2021-22 to study the effect of sulphur, zinc and boron on yield and quality of watermelon in *Vertisol*. The experiment consists of ten treatments, which were laid out, in a randomized complete block design (RCBD) with three replications. Application of sulphur @ 30 kg ha^{-1} + 1% Zinc sulphate + 0.2% solubor foliar spray at flower initiation stage along with recommended dose of fertilizer (RDF) (T10) significantly recorded highest length of fruits, girth of fruits and lower number of percentage of fruit cracking, with respect to yield and quality, highest number of fruit per vine, weight of fruit per vine, average weight of fruits per vine, fruit yield per hectare, total soluble solids (TSS), reducing sugar, non reducing sugar, total sugar, ascorbic acid and anthocyanin content of fruit was observed in T_{10} treatment over control (T_1). The increase in fruit yield over control was 58.02% in watermelon. Higher uptake of nitrogen, phosphorus, potassium, sulphur and micronutrients (zinc and boron) by watermelon leaves were observed due to increased availability of these nutrients in soil with addition of sulphur, zinc, boron along with recommended dose of fertilizer (RDF). The available nitrogen, phosphorus, potassium, sulphur and micronutrients (zinc and boron) content of soil was also significantly highest in T_{10} treatment. Addition of Sulphur @ 20 kg ha^{-1} + 0.5% Zinc sulphate + 0.1% solubor foliar spray at flower initiation stage along with recommended dose of fertilizer (T_9) found to be beneficial and gave higher monetary return (Rs. 6,12,455 ha^{-1}) and B:C ratio (5.19) from watermelon crop production over control (T_1) and RDF (T_2).

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Behavior of Mica Waste under Submerged Conditions

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Potassium is added to soil as muriate of potash (MOP) and Sulphate of Potash (SOP). There is no reserve of potassium bearing minerals in India for production of commercial potassic fertilizers and whole consumption of potassic fertilizers are imported in the form of muriate of potash (MOP) and Sulphate of Potash (SOP) which attracts huge amount of foreign exchange. This necessitates to find an alternative indigenous source of K for plant needs and to sustain crop production. With this objective the investigation entitled "Behavior of mica waste under submerged conditions" was carried out at Research farm, Agricultural Research Station, Utukur, Kadapa in Alfisols of the Southern Agro-Climatic zone of Andhra Pradesh. The experiment was carried out with eight treatments *viz.*, T_1. Recommended Dose of fertilizers (RDF); T_2. RDN and RDP + Mica waste 0.5 t ha^{-1}; T_3. RDN and RDP + Mica waste 0.75 t ha^{-1}, T_4. RDN and RDP + Mica waste 1.0 t ha^{-1}; T_5: RDN and RDP + Mica waste 0.5 t ha^{-1} + KRB @ 5kg ha^{-1}; T_6: RDN and RDP + Mica waste 0.75 t ha^{-1} + KRB @ 5kg ha^{-1}; T_7: RDN and RDP + Mica waste 1.0 t ha^{-1} + KRB @ 5kg ha^{-1}; T_8. Absolute control in randomized block design with three replications using rice. Results revealed that Mica waste contains 10.50 per cent of potassium which was maintained the required concentration of 10 ppm throughout the crop growth period. The Microbes playing significant positive role in releasing of potassium from mica waste under submerged conditions and maintaining the optimum level of potassium in soil. Further, application of mica waste recorded Benefit cost ratio of 1.8. Thus bio-intervention of mica waste could be an alternative and viable technology to release potassium into plant available pool and sustain crop production in rice.

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Enhancement of Maize Yields with STCR Targeted Yield in Mancherial district of Telangana State

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Maize (*Zea mays* L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. The Soil Test Crop Response (STCR) is cost effective and allow us to provide plant need based nutrient which results in higher yield. It also aims to apply nutrients at optimal rates and time to achieve target yield and higher efficiency of nutrient use by the crop, leading to more net returns per unit of fertilizer invested. Krishi Vigyan Kendra (KVK), Mancherial conducted on farm trail (OFT) in three years during *Rabi* 2019-20, 2020-21 and 2021-22 in different locations of district based on Soil test values with targeted yields. The fertilizer prescription equations developed by the AICRP Centre of the project on STCR for different crops of different agro-ecological situations in different states. The treatments include farmers practice, recommended dose of fertilizers (RDF) and STCR based fertilizer recommendations with an yield target of 60 q ha^{-1}. The soils are low in available N, high in P and medium in K. The results showed that, the three years average yields of maize are 5730 kg ha^{-1}, 5287 kg ha^{-1} and 5429 kg ha^{-1} for STCR, RDF and Farmers practices respectively and application of fertilizers based on soil test based values with targeted yield increases the yield up to 5.5% compare to farmers' practice. Adaption of STCR based treatments reduced the use of fertilizer doses which saves the cost of inputs. The highest net returns (Rs. 51,769 ha^{-1}) and B:C (2.02) ratio also recorded with by adopting STCR based fertilizer application in maize compare to RDF and Farmers practice treatments during all the years.

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Soil Properties and Nutrient Uptake as Infuenced by Sulphur Application in Banana

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Field experiment was conducted at Banana Research Station, Jalgaon during 2019-20 to 2021-22 to study the effect of sulphur on soil chemical properties and nutrient uptake of banana. The experiment was laid out in Randomized Block Design (RBD) comprised with five treatment and four replications. The treatment were T_1: GRDF (150:60:150 g N:P_2O_5:K_2O + 10 kg FYM per plant without application of Sulphur, T_2, T_3, T_4, T_5 are GRDF + Sulphur @10,15,20 and 25 g plant^{-1} respectively in two equal splits at the time of planting and 165 DAP. Lower values of pH and EC was reported in all sulphur application treatments along with GRDF as compare to the treatment without sulphur. The available soil N, P and K content at harvest of banana was lower as compared to the control in all the treatments where sulphur was applied. Significantly higher available sulphur content (8.15 mg kg^{-1}) of soil was observed with treatment of sulphur @ 25 g plant^{-1} However it was on par with the treatments T_3 and T_4. Application of sulphur @ 25 g plant^{-1} in two splits, at planting and at 165 days after planting with recommended dose of fertilizer recorded highest nitrogen uptake of 610 kg ha^{-1}, phosphorus uptake of 108.6 kg ha^{-1}, potassium uptake of 1182 kg ha^{-1} and sulphur uptake of 117.7 kg ha^{-1}. However, it was at par with the treatment 20 g sulphur plant^{-1} with respect to nitrogen and phosphorus. Regarding potassium it was at par with the all the treatment except control. Significantly higher sulphur uptake of 117.7 kg ha^{-1} was recorded in treatment of sulphur 25 g plant^{-1}.

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Assessment of SOC Stocks and SOC Density on Cotton Growing Belt of South Gujarat as Influenced by Diversified Crop Condition

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Cotton (*Gossypium* spp), the queen of fibres or white gold and one of the most important cash crops of Gujarat state. Soil carbon stock, especially soil organic carbon (SOC) is a good indicator of soil productivity potential. It affects physical, chemical and biological properties of the soil and plays a crucial role in sustaining soil quality, agricultural production and environmental quality (Zhang *et al.* 2003). Soil organic carbon is thus an extremely valuable natural resource and hence the SOC stock must be restored, enhanced and improved. Therefore, proper management of SOM assumes importance in sustaining soil productivity in tropical soils and ensuring food security. Hence, the determination of SOC stock and SOC density from profile soils of South Gujarat from rainfed and irrigated cotton (hybrid/*Bt*/desi) is one of the main objectives of the present study. All the profiles were excavated up to 120 cm soil depth. The size of total SOC stock (t ha^{-1}) in each layer of soil profiles was computed by multiplying OC concentration (g kg^{-1}) in the layer with bulk density (Mg m^{-3}), thickness (m) and multiplying it with 10 (Batjes, 1996). However, in the profiles under study soil layers were as follows, 0-15, 15-30, 30-60, 60-90 and 90-120 cm soil depth. The highest and the lowest SOC stock up to 30 cm soil depth for irrigated profiles P5 (31.6) and P9 (27.9), respectively and the same for rainfed soils were P6 (30.4) and P10 (18.4), respectively which indicated that P5 and P6, respectively in irrigated and rainfed situations exhibited the higher capacity to help in mitigating global warming and climate change and higher productivity potential coupled with available water capacity and nutrient dynamics as compared to other respective irrigated and rainfed profiles. Mean SOCD at 0-15, 15-30, 30-60, 60-90 and 90-120 (all irrigated profiles collectively), were 1.50, 1.26, 2.15, 1.93 and 1.53 t ha^{-1} respectively. Further, Mean SOCD at 0-15, 15-30, 30-60, 60-90 and 90-120, were 1.22, 1.00, 1.93, 1.56 and 1.27 respectively. Up to 30, 60 and 120 cm soil depth from surface, the mean SOCD of rainfed profiles were 2.22, 4.14 and 6.97 t ha^{-1}, respectively.

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Effect of Soil Quality on Nutritional Value of Finger Millet (*Eleusine coracane*)

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The effect of soil quality on nutritional value of finger millet was assessed in LTFE plot which has been in progress since 1986 at UAS, Bangalore with finger millet-maize cropping sequence. Eleven treatments with three replications laid in randomized block design. The nutrient management practices include different doses of NPK (0%, 50%, 100% and 150% RDF-NPK), integrated nutrient management (100% NPK + FYM @15 t ha^{-1} with and without lime) and imbalanced nutrition [100% NP(-K), 100% N (-PK), 100% NPK(-S)]. The soil quality index (SQI) was assessed by collecting the soil samples at a depth 0-15 cm from different treatments during 2022 and grain samples were collected and analysis for proximate, nutritional and phytonutrients composition. The SQI for different management practices varied significantly from 0.98 to 0.70 and recorded significantly higher in integrated nutrient management plots *viz.*, 100% NPK + FYM + Lime (0.98) followed by 100% NPK + FYM (0.97). Lower SQI values were observed in control (0.70) and imbalanced nutritional plots *i.e.*, 100% N (0.74) and 100% NP (0.76). Significantly higher P and Fe content in finger millet grain were noticed in 150% NPK (T_3) followed by 100% NPK + FYM + Lime (T_{10}) and lowest in control. Significantly high Ca, Mg and Zn values in grains were recorded in T_{10} treatment (333, 176 and 2.76 mg 100 g^{-1}, respectively). Crude fat, crude fibre and ash values were significantly higher in T_{10} (2.02, 4.31 and 2.74 g 100 g^{-1}, respectively) and lowest in 100% NP (1.09, 3.33 and 1.36 g 100 g^{-1}, respectively). Significantly higher carbohydrates content was recorded in 100% NPK + FYM (T_8) treatment followed by T_{10} and T_3 treatments. Protein content was highest in 100% NP which was at on par with T_3 and lowest was noticed in control. Significantly higher values of phytonutrients *i.e.,* total polyphenols, tannins and oxalates were registered in control followed by 50% NPK and lowest in 100% NP. Both bulk and true densities of grain were significantly higher in 100% NP (752.08 and 1307.34 kg m^{-3}) followed by 100% NP and lowest in T_3 and T_{10}. Water and oil absorption capacity of flour was significantly more in T_8 treatment followed by T_{10}. From the findings it is revealed that, the soil quality decides the nutritional value of finger millet and to maintain the soil quality conjunctive use of organic manures and chemical fertilizers in balanced form is highly essential.

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Impact of Soil Beneficial Microorganisms through different Liming Techniques in Blackgram for Increasing Productivity under Some Acidic Soils of Dakshin Dinajpur district

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The low productivity of pulse crop in Northern region of West Bengal, India is mainly due to the improper soil nutrient management practices and acidic nature of soil. An field experiment was conducted as On Farm Trial (OFT) during *kharif* 2021 to 2022 at the different Farmers' Fields under adopted villages of Tapan Block by the supervision of Dakshin Dinajpur Krishi Vigyan Kendra, through the application of lime treatments along with organic and inorganic fertilizer to access growth and yields of blackgram as well as enhancement of beneficial microorganisms. The experiment was laid out in a Randomised Block Design consisting of four treatments *viz.* T_1 = farmers' practice as control (NPK of 15:30:15), T_2 = RDF (NPK: 20:60:20 kg ha^{-1}) + seed treatment with rhizobium, T_3 = RDF + Rhizobium + lime @ $1/3^{rd}$ of LR value and T_4 = RDF + Rhizobium through lime pelleting in blackgram cv. PU31. Each treatment was replicated by using different farmer's field be fitting the statistical design. The results of the experiment revealed that significant variation was observed among all the treatments in both the year under On Farm Trial (OFT). The variable microbial population was noticed among the treated fields in which T_3 treatment exerted maximum population of fungi (56 cfu $\times 10^3$ g^{-1} soil), bacteria (44.67 cfu $\times 10^5$ g^{-1} soil), Actinomycetes (34.33 cfu $\times 10^5$ g^{-1} soil), PSB (16.67 cfu $\times 10^5$ g^{-1} soil) and Azotobacter (8.33 cfu $\times 10^3$ g^{-1} soil). For growth and yield analysis study found that T_4 provided better results with maximum plant height (49.3 cm), number of branches $plant^{-1}$ (10.9), nodules $plant^{-1}$ (32.3), pods $plant^{-1}$ (24.1), seeds pod^{-1} (6.7), seed yield (1016.8 kg ha^{-1}) and stover yield (1321.9 kg ha^{-1}). The maximum benefit cost ratio also expresses from the T_4 treatment (3.14). Whereas, the improvement of soil fertility status occurred by T_3 treatment in blackgram fields, with increment of 13.59% soil pH, 40% of organic carbon content and available N (18.11%), P (47.13%) and K (11.22%). This study delineates the application of lime treatments could uplifts activity of beneficial microorganism for symbiotic association that increases blackgram yields and such practices could be adopt by the farmers for pulses crop production.

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Applied Multivariate Statistics to Understand Multi-dimensional Data of Soils and Soil-plant Interactions

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Soils and soil-plant interrelationships have multi-dimensional data structure and require reduction in dimensionality for practical crop management and applied multivariate statistics help in understanding the latent structure in the data. Comparison of Soil Taxonomy (USDA) and numerical taxonomy of 18 soil profiles on different slope positions and physiographic units supporting natural rubber resulted in grouping of soils of same taxonomic unit to different numerical classes because of variance in soil attributes, which has a practical significance. Similarly, 23 out of 62 soil series belonged to *Ustic Kanhaplohumults* with depth ranging from 53 to 138 cm, posing a question in soil management. Cluster analysis solved it by grouping 62 soils series in to eight soil management units in Kerala. Factor analysis of a dataset extracted 'Reactive surfaces factor', 'Available water capacity factor' and 'Surface charge factor' with association of soil variables influencing 'Factors' including soil particles, coarse fragments, depth and available water capacity, ?pH and ECEC. 'Soil reaction control factor' associated with bases, Al and Zn that influence soil pH and 'P limitation factor' with association of pH, Mn, available P and exchangeable Al were extracted from another dataset. Multiple regression showed the inverse dependence of tree volume of rubber plants to increasing 'P limitation'. Path analysis highlighted ($R^2 = 0.826$) an increase in Fe and Mn had significant negative effect on plant volume (-0.584* and -0.654*, respectively) particularly during period from July to September 1997, corresponding to high rainfall period. This path analysis highlighted the role of native elements on plant growth particular besides the impact of temporal changes in soil properties and plant growth. Unraveling latent structure in the data of soil and soil-plant interactions certainly helped the learning. Data from multi-locational trials under All India Coordinated Research Projects can best be analysed to understand the latent structure for profitable management.

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Geo Spatial Techniques for Productivity Enhancement through Inventorization in Doddenahalli-1 Micro-watershed of Arsikere Taluk, Hassan District

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A detailed land resource inventory of Doddenahalli-1 micro-watershed at 1:8000 scale, was conducted to evaluate the land suitability for the existing major field and horticultural crops. The evaluation of land in terms of suitability classes were based on the method described in FAO guideline for land evaluation. The factors considered for evaluation of the land suitability were soil slope, soil drainage, soil texture, soil depth, soil fertility and the present land use of the study area. Twenty-three soil series were identified and grouped into 43 mapping units in Doddenahalli-1 micro-watershed of Arsikere taluk, Hassan district in southern dry zone of Karnataka (zone-6) with a total geographical area of 903 ha based on soil morphological, physical and chemical properties. Findings of the study revealed that majority of the soils (384.5 ha) were having sandy loam texture, slight to moderate erosion (742.4 ha) and moderately sloping (263.3 ha) lands. The land evaluation for Land Capability Classification (LCC) indicated that out of 903 ha area, 361.2 ha were classified under class II with soil depth and surface gravelliness as major limitations. Suitability assessment of the crops grown in the area revealed that majority of the area (300.6 ha) was marginally (S_3) suitable for maize, ragi, minor millets, greengram, field bean, soybean, sesamum, brinjal, cabbage, chrysanthemum and marigold with limitations of depth, gravelliness, erosion and slope. While the area under crops like castor (351.9 ha), groundnut (436.6 ha), potato (428 ha) and tobacco (307.3 ha) were moderately (S_2) suitable with limitations of depth, texture, gravelliness, erosion and slope. Soil suitability maps provides farm specific crop choices and to provide inputs needed for planning, implementing and monitoring of all the crop based developmental programmes to develop tools, packages and thematic outputs.

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Effect of FYM, Sulphur and Zinc on Yield, Nutrients Content and Fertility Status of Soil under Rabi Maize - Green Gram Cropping Sequence

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A field experiment was conducted in the *rabi* seasons for maize and in the summer seasons for succeeding green gram during the year 2019-20 and 2020-21 at College of Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The experiment was laid out in a randomized block design with factorial concept, comprising eighteen treatment combinations of two levels of FYM (0 and10 t FYM ha^{-1}) three levels of sulphur (0, 20 and 40 kg S ha^{-1}), and three levels of zinc (0, 2.5 and 5 kg Zn ha^{-1}) with three replications. The soil of the experimental plot was loamy sand in texture, alkaline in reaction ($pH_{1:2.5}$ 8.30), low in soluble salts ($EC_{1:2.5}$ 0.23), organic carbon (0.30 %) and available nitrogen (197 kg ha^{-1}), medium in available phosphorus (44.5 kg P_2O_5 ha^{-1}), high in potash (287 kg K_2O ha^{-1}) and deficient in sulphur (7.56 mg/kg) and zinc (0.55 mg kg^{-1}). The recommended dose of fertilizer was applied to maize (150: 60: 00 kg NPK ha^{-1}) and greengram (20:40:00 kg NPK ha^{-1}) at the time of sowing. In light of the two years of experimentation, it can be concluded that the application of FYM 10 t ha^{-1}, 40 kg S ha^{-1} and 5.0 kg Zn ha^{-1} also recorded higher values of different fractions of S and Zn in soil after completion of two successive cropping sequence of maize-greengram, grown in sequence. Application of FYM 10 t ha^{-1}, 40 kg S $ha^{-1}$and 5.0 kg Zn ha^{-1} besides RDF (150:60 kg N:P_2O_5 ha^{-1}) applied to rabi maize crop not only found beneficial to maize crop, but also found beneficial for succeeding crop of summer greengram [RDF (20:40 kg N:P_2O_5 ha^{-1})] in terms of growth, yield, quality, content and uptake of nutrients and availability of nutrients in soil.

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Influence of FYM, Sulphur and Zinc on Soil Fertility Status, Fractions of S and Zn after Harvest under Rabi Maize - Green Gram Cropping Sequence

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A field experiment was conducted in the *rabi* seasons for maize and in the summer seasons for succeeding green gram during the year 2019-20 and 2020-21 at College of Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The experiment was laid out in a randomized block design with factorial concept, comprising eighteen treatment combinations of two levels of FYM (0 and10 t FYM ha^{-1}) three levels of sulphur (0, 20 and 40 kg S ha^{-1}), and three levels of zinc (0, 2.5 and 5 kg Zn ha^{-1}) with three replications. The soil of the experimental plot was loamy sand in texture, alkaline in reaction ($pH_{1:2.5}$ 8.30), low in soluble salts ($EC_{1:2.5}$ 0.23), organic carbon (0.30 %) and available nitrogen (197 kg ha^{-1}), medium in available phosphorus (44.5 kg P_2O_5 ha^{-1}), high in potash (287 kg K_2O ha^{-1}) and deficient in sulphur (7.56 mg kg^{-1}) and zinc (0.55 mg kg^{-1}). The recommended dose of fertilizer was applied to maize (150: 60: 00 kg NPK ha^{-1}) and greengram (20:40:00 kg NPK ha^{-1}) at the time of sowing. In light of the two years of experimentation. The fractions of sulphur and zinc after harvest of two cropping sequences were recorded. The results indicated that in general, application of FYM, sulphur and zinc significantly increased all the fractions of sulphur and zinc studied. The chronologically fractions of sulphur were in order oforganic sulphur >residual sulphur >water soluble sulphur >sulphate sulphur >adsorbed formandorganic sulphur isdominant fraction of total sulphur. Whereas in case of zinc fraction, the sequentially fractions of zinc were in order ofresidual zinc> Fe-Mn oxide> organically bound >carbonate bound zinc >water soluble + exchangeable formand residual zinc is dominant fraction of total Zinc.

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Impact of Soil and Nutrient Management Practices on Soil Quality Index in Subtropical Mollisols

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Mollisols are one of the most productive soils of the world and are formed under subhumid to humid conditions under grassland vegetation. This soil order is characterised by the presence of a mollic epipedon which has dark colour, base rich horizon (>35%) with granular or crumby soil structure and is rich in organic matter. A field experiment was conducted to study the impact of various soil and nutrient management practices on soil quality index in the Mollisol regions of Uttarakhand. There were nine treatment combinations, namely: T1 - Control, T2 - RDF, T3 - STCR (inorganic mode), T4 - STCR INM mode, T5 - 75% STCR dose of N (inorganic mode) + full P and K+ Green manuring (*Sesbania*), T6 - 50% STCR dose of N 14 (inorganic mode) + full P and K + Green Manuring (*Sesbania*), T7 - 75% RDN + full P and K + Green Manuring (*Sesbania*), T8 - 50% RDN + full P and K + Green Manuring (*Sesbania*), T9 - FYM + Green Manuring (*Sesbania*). Results showed that among different nutrient management practices, STCR based use of fertilizers along with FYM application, maintained better physical, chemical and biological properties of soil. The key soil quality indicators which were found best for monitoring soil quality status using Principal Component Analysis (PCA) were water holding capacity, organic carbon, available N and dehydrogenase activity. Based on the above results, it can be concluded that integration of organics with inorganic fertilizers helped in maintaining better soil quality and reduces dependency on chemical fertilizers, ultimately also improving environmental health.

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Assessment of Soil Fertility Status using Nutrient Index Approach in Jadaghatta Micro-watershed of Southern Dry Zone of Karnataka

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Assessment of soil available nutrient status of a region is important for sustainable agricultural production. Nutrients in soil govern its fertility and control the yields of crops. A detailed soil survey was undertaken in Jadaghatta micro-watershed in Karnataka state, India with the aim of evaluating the fertility status of soils using nutrient index approach. A total of 47 geo-referenced surface samples were collected on grid basis (320 meters) with a shovel from a depth of 0-20 cm and analysed for pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus, available potassium and available sulphur using standard analytical methods. Based on fertility ratings, pH of soils was acidic to alkaline. Electrical conductivity was normal (<0.8 dS m^{-1}). Per cent organic carbon was low to high, with more than 68 per cent of study area falling in the medium category. Available macronutrients status (available phosphorus & sulphur) were low to high and available potassium ranged from medium to high. Whereas, more than 90 per cent samples were low in available nitrogen. Considering nutrient index values (NI) of >2.33 for high, 1.67-2.33 for medium and <1.67 for low fertility status, the soils of the study area were found to be in the category of low for EC (NI:1), available nitrogen (NI:1.06), available phosphorus (NI:1.46) and sulphur (NI:1.47); medium for pH (NI:1.74) and organic carbon (NI:1.93); and high with available potassium (NI: 2.46). From the study, it is concluded that the soils of Jadaghatta micro-watershed is deficient in available nitrogen, available phosphorus (60%) and available sulphur (55%). Therefore, balanced and soil test based nutrient management practices should be followed to alleviate nutrient deficiencies of soils for sustainable crop production.

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Assessment of Spatial Variability of Soil Fertility using Semivariogram Model in Balepalli Sub-watershed of Doddaballapura Taluk, Bangalore Rural District, Karnataka State for Sustainable Agriculture

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Capturing site-specific variability in soil attributes is crucial for precision agriculture. A study was conducted in Balepalli sub watershed of Doddaballapura taluk, Bangalore rural district, Karnataka. An area of 2406 ha was selected in the Eastern Dry Zone of Karnataka for investigating the spatial distribution of soil fertility parameters *viz*., pH, EC, organic matter, available macro (Available N, P_2O_5, K_2O and S) and micronutrients (Fe, Mn, Zn and Cu). Total 471 surface samples (0-15 cm depth) were collected using grid sampling method at 320 meter intervals and analysed for the soil properties. The geo-database was subjected to kriging through best-fit experimental semi-variogram based on lowest root mean squared error. Exponential model was found best fit for pH, OC, available P_2O_5 and Zn whereas, spherical model was best fit for remaining soil parameters. The spatial distribution of maps revealed that major portion of the study area was neutral (6.5-7.3) and non-saline in nature. Majority of the area was found to be low in available nitrogen and sulphur and medium in organic carbon, available phosphorus and potassium content. The spatial distribution of maps showed sufficiency of Fe, Mn and Cu whereas Zn was deficient to sufficient in the study area. Spatial dependence was moderate for all soil fertility parameters (N:S ratio of 0.25-0.75) whereas available nitrogen exhibited strong spatial dependency (N:S ratio of 0.18). This study can support site-specific plant nutrient management at cadastral level for precision farming.

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Effect of NPK Fertilization on Nutrients Content and Uptake in Watermelon

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The field experiment was conducted during two consecutive summer seasons of the year 2020-21 and 2021-22 at ARS, COA, AAU, Jabugam, Dist. Chhota Udepur (Gujarat). The soil of experimental site was loamy sand. The treatments consisted of three levels of nitrogen (N) i.e.100, 150 and 200 kg ha^{-1}, two levels of phosphorus (P) i.e. 50 and 75 kg ha^{-1} and two levels of potassium (K) i.e. 75 and 100 kg ha^{-1} were replicated 3 times in factorial RBD design. The initial soil status: 119.5 and 122.5 kg ha^{-1} avail. N, 20.3 and 21.6 kg ha^{-1}avail. P_2O_5, 274.6 and 281.7 kg ha^{-1} avail. K_2O, 0.74 and 0.67% EC, 7.23 and 7.08 pH and 0.26 and 0.31% OC. The pooled data result shows that NPK content was not found significant due to nutrient treatments and their interactions. Looking to NPK uptake, nitrogen treatment N3 (200 kg N ha^{-1}) recorded significantly higher which was found to be at par with treatment N2 (150 kg N ha^{-1}) during individual years and in pooled data. NPK uptake was found to be non- significant due to different phosphorus and potash levels during both the years and in pooled analysis. In case of soil analysis after harvest of the crop, available N, P_2O_5 and K_2O were found to be significant. Treatment N3 (200 kg N ha^{-1}) recorded significantly higher value for available nitrogen, while available P_2O_5 and K_2O were found significantly higher in the treatment N1 (100 kg N ha^{-1}). Looking to phosphorus levels, available N and K_2O were found to be non-significant, where as available P_2O_5 was found significantly the highest in treatment P2 (75 kg ha^{-1}). In case of potash levels, available N and P_2O_5 were significantly unaffected, while available K_2O was reported significantly the highest in the treatment K_2 (100 kg ha^{-1}). All the interactions were found to be non significant for available nutrients.

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Effect of Tillage and Non-tillage on Physical Properties of Soybean under Vertisol

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The field investigation entitled "Effect of tillage and non-tillage on physical soil properties of soybean under Vertisol" was conducted during kharif at Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani with a view to find out appropriate combination of tillage practices, fertilizers and weeding practises to improve the physical properties of soybean. The experiment was laid out in factorial randomized block design with three replications comprising two levels of tillage practices (tillage, non-tillage), three levels of fertilizers (organic, inorganic, combined use) and two levels of weed management (manual weeding, herbicide spraying) thereby involving twelve treatment combinations on soybean variety Soybean: JS-335. The plot size was 5.4 m × 6 m. The crop was sown by dibbling method keeping row to row spacing 45 cm and plant to plant 5 cm, on 18th June, 2013 and recommended cultural practices were followed. The results indicated that, physical properties of soil were significantly influenced with adaption of tillage and combined use of fertilizer and recorded maximum 21.47 and 21.47 cm moisture content, 1.21 and 1.25 Mg m^{-3} bulk density and 2.79 and 2.58 cm hr^{-1} hydraulic conductivity, of soil respectively during growing period of soybean. It is concluded that tillage in combination either with organics and manual weeding or combined use of fertilizer and herbicidal application these combinations were found better in obtaining improved physical properties of soybean will be sustaining the fertility of soil in Vertisol. Tillage operation was found significant importance in Vertisol.

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Influence of Levels of Water Soluble Fertilizer on Yield and Quality of Sugarcane through Fertigation

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A field experiment was conducted at ZARS, V. C. Farm, Mandya during 2018-19 to study the effect of water-soluble fertilizer levels (urea, MAP, MOP) under drip fertigation on yield and quality of sugarcane. The investigation was carried out in Randomized Complete Block Design with seven treatments and replicated thrice. The treatments comprised of four levels of fertigation *viz.*, 150, 125, 100 and 75 per cent RDF through water soluble fertilizers, 100 per cent RDF through conventional fertilizers without FYM, 100 per cent RDF through conventional fertilizers with FYM and control. The results revealed that application of 125 per cent RDF through water soluble fertilizers recorded significantly higher cane yield (212 t ha^{-1}) and was on par with 150 per cent RDF and 100 per cent RDF through water soluble fertilizer application. Least cane yield was recorded in control (112.60 t ha^{-1}). Quality parameters like pol (18.0%), CCS production (12.44%), sugar yield (26.38 t ha^{-1}) and juice extraction per centage (69.65%) were observed significantly higher with 125 per cent RDF through drip fertigation and was on par with 150 per cent RDF and 100 per cent RDF through water soluble fertilizer application. Other quality attributes like brix (%) and purity (%) of sugarcane exhibited no significant difference due to water soluble fertilizer levels. The brix, pol, purity, CCS per cent, sugar yield, juice extraction per centage and cane yield were increased with increase in fertilizer levels up to 125 per cent RDF then declined by further increased in fertilizer level.

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Effect of Continuous Fertilization on Soil Properties of Entisols under Sunflower Maize Cropping Sequence

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Permanent Manurial Experiment was started at Kumaraguru Institute of Agriculture in 2019 with the following experiments Control, Organic manuring, STCR-inorganic fertilization alone, Integrated Nutrient Management (INM)-blanket recommendation as per CPG and STCR-IPNS with the sunflower-maize cropping sequence. After the three-cropping sequence, the treatment which received the STCR-IPNS based application of fertilizer recorded the highest yield all the three cropping sequence. In first two cropping sequence the fertility status of the organic manuring plot declined and in the third sequence, the fertility status of the plot which received the organic manuring alone shows increased value for organic carbon (0.48% against the initial value of 0.28%. The available N, P & K status also increased in the STCR-IPNS plot followed by organic manuring plot. The soil microbial activity and enzyme activity was found higher in the STCR- IPNS, organic manuring and also in the blanket recommendation. The yield of sunflower and maize in all the three sequence was recorded highest in the STCR-IPNS plot followed by the STCR-inorganic fertilizer alone. Even though there is yield increase in the inorganic fertilizer alone treated plot, there is decline in the soil microbial activity. The soil test based fertilizer application along with the organic manures found to maintain the soil health as well as increases the yield in crops.

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Effect of Soil Application of Panchagavya on yield of Green Gram

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A Pot culture experiment was conducted at Kumaraguru Institute of Agriculture in 2023 to study the effect of soil application of Panchagavya on Green Gram. Pot culture experiment was conducted with Green gram plant with 5 treatments *viz.*, T1 - RDF + FYM as per CPG (control) T2-T1 + 3% panchagavya soil application, T3-T1 + 3% panchagavya foliar application, T4- FYM +3% panchagavya soil application and T5-FYM + 5% panchagavya soil application. The experimental soil was taken from the permanent manurial experiment plot which received the blanket recommendation of fertilizers for maize-sunflower cropping sequence. The application of Panchagavya positively influenced the plant growth parameters of Green Gram. The treatment T4 - 3% soil application of Panchagavya recorded the highest value for the observations such as plant height, no. of leaves, leaf length, leaf width which was significantly superior than the control treatment and on par with the treatments which received 5% soil application of Panchagavya. The application of Panchagavya positively influenced the plant growth parameters of Green Gram. The treatment T4 - 3% soil application of Panchagavya recorded the highest value for the observations such as stem girth, number of nodes, internodal length which was significantly superior than the control treatment and on par with the treatments which received 5% soil application of Panchagavya and also with the treatment T3 - Recommended dose of fertilizers and 3% foliar application of Panchagavya. The number of pods, number of cluster/pod, number of seeds/pod, and test weight for the green gram was recorded highest in the treatment 3% Panchagavya as soil.

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Effect of Irrigation Methods and Potassium Levels on Growth, Yield and Soil Chemical Properties of Pigeon Pea

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A field experiment was conducted during *kharif* season of 2021 at AICRP on Irrigation Water Management farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra (India) situated between 19° 47' N to 19° 57' N latitude and 74° 18' E to 74° 19' E longitude. The soil of the experimental site was medium deep black having pH of 7.74, EC (0.28 dSm^{-1}) organic carbon (0.65 g kg^{-1}), available nitrogen of (158.12 kg ha^{-1}), available phosphorus of (13.05 kg ha^{-1}), and available potash of (396.7 kg ha^{-1}). The experiment was laid in randomized block design with eight treatments and three replications *viz.*, T_1 = Absolute control (Furrow irrigation), T_2 = GRDF (25:50:00 N:P_2O_5:K_2O kg ha^{-1} + 5 t FYM ha^{-1}) (Band placement with furrow irrigation), T_3 = GRDF + 30 kg K_2O ha^{-1} (Band placement with furrow irrigation), T_4 = GRDF + 40 kg K_2O ha^{-1} (Band placement with furrow irrigation), T_5 = GRDF + 50 kg K_2O ha^{-1} (Band placement with furrow irrigation), T_6 = GRDF + 30 kg K_2O ha^{-1} through drip (weekly application), T_7 = GRDF + 40 kg K_2O ha^{-1} through drip (weekly application) and T_8 = GRDF + 50 kg K_2O ha^{-1} through drip (weekly application). Growth parameters like plant height (cm), Number of branches per plant, No. of pods per plant, No. of grains per pod, 1000 seed weight and also seed yield (28.83 q ha^{-1}), stover yield (66.31 q ha^{-1}) were significantly higher with application of GRDF + 50 kg K_2O ha^{-1} through drip (weekly application). The treatment T_8 was noticed significantly higher available P (27.99 kg ha^{-1}), K (401 kg ha^{-1}), enhanced nutrient uptake of total N (152.09 kg ha^{-1}), P (27.99 kg ha^{-1}), K (167.23 kg ha^{-1}) and increased water use efficiency (6.97), respectively. The available N, pH, EC and organic carbon had observed non-significant result.

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Changes in Crop Yield and Soil Properties under Conservation Agriculture-based Pearl Millet-Wheat Cropping System in Semi-arid Region

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Conservation agriculture (CA) practices are getting space worldwide to answer many emerging challenges like; declining factor productivity, deteriorating soil health, water scarcity, climate change, and farm profitability and sustainability. Therefore, an experiment consisting of six establishment techniques in pearl millet (PM)-wheat (W) cropping sequence with different combinations of conventional tillage (CT), zero-tillage (ZT), and minimum tillage (MT) *viz*. CTPM-CTW, ZTPM-ZTW, MTPM-ZTW, CTPM-ZTW, ZTPM-CTW and MTPM-CTW was conducted during 2015 to 2019 at the research farm of Regional Research Station, Bawal, Haryana with a plot size of large each treatment. The findings of the study indicated that the adoption of zero tillage (ZT) techniques had positive effects on crop yield, plant nutrient availability, and soil organic carbon (SOC) over a period of five years. The MTPM-ZTW treatment achieved the highest grain yield in pearl millet, reaching 2507 kg ha^{-1}. Following closely behind was the ZTPM-ZTW treatment, which recorded a grain yield of 2444 kg ha^{-1}. In terms of stover yield, the MTPM-ZTW treatment yielded the highest amount at 5515 kg ha^{-1}, while the ZTPM-ZTW treatment produced 5350 kg ha^{-1} of stover. All tillage practices reflect statistically similar yield after five years cycle of cropping however the least grain and stover yield was recorded under CTPM-CTW (2184 and 4805 kg ha^{-1}) treatment. The benefit-cost ratio (BCR) of the cropping system was found to be higher in the MTPM-ZTW treatment with a calculated value of 1.64 followed by ZTPM-ZTW treatment of 1.58 as compared to CTPM-CTW treatment had a lower BCR of 1.25. The result from the analysis of soil after five years of study in indicated that the available micronutrient in the soil after crop harvest was significantly increased with CA-based zero tillage practices over the conventional tillage. Further, available micronutrients of Zn, Cu, Mn, and Fe in soil were also found to be maximum in ZTPM-ZTW (1.50, 0.28, 1.99 & 2.79 mg kg^{-1}) and minimum CTPM-CTW (1.20, 0.18, 1.89 & 2.67 mg kg^{-1}) under pearl millet cropping system. The content of micronutrients was found higher under without tillage system as compared to with tillage practices because of the higher amounting of crop residues under the former which directly enhances the content of these micronutrients.

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Assessing the Effect of Sulphur Application and Planting Methods on Yield and Quality Parameters of Groundnut (*Arachis hypogaea* L.)

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The productivity and quality of groundnut also depends on the environmental conditions and the improved agronomic practices, especially the planting methods which plays a significant role in achieving higher productivity of groundnut crop. The present investigation was carried out to assess the effects of sulphur application and planting methods on groundnut (*Arachis hypogaea* L.) pod yield and quality parameters. The study was carried out during *kharif* 2022 at the research farm of Regional Research Station, Bawal, Rewari, Haryana with a factorial randomized block design. The treatments included three levels of sulphur application (0, 25, and 50 kg S ha^{-1}) and three planting methods: flat bed, flat bed with earthing up, and ridge-furrow method with basal application of a recommended dose of fertilizer (N:15 kg ha^{-1}, P:50 kg ha^{-1}, and K: 25 kg ha^{-1}). The findings of the study indicated that sulphur application and different planting methods significantly influenced of pod yield and quality parameters of groundnut. Groundnut pod yield, stover yield as well as nutrient content, showed substantial increases with higher sulphur application rates (50 kg S ha^{-1}) and ridge-furrow planting method. Moreover, this treatment positively impacted quality parameters such as protein content, shelling percentage, and oil content. In conclusion, the research indicated superior groundnut yield and enhanced quality through the application of 50 kg ha^{-1} sulphur and the implementation of the ridge-furrow planting method. These findings underscore the importance of sulphur management and optimized planting techniques for improving groundnut cultivation outcomes.

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Assessment of Soil Test, Fertilizer NPK and Sweet Corn Yield Based on Soil Test Crop Response Correlation Studies using Targeted Yield Approach in a Vertisol of Chhattisgarh

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For sustainable nutrient management, the soil test crop response (STCR) approach is gaining importance due to its focus on precise application of fertilizers under different soil test levels for selected yields. An experiment was conducted on research farms of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during *Rabi* season of 2020-21 and 2021-22. Fertility gradient and diagnosis of test crop trials were conducted using the technical program of STCR. Soil test phosphorous and fodder yield of maize best reflected on the creation of fertility gradient. The test crop trial with sweet corn after the harvest of fodder maize showed higher variability values under P followed by N and K. Green cob yields of sweet corn showed percent coefficient of variance being highest in $L_0 > L_1 > L_2$ fertility strips. Fertilizer N and P had a considerable effect on the green cob yields of sweet corn as revealed by multivariate regression analysis, with fertilizer N showing the highest variation on green cob yields ($R^2 = 0.91$). The combination of fertilizers with FYM had no remarkable effects on green cob yields as compared with the sole combination of fertilizers. After performing linear regression between the nutrient uptake and green cob yields of sweet corn, it was found that the total N uptake had highest variation ($R^2 = 0.95$ and 0.97) on green cob yields for both the cropping years. The results indicated that for producing 1 q green cob yield of sweet corn, 0.26 kg nitrogen, 0.07 kg phosphorous and 0.30 kg potassium was required. After the development of fertilizer prescription equations, followed by ready reckoners chart, it was observed that under integrated plant nutrition system (IPNS) fertilizer requirement decreased with increase in soil test values, and increased with increment in yield targets. Therefore, STCR-IPNS approach can help in saving fertilizer costs.

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Evaluation of GIS-Based Geostatistical Models for Spatial Distribution of Soil pH Status in Telangana

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The study aims to assess various interpolation methods used to map the spatial distribution of soil pH in Telangana Forest. Soil pH stands out as a crucial soil factor due to its impact on multiple soil attributes, encompassing physical, chemical, and biological properties, as well as plant growth processes. The investigation took place across five districts in Telangana, India: Nizamabad, Kamareddy, Medak, Siddipet, and Sangareddy. These districts span a diversity of forest types, including dry deciduous scrub, dry teak forest, southern dry mixed deciduous forest, and non-forest areas. A total of 261 soil samples were collected from both non-degraded (MDF) and degraded (SF, OP, and NF) forest regions at three depths (0-30, 30-60, and 60-90). These samples were subsequently analyzed to determine soil pH. In the study area, the pH values range from 5.2 to 8.14, 4.6 to 7.63 and 4.7 to 7.7 at 0-30 cm, 30-60 cm, and 60-90 cm, respectively. Soil quality inherently varies, and even within the same ecosystem, soil attributes can exhibit noteworthy spatial discrepancies. Notably, no significant correlations were identified between vegetation and soil attributes such as pH. Moreover, outcomes from geostatistical analysis revealed the superiority of kriging and cokriging techniques over the inverse distance weighting (IDW) method in predicting the spatial distribution of soil pH.

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Nutrient Management in Cotton + Pigeonpea and Soybean + Pigeonpea biennial Intercropping Systems with Tillage Practices under Rainfed Eco-system

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A long term experiment on evaluation of nutrient management practices in cotton + pigeonpea and soybean + pigeonpea biennial intercropping system under rainfed condition was conducted on fixed site at All India Coordinated Research Project on Dryland Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The various nutrient levels of recommended dose of fertilizer and combination of RDF with FYM and vermin-compost were evaluated for both the intercropping systems. The long term data revealed that Soybean + pigeonpea intercropping system recorded higher yield than cotton + pigeonpea intercropping system. The intercropping system of soybean + pigeonpea recorded significantly higher cotton equivalent yield (1540 kg ha^{-1}). The Nutrient level of FYM 5 t ha^{-1} + RDF 75 per cent (N3) recorded significantly higher cotton equivalent yield (1750 kg ha^{-1}) than rest of the nutrient levels. Whereas the intercropping system of Soybean + pigeonpea with the nutrient level of FYM 5 t ha^{-1} + 75 per cent RDF recorded significantly higher cotton equivalent yield (1460 kg ha^{-1}). The gross monetary return and net monetary return under soybean + pigeonpea intercropping system were found to be Rs. 68073 ha^{-1} and Rs. 45140 ha^{-1} respectively. The BC ratio (2.71) was found higher under soybean + pigeonpea intercropping system with higher RWUE of 3.16. Under nutrient levels, the treatment of FYM 5 t ha^{-1} + 75% RDF (cotton) and FYM 5 t ha^{-1} + 75 % RDF (soybean) recorded higher equivalent yield of 1750 kg ha^{-1} with GMR and NMR of Rs. 76715 and Rs. 47422 ha^{-1}. The higher BC ratio of 2.50 and RWUE of 3.52 was also recorded under this treatment. A long term soil analysis indicated that organic carbon was substantially increased.

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Boron nutrition in Safflower (*Carthamus tinctorius* L.) under Northern Dry Zone of Karnataka

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The field investigation was performed at UAS, Dharwad in black soil to know the response of safflower (*Carthamus tinctorius* L.) to soil and foliar application of boron in a vertisol during 2021-22. The experiment was laid out under RCBD design with thirteen treatments replicated thrice. The treatments included were absolute control, RPP, three soil application (1, 1.5 and 2 kg ha^{-1}), two foliar rates (0.1% and 0.2%) of boron and their combination. The results revealed that RPP along with soil application of boron @ 2 kg ha^{-1} + foliar spray of boron @ 0.2% (T_{13}) recorded significantly higher plant height, number of branches per plant, dry matter production, number of capitulum $plant^{-1}$, weight of capitulum $plant^{-1}$ and test weight. A significant seed yield of 1603 kg ha^{-1} and haulm yield (3491 kg ha^{-1}) was recorded with RPP + soil application of boron @ 2 kg ha^{-1} + foliar spray of boron @ 0.2%. At harvest uptake of macronutrients, micronutrients, soil available N, P, K, S and B were also higher in the above said treatment. Boron concentration in safflower after foliar spray of boron at flowering and seed setting increased significantly due to both soil application.

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Enhancing the Productivity of Chickpea through Micronutrients and Biofertilizers in Vertisols of Northern Dry Zone of Karnataka

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A field experiment on "Influence of micronutrients and biofertilizers on soil fertility status, nutrient uptake, growth and yield of chickpea in Vertisols" was conducted at College of Agriculture, Vijayapur during *rabi* 2020-21. The experiment was laid out in RCBD with nine treatments and three replications. Apart from the recommended dose of fertilizers, the treatments included the application of iron @ 10 kg ha^{-1}, zinc @ 10 kg ha^{-1}, boron @ 10 kg ha^{-1} and sodium molybdate @ 1.0 g kg^{-1} seeds in various combinations along with RDF. The effect of these treatments on growth, yield, dehydrogenase activity and quality of chickpea was studied.Among the different treatments, the treatment which received RDF + *Rhizobium* + PSB (@ 1250g ha^{-1}) + Fe SO_4 @ 10 kg ha^{-1} + Zn SO_4@ 10 kg ha^{-1} + Borax @ 10 kg ha^{-1} + Sodium Molybdate @ 1.0 g kg^{-1} seeds resulted in maximum plant height (32.10 cm), number of branches $plant^{-1}$ (12.74), total dry matter accumulation at flowering (12.60 g $plant^{-1}$), at pod filling (22.57 g $plant^{-1}$) at harvest (25.56 g $plant^{-1}$), grain yield, straw yield and harvest index (1591.4 kg ha^{-1}, 1350 kg ha^{-1} and 0.54, respectively). The treatment also resulted in higher crude protein content in seeds, available Fe, Zn status in soil after harvest of crop, uptake of major (N, P, K and S) and micro (Zn, Fe, Cu and Mn) nutrients by chickpea crop. Thus, the combined application of these micronutrients, biofertilizers along with RDF (10:25:00: N: P_2O_5:K_2O kg ha^{-1}) was found to be a better means of balanced nutrition of chickpea crop to ensure higher productivity.

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Validation of Fertiliser Prescription Equations for Rice in Tiruvallur district of Tamil Nadu

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Rice is the major crop in North Eastern Zone of Tamil Nadu. In Tiruvallur District, Rice is the major crop cultivated in an area of 96,967 ha with a share of 6.7% to State in three seasons *viz.*, Sornavari, Samba and Navarai. At present the productivity of rice in Tiruvallur district is 4,200 tonnes per hectare. Due to intensive cropping and application of chemical fertilisers without organic manures the organic matter content of the soils in Tiruvallur district is very low in most of the areas with the occurrence of multi-nutrient deficiencies especially zinc and iron deficiency in rice. In STCR-IPNS technology, the fertiliser doses are tailored to the requirements of specific yield target levels of crop taking into account the nutrient requirement of the crop, the contribution of nutrients from soil, fertilsers and organic manures. In this regard, Fertilizer Prescription Equations (FPEs) for specific yield target levels on Kadambady soil series in Tiruvallur district in irrigated Rice was developed following the STCR-IPNS concept by adopting Inductive cum Targeted yield approach. Validation of the developed FPEs were done at farmers holding of Melkondaiyar village in Tiruvallur District with rice variety TKM 13. The experiment has been laid out with ten treatments *viz.*, blanket recommendation, blanker recommendation + FYM, STCR-NPK alone for 5, 6 and 7 t ha^{-1} yield targets, STCR-IPNS for 5, 6 and 7 t ha^{-1} yield targets, farmer's practice and absolute control in RBD with three replications. If 90 per cent of the targeted yield was achieved, then the equations are found to be valid (Velayudham *et al.*, 1984). At Melkondaiyar village, highest grain yield of rice, response ratio and BCR was recorded with STCR-IPNS 7 t ha^{-1} (6.74 t ha^{-1}, 11.82 kg kg^{-1} and 2.33 respectively). Hence, Soil Test Crop Response based fertilizer prescriptions under Integrated Plant Nutrition System (STCR-IPNS for 7 t ha^{-1}) can be recommended for achieving aimed yield target, response ratio and BCR for rice on Kadambady soil series in Tiruvallur district of North Eastern Agro climatic zone of Tamil Nadu.

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Reclamation Efficiency of Soil Amendments on Maize Crop in Fluoride - Contaminated Soils of Reddiyarchatram Block, Dindigul District

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Reclamation of problematic soils with crops is one of the most effective technological approaches. An attempt was made to determine the reclamation potential of maize crop in fluoride contaminated soils. A field experiment was conducted during Rabi season 2020-2021 at Ammapatti village, Reddiyarchatram Block, Dindigul District, Tamil Nadu, India, to study the effect of soil amendments with Maize CO 6 as a test crop. The crops was grown up to harvest stage, sampled and analyzed for various parameters. The field experiment was laid out in a randomized block design with three replications; Five treatments were implemented and compared with an unfertilized plot (Control). The treatments consisted of soil amendments like FYM (12.5 t ha^{-1}), Vermicompost (5 t ha^{-1}) Lime (2 t ha^{-1}) and Gypsum (2 t ha^{-1}) with RDF and one fertilized plot without soil amendments. Applied soil amendments differed significantly among themselves in growth and reclamation efficiency. The Maximum yield of maize was noted with the application of FYM (8102 kg ha^{-1}), which was closely followed by vermi compost (7868 kg ha^{-1}). This may be due to the fluoride toxicity, amelioration of enzyme activity, lower the fluoride uptake by plants and higher microbial population present in organic sources (FYM + Vermi compost), which can helps in better uptake of nutrients from soil, accumulation of soluble sugars, maintaining peroxidase and catalase activity, decreasing fluoride concentration and stimulating maize crop production. Hence, it can be concluded that Maize crop can perform better with the application of FYM and suitable management strategies for better crop yield.

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Response of Maize Crop to Applied Amendments under Fluoride Stress Conditions

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An on- farm field experiment was conducted in 2020-2021 at three locations; Krishi Vigyan Kendra, Pongalur, Tiruppur district, Maize Research Station, Vagarai Dindigul District and Regional Research Station, Pappireddipatti (Block) Dharmapuri District to evaluate the crop response to applied soil amendments. The treatments were scheduled based on the STCR recommended doses of NPK, FYM and Gypsum applied to the maize crop. The initial soil fluoride concentrations were recorded as 1.85 ppm (KVK), 1.81 ppm (MRS) and 2.05 ppm (RRS). Application of NPK through STCR based recommendation + 2 tonnes gypsum ha^{-1} recorded the highest maize grain mean yield of 6734, 7320 and 7410 kg ha^{-1} in Pongalur, Vagarai and Pappireddipatti with an straw yield of 8510, 9250 and 11240 kg ha^{-1}. Application of NPK through STCR recommendation + 2 tonnes gypsum ha^{-1} recorded the lowest water soluble fluoride content in all the centers (1.57, 1.52 and 1.62 ppm) in Pongalur, Vagarai and Pappireddipatti whereas the highest soil fluoride was recorded in the control treatment (1.81, 1.75 and 1.98 ppm). Hence, the finding of OFT focuses on the practice of balanced fertilization for achieving the highest yield of crops and reducing fluoride toxicity level will be achieved through the combined application of gypsum and FYM along with the STCR based recommendation.

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Effect of Potassium, Sulphur and KSB on Various Fractions of K and S under Direct Seeded Rice-Chickpea Cropping Sequence in Loamy Sand Soil

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A field experiment was carried out on loamy sand soil at Regional Research Station, Anand Agricultural University, Anand, Gujarat to evaluate the "Effect of potassium, sulphur and KSB on various fractions of K and S under direct seeded rice-chickpea cropping sequence in loamy sand soil" during two successive seasons of *kharif-rabi* 2021-22 and 2022-23. The experiment was laid out in a randomized block design with factorial concept, comprising eighteen treatment combinations *i.e.,* two levels of KSB (0 and 1 L ha^{-1}), three levels each of potassium (0, 30 and 60 kg K ha^{-1}) and sulphur (0, 20 and 40 kg S ha^{-1}) with three replications. The treatments were imposed to rice only and the residual effect was tested on succeeding crop of chickpea with recommended dose of fertilizers only. The soil of the experimental plot was alkaline in reaction ($pH_{1:2.5}$ 8.15), normal with respect to soluble salts ($EC_{1:2.5}$ 0.17 dS m^{-1}), low in organic carbon (0.42%), available nitrogen (219.52 kg ha^{-1}) and sulphur (9.50 mg kg^{-1}) while, available phosphorus (57.33 kg ha^{-1}) was high and available potassium (217.7 kg ha^{-1}) was medium in status. The recommended dose of fertilizer was applied to rice (80:40:00 kg NPK ha^{-1}) and chickpea (20:40:00 kg NPK ha^{-1}). The results revealed that application of 60 kg K ha^{-1}, 20 kg S ha^{-1} and KSB 1 L ha^{-1} to the rice crop recorded maximum improvement in grain and straw yield of direct seeded rice as well as the yields of succeeding chickpea over control in 2021, 2022 and in pooled results. Looking to the various fractions of potassium, the results indicated that individual application of KSB 1 L ha^{-1} and 60 kg K ha^{-1} to the rice crop significantly improved water-soluble K, exchangeable K and non-exchangeable K. These two factors as well as application of sulphur didn't much contribute for lattice and total K content of soil during two years of experimentation. In case of sulphur fractions, significantly higher values of different forms of sulphur *viz.,* water soluble S, available S and total S were noted under 60 kg K ha^{-1} over control. Application of 40 kg S ha^{-1} recorded significantly higher water-soluble S, available S, residual S and total S. The organic S was not affected by any of the factor during two successive cropping sequence of directed seeded rice-chickpea.

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Rationalised Fertiliser Prescription through STCR - IPNS for Pearl Millet on Inceptisol of Tamil Nadu

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Rationalised fertiliser prescription through Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS) helps the farmers to achieve the targeted yield by eliminating over or under usage of fertiliser inputs. Keeping this in view, Fertiliser Prescription Equations (FPEs) under IPNS have been developed for pearl millet (TNAU Cumbu Hybrid CO 9 & *var.* CO 10) on mixed black calcareous soils adopting the Inductive cum Targeted yield model. In the present study, the FPEs were validated at various locations in Southern & Western Agro-climatic zones of Tamil Nadu during *kharif* and rabi seasons of 2017-18 & 2020. There were ten treatments *viz.,* blanket (RDF alone), blanket (RDF + FYM @ 12.5 t ha^{-1}), STCR-NPK alone - 3.0, 3.5 and 4.0 t ha^{-1}, STCR-IPNS - 3.0, 3.5 and 4.0 t ha^{-1}, farmer's practice and absolute control. At all the locations, the per cent achievement of yield targets was within +/-10 per cent variation proving the validity of the equations. In case of hybrids, the highest mean grain yield was recorded in STCR-IPNS-4.0 t ha^{-1} (4155 kg ha^{-1}) with the fertiliser use efficiency (in terms of Response Ratio) of 11.85 kg kg^{-1} and BCR of 1.86. In case of variety, the highest mean grain yield was recorded in STCR-IPNS-3.5 t ha^{-1} (3455 kg ha^{-1}) with the Response Ratio of 12.57 kg kg^{-1} and BCR of 1.94. In general, STCR treatments proved their superiority over blanket and farmer's practice in terms of yield, RR and BCR. The mean increase in yield due to STCR-IPNS-4.0 t ha^{-1} was 61.7 per cent over blanket (RDF alone), 18.8 per cent over blanket + FYM and 76.4 per cent over farmer's practice for hybrid pearl millet; 43.1 per cent over blanket (RDF alone), 21.2 per cent over blanket + FYM and 74.6 per cent over farmer's practice for pearl millet variety. Post-harvest soil fertility data indicated that there was either maintenance or built-up of soil available N, P and K in all the fertilised treatments while depletion has been noted in absolute control. Therefore, STCR-IPNS for 4.0 t ha^{-1} and 3.5 t ha^{-1} respectively for pearl millet hybrid and variety can be recommended for achieving higher yield, response ratio and BCR with soil fertility maintenance on Perianaickenpalayam series (mixed black calcareous soil) of Tamil Nadu.

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Zinc Fortification in Wheat through Enrichment of Organics, with Zinc and Zinc Solubilizing Bacteria in a Vertisol of Central India

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Wheat (*Triticum aestivum L.*), is the only cereal that had low zinc concentration, is consumed by 40% of people worldwide. Zn deficiency is common problem in soils of Madhya Pradesh that affects agricultural produce thus causing inadequacy in humans. Fortification is a viable strategy for resolving this issue by increasing Zn concentrations in edible part of wheat. Keeping in view of the above facts a pot experiment was conducted in a Vertisol during 2019-2020 at Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur. The study included incubation of organics with ZSB and $ZnSO_4.7H_2O$ and thereafter a pot experiment was conducted where the incubated materials was mixed with 5 kg of soil and wheat crop (Variety-GW-366) was sown. Treatments organic materials viz., FYM@ 10 t ha^{-1}, Poultry manure@ 2.5 t ha^{-1} and Vermicompost@ 5 t ha^{-1} used which were enriched with ZSB strain (*Pseudomonas aeruginosa*) and Zn @2.5 kg ha^{-1} and 5.0 kg ha^{-1} through $ZnSO_4.7H_2O$.

The results revealed that enriched inputs *viz.*,

- FYM enriched @ 5 kg Zn ha^{-1} and ZSB showed maximum Zn content in grain (36.02 mg kg^{-1}) followed by FYM+5 kg Zn ha^{-1} (34.06 mg kg^{-1}) where not enriched with ZSB
- Vermicompost enriched @ 5 kg Zn ha^{-1} and ZSB increased zinc content in grain (33.59 mg kg^{-1}), followed by Vermicompost@ 2.5 kg Zn ha^{-1} (31.74 mg kg^{-1}) where not receiving ZSB and
- Poultry manure enriched @2.5 kg Zn ha^{-1} and ZSB showed (29.47 mg kg^{-1}) followed by Poultry manure + 5 kg Zn ha^{-1} 28.85 mg kg^{-1} where not receiving ZSB over control (22.53 mg kg^{-1})

Thus, it was concluded that amongst the different enriched organics materials, enriched FYM @ 5 kg Zn ha^{-1} along with ZSB improved Zn fortification in wheat in a Vertisol.

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Effect of Sulphur and Zinc Application on Improving Growth, Yield and Nutrients Concentration of Indian Mustard and Soil Properties in a Vertisol

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Indian mustard (*Brassica juncea* L.) serves as a vital oilseed crop, providing essential nutrients to humans. However, potential deficiencies in sulfur (S) and zinc (Zn) could threaten public health. To address this concern, a study was conducted at Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during Rabi season of 2022-23. Fifteen treatments comprises of three S levels (0, 20, and 40 kg S ha^{-1}) arranged in main plot and five Zn levels (0, 2.5, 5, 7.5 and 10 kg ha^{-1}) in sub-plot treatments, which were replicated three times in a split plot taking mustard variety "RH0749" to evaluate the effects of S and Zn fertilization on productivity, nutrients concentrations in mustard and changes in soil properties. Notably, applying 60 kg S ha^{-1} and 10 kg Zn ha^{-1} led to notably higher metrics such as plant growth, primary branches per plant, siliqua count per plant and harvest index. Meanwhile, dry matter accumulation per plant, 1000-grain weight, biological yield, seed yield, and stover yield exhibited marked increases with rising S levels up to 40 kg and Zn levels up to 10 kg ha^{-1}. The treatment T_5 (0 kg S ha^{-1} and 10 kg Zn ha^{-1}) demonstrated the highest Zn concentration in seeds and stover, while treatment T_{12} (40 kg S ha^{-1} and 2.5 kg Zn ha^{-1}) exhibited the highest S content in both seed and stover. Notably, the interaction effect between sulfur and zinc levels showed no significant impact on various mustard parameters.

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Under Long Term Fertilizer Experiment Soil Properties as Key Indicators for Assessing Soil Quality and Yield under Soybean-Safflower Cropping Sequence in Vertisols

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Long-term fertilizer experiment carried out during 2020-21 at experiment research farm, VNMKV, Parbhani which is located at 17°, 35 to 26°, 40 N latitude and 74°, 40 to 78°, 15 E longitudes with an altitude of 347 m MSL. The experiment was carried out in Randomized Block Design with 12 treatments and four replications. The surface soil samples were collected at depths of 0-15 cm after harvesting of soybean. The experiment under soybean-safflower cropping sequence with different treatments containing T_1 (50% NPK), T_2 (100% NPK), T_3 (150% NPK), T_4 (100% NPK + HW), T_5 (100 %NPK + 25 kg ha^{-1} $ZnSO_4$), T_6 (100% NP), T_7 (100% N), T_8 (100% RDF + FYM @ 5 t ha^{-1}), T_9 (100% NPK - Sulphur) and T_{10} (Only FYM @ 10 t ha^{-1}), T_{11} (Absolute control) and T_{12} (Fallow). The maximum grain and straw yield of soybean and safflower crop under soybean-safflower cropping sequence was recorded in 100% NPK + FYM @ 5 t ha^{-1} treated plots followed by treatment receiving 150% NPK and lowest at imbalance application of fertilizers N alone.The soil quality assessment based on principal components analysis (PCA) showed that highest weighted variables under PC1 to PC4 included pH, EC, PD, MWD, CEC, Available P, K, DTPA Cu, DHA, Acid phosphatase, Alkaline phosphates, SMBC. A correlation matrix assumed that, MWD, Available K and SMBC were retained in the minimum data set (MDS). Significantly highest soil quality index (2.23) was found at 100% NPK + FYM @ 5 t ha^{-1} followed by 150% NPK (2.15), T_5 100% NPK + Zn 25 Kg ha^{-1} (2.06) and T_{10} FYM @ 10 t ha^{-1} (2.04). The lowest SQI was found in 100% N alone (1.63) followed by control plot (1.64). This indicated that the continuous application N alone reduce the yield and soil quality under long term fertilizers experiment in soybean-safflower cropping sequence in Vertisols.

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Response of Sulphur in Field Pea (*Pisum sativum*) on Coarse Textured Soils of Southern Haryana

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A field study was carried out on coarse textured low sulphur status soils of CCS HAU, Regional Research Station, Bawal (Haryana) in during the year 2019-20 and 2020-21 to study the effect of sulphur fertilization in field pea. The soil of experimental field was loamy sand, alkaline in reaction (pH 8.30 to 8.40), low soluble salt content (EC 0.17 to 0.20 dS m^{-1}), low in organic carbon (1.92 to 2.05 g kg^{-1}), medium in available P (11.10 to 11.65 kg ha^{-1}) and medium in available S (170.00-172.25 kg ha^{-1}). The experiment was laid out in randomized block design with three replications. There were 5 graded levels of sulphur *viz.,* 0, 10, 20, 30 and 40 kg S ha^{-1} applied through gypsum as a basal dose before sowing. Recommended doses of fertilizers for crop were also applied @ 20 kg N and 40 kg P_2O_5 ha^{-1}. The pooled data of two-year experimental result revealed that field pea seed yield was increased significantly with the application of Sulphur up to 30 kg ha^{-1}. The seed yield of field pea was increased 4.04, 6.22, 13.91 and 15.76% due to application of 10, 20, 30 and 40 kg S ha^{-1}, respectively over control. The S-uptake was also increased with the application gypsum as a source of sulphur. The mean post-harvest available S status was 7.55, 8.81, 9.70, 11.94 and 12.43 ppm at 0, 10, 20.30 and 40 kg S ha^{-1}, respectively. The S-use efficiency varied from 7.30 to 15.10 per cent being maximum (15.10%) with the application of 30 kg S ha^{-1}. The finding of this study concluded that application of 30 kg S ha^{-1} in coarse textured medium potash status soils of Southern Haryana was found to be optimum for field pea in terms of crop yield and soil S fertility status.

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Carbon Sequestration in High Density Guava Orchards in Relation to Nutrient Management

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High density orcharding is expanding and is going to be the future orcharding systems in fruit crops. Management of high density planting (HDP) orchards is not the same as conventional fruit orchards. These new systems of management affect the carbon (C) sequestration of fruit trees under HDP. Hitherto to our knowledge no such effort was made to assess the influence of nutrient management on the carbon sequestration (CS) under HDP. In this paper we report the C sequestration by HDP guava as a function of nutrient management. In a high density guava orchard under different plant density and nutrient management, the C sequestration was estimated using allometric equation. The study showed that both plant population and nutrient management significantly affected the C sequestration by guava plants. Carbon sequestration increased with increase in plant population. Application of secondary and micronutrients and biofertilizersalong with NPK enhanced the growth parameters and consequently the C sequestration by the trees. Soil C is the largest pool of C followed by AGB, BGB, and litter ≥ weed. The biomass alone (tree+weed+litter) in guava orchard sequestered 24.32 t C ha^{-1} accounting for 29.22% of the total C sequestered under 3 × 2.5 m spacing accommodating 1333 plants ha^{-1} and 52.37 t C ha^{-1} accounting for 45.67% of total C sequestration under 2 × 1.5 m spacing orchards accommodating 3333 plants ha^{-1}. Averaged across the different nutrient management strategies, the highest potential for C storage was observed to be 114.67 t ha^{-1} for guava orchard at 2 × 1.5 m spacing, 1.38-fold higher than in guava orchard at 3 × 2.5 m spacing Our study generated a unique information in terms of C stocks for HDP guava orchards and is a valuable first step for advancing our knowledge of the C cycle in intensified HDP orchards.

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Evaluation of Different Fe Management Practices for Enhancement of Fe in Wheat

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A field experiment was conducted on deep black soil at Agricultural Research Station, Niphad, Dist. Nashik, Maharashtra during year 2020-21 to 2022-23. The experimental soil was calcareous and slightly alkaline in reaction. The soil was medium in organic carbon, low in available nitrogen, medium in available phosphorus, high in available potassium, deficient in available micronutrients like Fe and Zn. The experiment was laid out in randomized block design and consisted of nine treatments with three replications.The treatments details were: T1 - Absolute control; T2 - General Recommended dose of fertilizers (120:60:40 N:P_2O_5:K_2O kg +10 t FYM ha^{-1}); T3 - GRDF +Seed treatment with Fe EDTA (10 g kg^{-1} seed); T4 - GRDF + Soil application of FeSO4 @ 20 kg ha^{-1} ; T5 - GRDF + Sprays of Fe EDTA (0.2%) at tillering (40-45 DAS) and flowering stage (60-65 DAS); T6 - GRDF + Sprays of Fe EDTA (0.2 %) at flowering stage (60-65 DAS) and milk stage (80-85 DAS); T7 - GRDF + Soil application of $FeSO_4$ @ 20 kg ha^{-1} + sprays of Fe EDTA (0.2%) at tillering (40-45 DAS) and flowering stage (60-65 DAS); T8 - GRDF + soil application of FeSO4 @ 20 kg ha^{-1} + Sprays of Fe EDTA (0.2 %) at flowering stage (60-65 DAS) and milk stage (80-85 DAS): T9 - GRDF + spray of vermiwash @ 4 per cent with FeSO4 @ 0.5 per cent (30 DAS). The three years pooled data revealed that all yield and yield parameters were significantly affected with soil and foliar application of Fe along with GRDF. The treatment, GRDF + soil application of $FeSO_4$ @ 20 kg ha^{-1} + sprays of Fe EDTA (0.2%) at tillering stage (40-45 DAS) and flowering stage (60-65 DAS) significantly produced higher grain yield (46.17 q ha^{-1}) and straw yield (59.53 q ha^{-1}) of wheat along with increase in total Fe uptake (485.20 g ha^{-1}) and Mn uptake (303.9 g ha^{-1}) with higher grain iron concentration (58.30 mg kg^{-1}). It is concluded that application of $FeSO_4$ @ 20 kg ha^{-1} incubated in FYM (1:10 proportion) for one week along with general recommended dose of fertilizer (120:60:40 N:P_2O_5:K_2O kg ha^{-1} + 10 t FYM ha^{-1}) at the time of sowing followed by foliar sprays of Fe EDTA @ 0.2% at tillering stage (40-45 DAS) and flowering stage (60-65 DAS) to wheat crop is recommended for higher yield, iron concentration in grain and monetary returns in iron deficient soils of plain zone of Maharashtra.

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Assessment of Spatial Variability of Soil Properties and Delineation of Soil Management Zones at a Regional Scale in Eastern India

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Assessment of regional-scale soil fertility status is essential for supporting farmers with effective nutrient management decisions. This study assessed the spatial variability of 14 soil properties *i.e.*, SOC, pH, EC, mineralizable N, Bray's P, available K, S, Fe, Mn, Cu, Zn, B, and exchangeable Ca and Mg in Keonjhar district, Odisha located in eastern India having a geographical area of 8303 km^2. A soil dataset of 1,024 surface soil (0.3 m) samples was prepared and spatial maps were prepared using ordinary kriging geostatistical approach. SOC varied from 0.09 to 1.38% with mean and SD values of 0.73 ± 0.29%. Soil pH varied from 4.15 to 7.38, with mean and SD values of 5.61 ± 0.88. EC was in safe range. Available N, P, and K varied from 50.9 to 533.3, 5.7 to 44.5, and 76.9 to 728.2 kg ha^{-1}. Available S, exchangeable Ca and Mg varied from 1.06 to 29.71 mg kg^{-1}, 0.41 to 6.60 cmol ($^+$) kg^{-1} and 0.06 to 3.68 cmol ($^+$) kg^{-1}, respectively. Available Fe, Mn, Cu, Zn, and B ranged from 5.61 to 180.60, 0.52 to 91.28, 0.03 to 5.90, 0.01 to 2.49, and 0.04 to 2.63 mg kg^{-1}, respectively. Low SOC status in 23% of the soils, soil acidity in 99% of the soils, low available N in 61% of soils, low available P content in 50% of the soils, low available S content in 29% of the soils, deficiency of available Zn in 31% of soils, and deficiency of B in 52% of the soils were observed as the major soil-related crop production constraints of the study area. Further, soil maps were stacked to generate a composite and five soil management zones were generated using fuzzy k-means clustering. Based on the zonal constraints, management practices were recommended.

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Yield Sustainability and Soil Health in Rice-Rice Cropping System under Long-term Target Yield based Nutrient Management in Typic Haplustalf

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We studied the effect of long-term target yield based nutrient management on yield sustainability and soil health under 22 year old rice-rice system in a Typic Haplustalf. The experiment was designed in randomized black design with five treatments, *viz*, control, recommended dose of fertilizer (RDF), STCR-NPK for target yield of 6 t ha^{-1} for *kharif* rice and 5 t ha^{-1} for *rabi* rice (STCR-NPK1), STCR-NPK for 7 t ha^{-1} for *kharif* rice and 6 t ha^{-1} for *rabi* rice (STCR-NPK2), and STCR-IPNS for 7 t ha^{-1} for *kharif* rice and 6 t ha^{-1} for *rabi* rice (STCR-IPNS), and these treatments were replicated thrice. The 10-years mean data suggested that minimum yield was observed from control whereas highest was achieved in STCR-IPNS in both *kharif* as well as *rabi* seasons. The highest sustainable yield index (SYI) was 0.87 and 0.78 in *kharif* and *rabi* rice, respectively under STCR-IPNS, and lowest was observed in control. Soil fertility status after 44 cropping cycles revealed that disregard for external application of nutrients resulted in depletion of 108 kg N, 11.6 kg P and 200 kg K per ha. Significant build-up of P and SOC were observed in all treatments except control. For N and K, the intensity of nutrient depletion was lowest in STCR-IPNS plots followed by STCR-NPK2, STCR-NPK1 and RDF plots. Enzymatic activities *viz.,* urease, phosphatase and dehydrogenase and microbial biomass C were found to be higher in STCR-IPNS when compared with other nutrient management practices while minimum values were recorded in control.

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Effect of Sulphur and Iron on Nutrient Content in Chickpea and Soil Properties

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A field experiment was carried out at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *rabi* season of 2021-22 to study the effect of sulphur and iron on nutrient content in chickpea and post-harvest soil properties. An experiment consisted of four levels of sulphur *viz.*, S_0 - 0 kg S ha^{-1}, S_{10} - 10 kg S ha^{-1} and S_{20} - 20 kg S ha^{-1} and S_{30} - 30 kg S ha^{-1}, and three levels of iron *viz.,* Fe_0 - 0 kg Fe ha^{-1}, Fe_5 - 5 kg Fe ha^{-1} and Fe_{10} - 10 kg Fe ha^{-1} which were tested under Randomized Block Design (factorial) with three replications. The soil of the experimental plot was loamy sand in texture, low in organic carbon, available nitrogen and DTPA extractable-iron, medium in available phosphorus, potassium and sulphur. The recommended dose of fertilizer (20-40-00 NPK kg ha^{-1}) was applied to each plot before sowing of chickpea seed. The N, P, S and Fe nutrients were applied by using sources of Urea, DAP, Bentonite sulphur and Ferrous sulphate, respectively. Results revealed that the treatment S_{30} (30 kg S ha^{-1}) significantly increased the N, P, K, S and Fe contents in chickpea seed (3.31, 0.68, 0.814, 0.334% and 125 mg kg^{-1}) and haulm (1.32, 0.367, 1.068, 0.159 and 150 mg kg^{-1}), respectively than other levels of sulphur. The treatment receiving application of 10 kg Fe ha^{-1} (Fe 10) recorded significantly maximum S and Fe contents in chickpea seed (0.327% and 122 mg kg^{-1}) and haulm (0.140% and 150 mg kg^{-1}) in comparison with rest of the levels of iron. The treatments receiving application of 30 kg S ha^{-1} as well as 10 kg Fe ha^{-1} in soil reported significantly maximum available sulphur and DTPA extractable-Fe in soil after harvest of chickpea.

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Effect of Sulphur Sources and Levels on Growth, Yield Attributes and Yield of Kharif Groundnut (*Arachis hypogaea* L.) in Loamy Sand

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An experiment was conducted during *kharif* season of the year 2021 at Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Banaskantha (Gujarat). to study the "Effect of sulphur sources and levels on growth, yield and nutrient uptake by *kharif* groundnut (*Arachis hypogaea* L.) in loamy sand". Nine treatment combinations comprising three sources of sulphur (Bentonite sulphur, liquid sulphur and gypsum) and three levels of sulphur (15, 30 and 45 kg ha^{-1}) were evaluated in randomized block design with four replications. Groundnut variety Gujarat Groundut 20 was used as a test crop. An application of sulphur @ 45 kg S ha^{-1} through gypsum recorded significantly maximum plant height at 60 DAS (31.49) and at harvest (42.47), number of branches per plant (8.95), number of nodules per plant (108.68) as well as fresh (221.51) and dry weight (77.83) of nodules per plant over rest of treatments. The similar trend was also observed for number of pods per plant (23.09), pod yield per plant (14.44), seed index (46.82), shelling percentage (70.91), pod yield and haulm yield (2442 and 3443) of groundnut.

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Comparative Study of Novel Nitrogen Nano Clay Polymer Composite (N-NCPC) and Other Nitrogen Carriers under Wheat Rhizosphere

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A pot culture experiment was conducted during rabi season of 2021-22 in Bihar agricultural university, where the effect of neem coated urea (NCU) on crop yield and soil health was compared with IFFCO nano urea, a completely organic source of N *i.e.*, vermicompost and a laboratory synthesized formulation *i.e.*, nitrogen-nano clay polymer composite (N-NCPC) with 3 graded doses of N *i.e.*, 100, 75 and 50% of recommended dose of N (RDN). The exfoliation and intercalation of bentonite tectoids were confirmed by the disappearance of characteristic XRD peak of bentonite (2? = 7.136^0) after its incorporation in the polymer matrix which acts as diffusion barrier to the release of N. The mineralizable N content in the post-harvest soil was found to be highest in the N-NCPC (100% RDN) treated soil (205.30 kg ha^{-1}) which was significantly higher than the NCU treated soil. Similar result was also found in case of nitrate (69.74 mg kg^{-1}) and ammonium- N (40.06 mg kg^{-1}) also. Study on various soil N fractions revealed that the N-NCPC significantly increased the hydrolysable ammoniacal-N, amino acid-N and amino sugar-N over other treatments. Moreover, it was also found that N-NCPC significantly increased the DHA (Dehydrogenase), AP (Acid phosphatase), AlP (Alkaline phosphatase) and Urease activity over NCU and its effect in promoting the soil enzymatic activities was statistically at par with vermicompost. Maximum grain N content (1.51%) was found in 100% N-NCPC followed by 75% and 50% respectively. Highest apparent N recovery (ANR) was observed in case of N-NCPC @ 50% RDN (74.44%) followed by IFFCO nano urea (71.49%) and N-NCPC @ 75% RDN (50.92%). However, these N-nano formulations need to be evaluated under long term experiment involving diverse types of soil, cropping system and agroclimatic conditions.

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Impact of Bio-fertilizers on Soil Physico-chemical Properties, Nutrient Availability and Leaf Nutrition of Banana (*Musa* spp.) cv. Grand Naine

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The research trial was carried out at Banana Research Station, Nanded (M.S.), VNMKV, Parbhnai, India during 2019-20 to 2021-21 to find out the effect of biofertilizers on soil physico-chemical properties, nutrient availability and leaf nutrition of banana (*Musa* spp.) cv. Grand Naine. The experiment was planned in randomized block design with nine treatments *i.e.* T_1 - 100% RDF (Control), T_2 - 75% RDF + Soil application of *Trichoderma harzianum* , T_3 - 75% RDF + Soil application of *Azospirillum*, T_4 - 75% RDF + Soil application of PSB, T_5 - 75% RDF + Soil application of *Trichoderma harzianum* + *Azospirillum* + PSB, T_6 - 100% RDF + Soil application of *Trichoderma harzianum,* T_7 - 100% RDF + Soil application of *Azospirillum,* T_8 - 100% RDF + Soil application of PSB and T_9 - 100% RDF + Soil application of *Trichoderma harzianum* + *Azospirillum* + PSB which replicated three times. Soil pH, EC, organic carbon and calcium carbonate content were improved due to application 100% RDF + Soil application of *Trichoderma harzianum@25 g plant^{-1}* + *Azospirillum@25 g plant^{-1}* + PSB*@25 g plant^{-1}*. Soil pH and calcium carbonate content were not reached to the level of significance due to application of different treatments. However, electrical conductivity of soil found safe in limit while, the highest organic carbon content available N, P, K, DTPA-Fe, Zn, Cu and Mn were recorded maximum with application 100% RDF + Soil application of *Trichoderma harzianum@25 g plant^{-1}* + *Azospirillum@25 g plant^{-1}* + PSB*@25 g plant^{-1}*. Highest N, P, K, Fe, Zn, Cu and Mn leaf nutrient content of banana were also observed with the same treatment during both the years of experimentation.

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Nutrient Status and Nutrient Index of Different Land Use System in Dharni Tehsil of Melghat Region in Amravati District of Central India

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A detailed soil survey was carried out at tribal area in Dharni tehsil of Melghat region during the year 2017-2019 to study the nutrient status and nutrient index of different land use system. The study covered whole tribal area of Melghat region in central India to identified different landform units to understand the soil heterogeneity as well as the present land use. Twenty-four (24) representative soil profiles were selected for sampling and analyzed for pH, Electrical conductivity, Organic carbon, available nitrogen, phosphorous and potassium and available micronutrient (Zn, Mn, Fe and Cu) as per standard methods. The soils were neutral to moderately alkaline in nature and free from soluble salts hazards. The results indicated that the soils are medium in organic carbon. Nutritionally, soils in this high rainfall region showed lower content of available N and P and higher in available K, however, medium to higher in available micronutrient status *viz*. Fe, Mn, Zn and Cu. Nutrient index values showed that available N and P were in low category, OC, $CaCO_3$, available Zn and Fe were moderately high, available Mn was in higher category, however, available K and Cu were very high in nutrient index values in Dharni Tehsil. Thus, there is need of proper land use according to capability of land by identifying the constraints for the production of available land. In order to use the land resources optimally on sustainable basis and also adaptation of management practice for increasing the fertility of soil.

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Organic Carbon Dynamics in Soil Amended with different Sources of Organic Manures

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Soil organic carbon and its fractions is widely considered as the most significant parameter for soil health and soil quality. Mineralization of organic carbon in soil is one of the decisive factor in release of nutrients in the soil and govern soil fertility. In present study, carbon mineralization pattern was observed in soil treated with different organic manure sources and change in the organic carbon fractions during mineralization recorded in a three-month incubation study. A consistent temporal trend of increasing carbon mineralization was observed throughout the study. Notably, soil amended with poultry manure (T4) exhibits the highest overall mineralization throughout the study (94.69 mg CO_2/ 100 g soil), while soil amended with urea (T6) initially records the highest CO_2 evolution within the first week (72.23 mg CO_2/100 g soil) which reduced to minimum comparison to other treatments at the end of the incubation period. The very labile carbon fraction initially decreased until 30 days and then increased. This fraction was highest in soil amended with urea (0.268%) initially however, at the end of incubation period (90th day), soil amended with FYM (0.205%) had the highest content of very labile pool of carbon The labile carbon fraction demonstrates a consistent increase throughout the incubation period. Contrasting trends are observed for the passive pool (less labile carbon fraction and recalcitrant fraction) which showed a declining trend during the incubation period. Mustard oil cake amended soil (T7) consistently holds the highest overall less labile carbon and recalcitrant carbon content, with 0.161% and 0.105%, respectively. This study emphasized the dynamic nature of carbon mineralization and its fractions influenced by diverse organic manure sources, offering insights into soil carbon sequestration processes and the potential implications for sustainable agriculture practices.

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Effect of Long-term Application of FYM and Fertilizer Nitrogen on Aggregate Bound Organic Carbon and Nitrogen

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The present investigation entitled as "Soil aggregation and organic carbon and nitrogen dynamics in long-term FYM amended soil" focused on analyzing the impact of application of FYM and fertilizer nitrogen on aggregate bound organic carbon and nitrogen fractions which was initiated in 1967 at Research Farm, Department of Soil Science, CCSHAU, Hisar. The experiment was laid out in split plot design having 7 FYM levels in main plot, 2 N levels in sub plot and 2 aggregate size class in sub-sub plot treatments. The mean value of soil organic carbon in macroaggregates increased from 0.54 to 2% and in microaggregates increased from 0.5 to 1.92% soil with increasing doses of FYM from F0 to F15+F15. Similarly total organic carbon of macroaggregates and microaggregates increased from 1.83 to 1.92% and 1.75 to 1.82% respectively with increasing doses of fertilizer nitrogen from 0 to 120 kg ha^{-1}. With the increase in FYM levels, all the fractions were found to be significantly highest under FYM @ 15 t ha^{-1} in both seasons with nitrogen @ 120 kg ha^{-1}. The aggregate bound nitrogen also shows the similar trends as like aggregate bound organic carbon. The highest amount of available nitrogen and total nitrogen found in the treatment in which application of 15 t ha^{-1} FYM in both season with nitrogen @ 120 kg ha^{-1}.

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Impact of Land Use Practices on Vertical Changes in Soil Properties of Kymore Plateau and Satpura Hills Zone of Madhya Pradesh

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Soil properties are key indicators of land uses of any region and directly altered by management practices. Land use practices significantly influence the soil properties at temporal and spatial scales. However, conversion of natural ecosystems into anthropogenically driven systems without considering potential management practices and adoption of suitable land uses may results rapid changes in soil properties. Hence, adoption of appropriate land uses would help in minimizing degradation in soil quality and ensure sustainability. An attempt has been made during 2021-22 at JNKVV, Jabalpur to assess the changes in soil properties under nine contrast land uses (uncultivated, rice-wheat, soybean-wheat, perennial forage, forest, mango, aonla, citrus and guava orchards) at three soil depths (0-20, 20-40 and 40-60 cm), which had been replicated thrice arranged in RBD. Results highlighted that land uses significantly altered the properties of soil across the depths. Soil parameters (EC, OC, exchangeable Ca and Mg, available S, Zn, Fe, Mn, Cu and B) were decreased with increase in depths, while pH was increased. Highest values of pH, EC and OC at respective depths were obtained under perennial forage, rice-wheat and forest, and lowest in forest land, citrus orchard and rice-wheat system, respectively. However, maximum exchangeable Ca, Mg and available S were obtained under forest and minimum in uncultivated land. Variability in available Zn, Fe, Mn, Cu and B of soil across depths were varied significantly under land uses with highest available Zn, Mn and Cu under guava orchard, while available Fe in citrus orchard and B in forest land. However, lowest available Zn, Fe, Mn, Cu and B at respective depths were obtained under uncultivated land, aonla, mango, aonla orchards and rice-wheat system, respectively. Present study concluded that land use practices significantly altered the properties of soil in Kymore Plateau and Satpura Hills zone of Central India.

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Effect of Nutrient and Crop Residue Incorporation on Yield and Soil Organic Carbon Pools on Soybean-linseed Cropping Sequence in Red and Lateritic Soil

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An investigation was carried out in the ongoing experiment started from the year 2017-18 to study the effect of nutrient and crop residue incorporation on yield and soil organic carbon pools on soybean-linseed cropping sequence in red and lateritic soil of Jharkhand in the year 2021-22. Ten treatment combinations comprising of inorganic fertilizers *viz.* urea, Diammonium phosphate (DAP), Muriate of Potash (MOP) and Bentonite S, 25% P_2O_5 replacement by crop residue and *Trichoderma viride* were laid down in the field. The highest grain yield both in case of soybean and linseed were recorded with 100% RDF (25% P_2O_5 as residue incorporation + 75% Basal) and *Trichoderma viride* with value of 24.40 q ha^{-1} in case of soybean and 18.10 q ha^{-1} in case of linseed respectively, while in case of straw yield the same trend was observed with the highest value of 44.90 q ha^{-1} in case of soybean and 36 q ha^{-1} in case of linseed respectively. Among different pools of soil organic carbon the highest value of very labile carbon (VLC) was associated with 100% RDF-25% P_2O_5 as residue incorporation + 75% Basal and *Trichoderma viride* (0.57 g C kg^{-1}) while the lowest value was associated with treatment having 75% RDF(0.2917 g C $kg^{-1)}$ and rest other treatments with 100% RDF (25% P_2O_5 as residue incorporation + 75% Basal) and *Trichoderma viride,* 100% RDF+ *Trichoderma viride*, 100% RDF (25% P_2O_5 as residue incorporation + 75% Basal) and the treatment containing only crop residues were at par with each other. In case of labile carbon (LC) the highest value was associated with only crop residue @ 5 t ha^{-1} in both seasons while the lowest value with 100% RDF (0.0473 g C kg^{-1}). The highest value of less labile carbon (LLC) with 100% RDF-25% P_2O_5 as residue incorporation + 75% Basal (0.106 g C kg^{-1}) which was at par with 100% RDF (25% P_2O_5 as residue incorporation + 75% Basal) and *Trichoderma viride.* Thus it can be concluded that incorporation of crop residue contributes in increasing the status of labile carbon in the soil.

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Effect of Soil Application of Jivamrut, Arka Microbial Consortium and 19-ALL (NPK) on Teasel Gourd Growth and Yield

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Field experiments were conducted by growing teasel gourd cv. Arka Bharath at experimental farm of Central Horticultural Experiment Station, Chettalli for two consecutive years (2021-22 and 2022-23) to study impact on plant growth, yield, nutrient uptake and soil health by soil application of NPK (19 ALL), Jivamrut and Arka Microbial Consortium (AMC) alone and in combinations. 1. NPK (19 ALL- 2 g plant^{-1}); 2. Jivamrut (0.5 L plant^{-1}); 3. AMC (10 g plant^{-1}); 4. NPK + Jivamrut; 5. NPK + AMC; 6. Jivamrut + AMC; and 7. NPK + Jivamrut + AMC were the treatments. All these treatments were replicated thrice adopting Randomized Block Design (RBD). These treatments were imposed to plants 20 days after planting at 15 days interval over 12 times, through soil drenching. The NPK and the AMC were mixed in 500 ml water separately and applied. Apart from this 5 kg FYM and 1 kg neem cake was applied 10 days before planting on the bed of 1 m length as basal dose and mixed well with soil. The results revealed that significant increase in number of fruits, yield, and DMY per plant was observed in Jivamrut + AMC (pooled mean 71.5, 4.99 kg and 1.82 kg) and AMC+NPK (pooled mean 68.3, 4.84 kg and 1.78 kg) than that of other treatments. Total uptake of N, P, K, Mg, S, Fe, Cu and Zn was also significantly higher in Jivamrut+AMC treated plants. Soil health parameters particularly SOC and available nutrients (N, K, Ca, Mg, Fe and Zn) were also significantly improved in this treatment. To sum up, soil application of Jivamrut plus AMC improved plant growth, productivity, nutrient uptake and soil health in teasel gourd. Thus teasel gourd can be cultivated organically by addition of FYM and neem cake as basal with periodical soil drenching of Jivamrut plus AMC. Farmers could benefit by higher remuneration, sustainable production and higher income through adoption of organic method of teasel gourd cultivation.

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Soil Test Crop Response Studies for Yield Targeting Equation for Onion with Vermicompost and Biofertilizers

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Soil Test Crop Response Study was conducted to formulate the yield target equations for Onion *cv.* N-2-4-1 under integrated plant nutrition system (IPNS) on Inceptisol at research farm of STCR, Soil Science, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2021-22. Fertilizer adjustment equations under IPNS were formulated for onion with vermicompost and biofertilizers (*Azotobacter* and Phosphate solubilising bacteria as seedlings treatment) by following Ramamoorthy's inductive cum targeted yield model. The nutrients requirement to produce one tonne yield of onion were 0.39, 0.05 and 0.28 kg ha^{-1} N, P_2O_5 and K_2O, respectively. The per cent contribution from soil for Nitrogen, Phosphorus and Potassium were 31, 43, and 11 respectively. The contribution of fertilizer nutrients in absence and presence of vermicompost were 60.5 and 39.6 per cent for Nitrogen, 14 and 18.8 per cent for Phosphorus and 73.3 and 52.9 per cent for Potassium, respectively. The per cent contribution of vermicompost along with biofertilizer were 53, 25.8 and 75.5 per cent for Nitrogen, Phosphorus and Potassium, respectively. The fertilizer prescription equations developed for Onion with the aim yield target of about 300 to 350 q ha^{-1}by using above basic data.

Fertilizer prescription equations are as below.

i) Without vermicompost
$FN = (0.83 \times T) – (0.65 \times SN)$
$FP_2O_5 = (0.41 \times T) – (3.21 \times SP)$
$FK_2O = (0.45 \times T) – (0.18 \times SK)$

ii) With vermicompost
$FN = (0.65 \times T) – (0.51 \times SN – 3.28\ Vc)$
$FP_2O_5 = (0.41 \times T) – (3.06 \times SP – 4.02\ Vc)$
$FK_2O = (0.38 \times T) – (0.15 \times SK – 4.33\ Vc)$

iii) With vermicompost alongwith biofertilizer
$FN = (0.63 \times T)$ - $(0.49 \times SN – 4.26\ Vc)$
$FP_2O_5 = (0.27 \times T)$ - $(2.13 \times SP – 3.85\ Vc)$
$FK_2O = (0.36 \times T)$ - $(0.15 \times SK – 5.88\ Vc)$

Where, FN, FP_2O_5 and K_2O is fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, T is yield target (q ha^{-1}) and SN,SP and SK are soil available N,P and K in kg ha^{-1} and Vc is Vermicompost in tha^{-1} (Fresh weight basis)

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Effect of Integrated Nutrient Management on Growth and Yield of Lablab Bean (*Lablab purpureus* L.) and Soil Properties in Alfisols

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A field experiment was conducted during *rabi*, 2019-20 to study the, "Effect of integrated nutrient management on growth and yield of Lablab bean (*Lablab purpureus*) and soil properties in Alfisols" at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The experiment was laid out in Randomized Block Design (RBD) comprising sixteen treatments replicated thrice. The effect of different inorganic fertilizers alone (Urea and SSP) or in combination with organic manures (Farm yard manure, vermicompost and poultry manure) and Biofertilizers (Rhizobium and PSB) on chemical properties of the soil, growth, yield, quality and nutrient content of lablab bean (var. Dapoli-2) were studied. The chemical properties *viz.*, Soil reaction, electrical conductivity and organic carbon content of soil did not show a significant change in their status. However, available macronutrients (N, P_2O_5, K_2O,) and micronutrient (Fe, Mn, Zn, Cu) status showed significant improvement as a consequence of various treatment combinations. The application of equal integration of recommended dose of nutrients through inorganics and through organics, either through poultry manure or vermicompost with or without bio-inoculations significantly increased the macro (N, P_2O_5, K_2O,) as well as micro nutrients (Fe, Mn, Zn, Cu) status of soil, enhanced the nodulation, yield (seed an stover yield) and quality (protein and chlorophyll) of lablab bean crop. Considering the yield response, nutrient content in the plant of lablab bean and build-up of soil fertility, the application of 50 per cent RDN + 50 per cent RDN through poultry manure with or without bio-inoculation was found suitable for the cultivating lablab bean in lateritic soil of Konkan. Integration is a need of future for sustaining soil fertility and maximising yield of lablab bean.

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Effect of Crop Residues and Fertilizer Management on Humus Fractions, Soil Properties and Yield of Rice in Alfisol

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An experiment was conducted during kharif, 2019-20 at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, to study the "Effect of crop residues and fertilizer management on humus fractions, soil properties and yield of rice in Alfisol". The study was taken on ex-situ incorporation of crop residue along with fertilizers in soil with an objectives *viz.* 1) To study the effect of crop residues and fertilizer management on humus fraction and soil properties 2) To study the effect of crop residues and fertilizer management on growth and yield of rice, and 3) To study the effect of crop residues and fertilizer management on nutrient content and uptake by rice in Alfisol. The experiment was laid out in 12 treatments and 3 replications at crop residue and fertilizer levels and were framed in strip plot design. The treatments consisting at two levels *viz.* 1) Crop residue [C_1 - Rice straw @ 5t ha^{-1}, C_2 - Ain leaf residues @ 5 t ha^{-1}, C_3-Rice straw @ 2.5 t ha^{-1} + Ain leaf residues @ 2.5 t ha^{-1} and C_4 - Control (Without residue)], and 2) Fertilizer levels (F_1 - 100% NPK, F_2 - 75% NPK and F_3 - 50% NPK). The results emerged out indicated that the application of rice straw @ 2.5 t ha^{-1} + ain leaf residue @ 2.5 t ha^{-1} along with 100% NPK was found to be significantly beneficial for improving humus fractions, soil properties, nutrient uptake, nutrient balance, yield and economics of rice in Alfisol. Application of 50%, 75% and 100% NPK alone was not gained optimum humus content in soil, nutrient status of soil and yield of rice because of unbalance use of fertilizers. However, incorporation of C2 along with F1 were found to be at par in most of the treatments than other treatment combinations.

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Balance Application of Chemical Fertilizers Enhances Soil Health and Sustain the Yield of Soybean (*Glycine max* L.) Safflower (*Carthamus tinctorious*) Cropping Sequence in Vertisol

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Balance application of chemical fertilizers in long term fertilizer experiments of Soybean (*Glycine max* L.) and Safflower (*Carthamus tinctorious*) cropping sequence after 18th cycle of experimentation during the year 2021-22. The study encircles different levels of optimum fertilizer rate (30, 60, 30 kg ha^{-1} and 60: 40: 00 k ha^{-1} N, P and K, respectively) for soybean and safflower. The treatments were 50% NPK, 100%NPK, 150% NPK, 100% NPK + (HW), 100% NPK + Zinc, 100%NP, 100%N, 100%NPK+ 5 t ha^{-1} FYM t ha^{-1}, 100% NPK-S and absolute control. The results were emerged out due to balance application of chemical fertilizers stated that grain and straw yield of soybean and safflower and sustainable yield index were recorded significantly highest by application of 100% NPK + FYM @ 5-ton ha^{-1} followed by 150% NPK and 100% NPK + zinc than imbalance use of inorganic fertilizers. However, the physico-chemical, soil biological properties and enzyme activities in soil were improved by application of 100% NPK + FYM @ 5 t ha^{-1} and only FYM @ 10 t ha^{-1} at harvest of safflower over imbalance use of chemical fertilizers. Similarly, soil quality index was also differed significantly due to balance application of chemical fertilizers along with manures under long term fertilizer experiments.

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Effect of Chemical Composition of Plant Residues on Nitrogen Mineralization

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Nitrogen mineralization is a biochemical process and vital part of soil fertility, it is the process by which organic nitrogen (N) is converted to plant available inorganic forms. Application of plant residues as soil amendment may represent a valuable recycling strategy that affects nitrogen (N) cycling in soil-plant (rhizosphere) systems. Different plant species have various chemical constituents and compositions in their respective parts (shoots, leaves, barks and roots etc.) and their decomposition rate varies from fast to slow decomposing components. The amount and rate of nutrient release from plant residues depend on their quality characteristics and biochemical composition which directly affects nitrogen mineralization process. Chemical composition of plant residues mainly contains: Sugars and Starches, Proteins, Hemicellulose and Cellulose, Fats, Waxes, resins and Lignin's. Plant residues showing greater concentration of sugars, starch and cellulose followed by rapid mineralization and can be used for early N demands of a crop, while residues with high C:N ratio and lignin contents immobilize N for longer time. High quality residues (*Sesbania sesban*, *liricidia sepium*, *Glycine max* and *Leucaena leucocephala*) with high N, sugars, cellulose content and low lignin, C:N ratio (<20:1) and polyphenol concentrations, released N rapidly. Residues of intermediate quality (*Azadirachta indica*, *Trifolium repens* and *Calanus cajan*) immobilized N for some time and released it later. Use of such high-quality plant residues in our cropping systems, especially in the regions subjected to land degradation or facing the threat of deterioration may be a useful management strategy to restore these soils for agriculture production.

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Impact of Nitrogen and FYM Levels on the Growth and Yield of Barley (*Hordium vulgare* L.)

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Barley (*Hordium vulgare* L.) belongs to the gross family is the fourth most important cereal crop in the world after rice, wheat and maize and is a drought resistant and tropical crop. It is used mainly as a human food and animal feed. Only a small portion of the produce is utilized in industry for malting, brewing and pearling and baby food. Major barley growing states in India are Uttar Pradesh, Rajasthan, Punjab, Haryana, M.P., H.P., Bihar, Uttrakhand, Jharkhand and Jammu and Kashimir. Uttar Pradesh is the leading producer of barley in the country. The state accounts for 36.65% of total area and 40.11% of the total production of barley in India. The present field experiment was conducted during rabi season of 2016-2017 at the Agriculture Research Farm of the department of Agricultural Chemistry and Soil Science, R.B.S. College, Agra, U.P., India, with 12 treatment combination consisting of four nitrogen levels (0, 40, 80 and 100 kg ha^{-1}) and three levels of FYM (0, 5 and 10 t ha^{-1}) which were replicated thrice in Randomized Block Design. Results revealed that the application of nitrogen and FYM increased the growth parameters of barley significantly. The highest plant height, number of tillers $plant^{-1}$ and spike length of barley were recorded with the application of 100 kg N ha^{-1} and FYM @ 10 t ha^{-1}. Results further revealed an improvement in yield attributing characters with the increased level of nitrogen and FYM application. Higher value for number of grain $spike^{-1}$, test weight and yield of both grain and straw was recorded with application of nitrogen 100 kg ha^{-1} and FYM 10 t ha^{-1}.

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Impact of Nano Biofertiliser on Growth and Yield of Okra (*Abelmoschus esculentus* L.)

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Indiscriminate use of inorganic fertilizers leads to nutrient imbalance in soil causing adverse effect on soil health on long term basis. Hence it is imperative to apply part of plant nutrients through organic sources and bio fertilizers for sustainable soil health and crop production. One novel bio fertilizer product of Rashtriya Chemicals and Fertilizers Ltd., Mumbai (A GOI undertaking) named "Geola" was evaluated for its efficiency towards increasing crop yield and economizing the inputs through the field experiments conducted at Central farm of Agricultural College and Research Institute, Madurai during *rabi* season 2022 to assess the effect of chemical fertilizers along with bio fertilizer in terms of growth and yield of Bhendi CoH1. Among the different treatments, maximum plant height (94.17 cm), crop growth rate (21.49), pod weight (11.20g), girh of pod (5.86 cm) and yield ha^{-1} (35.4 t) were observed in treatment that received 75% RDF (200:100:100 kg NPK ha^{-1}) along with geola bio fertilizer as soil application @ 2g in 100 l of water twice as basal and at 60 days after sowing and foliar application @ 1g in 100 l water twice during flowering stage and at 10 days interval. However the seed treatment of geola @ 0.5g in 1 litre for seeds of one acre along with drenching of geola solution @ 2g in 100l before sowing and foliar application @2 g in 100 l at flowering and pre harvest stages registered higher uptake of N and K and BCR of 2.45. The study revealed the substitution of 25 percent NPK chemical fertilizer with novel biofertilizer products like geola which is eco friendly cost effective, easier to handle besides contributes to better availability and use efficiency of the applied nutrients.

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Nutrient Release Behavior from Seaweed Extract-based Products and their Effect on Crop Productivity and Soil Fertility

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Seaweed extracts-based products have emerged as a promising agricultural input in the new age concepts of regenerative farming. The current study used two seaweed extract-based products *i.e.*, seaweed extract-based *Sagarika* Z++ granules (SG) and *Sagarika* liquid (SL) (developed by IFFCO). The incubation experiment reported that the release of N, P and K were maximum in the treatment containing the highest SG application. The nutrient concentrations in the solution increased up to 384 h, followed by a decline. The slope of decline was maximum in the case of N release, followed by that of P and K. In addition to that, a sharp increase was obtained up to 24 h, followed by a decline in the rate of increment, with the aforesaid feature being more prominent in the nutrient release curves of N, as compared to that of P and K. The simplified Elovich equation was the best fit for describing N and K release, while the power function model was ideal for describing P release. The results of the greenhouse study stated that the application of 75% recommended NPK along with SG @ 10.67 mg kg^{-1} soil and SL @ 5 ml L^{-1} of water (75%NPK+SG(10.67)+SL(5)) showed prominent bio-stimulatory effects and prohibited the signs of nutrient stress in spite of the lesser application of fertilizer nutrients. The application of seaweed extract-based products promoted efficient use of fertilizer nutrients, and the treatments 75%NPK+SG (10.67) + SL(5) and 100% NPK reported similar yield and harvest index. In acidic soils, the application of SG showed an indication of an ameliorative effect, without any visible signs of nutrient mining. The organic nature of SG promoted soil microbiological growth and activities. Therefore, the application of SG @ 10.67 mg kg^{-1} soil and 2 sprays of SL @ 5 ml L^{-1} has the potential for reducing fertilizer NPK application by 25%.

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Effects of the Biochemical Composition of Crop Residues on the Kinetics of Carbon Mineralization

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In-depth knowledge of the decomposition behavior of different crop residues is a prerequisite for predicting the effect of different crop residue addition on soil organic carbon (C). In the present study, we tried to assess the effect of the biochemical composition of different kharif crop residues on C mineralization kinetics. The sesbania residues were rich in C, N, P and S, along with the lowest C/N ratio, and lignin content, which reflected in the highest values of plant residue quality indices (PRQI), followed by that under moong bean and pigeon pea. The cotton residues had the lowest PRQI. The crop residues with a high C content, accompanied by lower values of C/N ratio were most preferred by the microbes for the decomposition process. The minimum CO_2 evolution took place from the cotton residue, owing to the low N content, and respective high C/N ratio. A high amount of holocellulose contents in rice and maize contributed to the high value of C_{Labile} (model-derived labile C). On the other hand, high amounts of lignin and polyphenol in cotton residues contributed to the highest values of C_{Recal} (model-derived recalcitrant C). The non-limitation of C_{Labile} and K_{Labile} (decomposition rate constant of C_{Labile}) registered the highest C mineralization from the moong bean residue. The lower values of C_{Labile} limited the C mineralization from cotton residues. The low K_{Labile} limited C mineralization from the rice and maize residue, whereas the low K_{Recal} (decomposition rate constant of C_{Recal}) value limited C *mineralization* from cotton. The mean K_{Labile} and K_{Recal} were higher at 35 than that at 25°C. Higher mean values of C_{Labile} and lower values of C_{Recal} hinted at the potential conversion of a portion of the recalcitrant C fraction to the labile fraction at an elevated temperature, promoting microbial activity and higher C mineralization.

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Effect of Crop Residue Retention and Phosphate Fertilization on Phosphorus Buffering Capacity under Conservation Agriculture in Maize-Wheat based Cropping System

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The present investigation aims at refining P fertilizer recommendation based on buffering capacity of soils under conservation agriculture (CA) system. A field experiment on CA was started during 2013 in the research farm of ICAR-IARI, New Delhi. The experimental field was laid out as a split-plot design with four treatments of residues *viz.* No crop residue (CR), 2 ton ha^{-1} CR, 4 ton ha^{-1} CR and 6 ton ha^{-1} CR as main-plots and five combinations of P treatments *i.e.* No P fertilizer, 50% of recommended dose of P (RDP), 100% RDP, 150% RDP and 50% RDP + arbuscular mycorrhizae (AM) + P solubilizing bacteria (PSB) as sub-plots. During 2018, representative soil samples were collected from the top most 0-5 cm depth from each plots. Phosphorus adsorption isotherms were obtained by fitting the adsorption data into Langmuir, Freundlich and Temkin equations. Accordingly, results showed that Langmuir's maximum P buffering capacity (MPBC) was found to be least under soil receiving 4 ton ha^{-1} CR (46.3 ml kg^{-1}) as compared to No CR (91 ml kg^{-1}). While, as a result of phosphate fertilization, 50% RDP+AM+PSB was found to be least buffered having lowest MPBC (46.1 ml kg^{-1}). Freundlich adsorption isotherm constants '1/n' and 'a' also showed variability in differentially treated plots as a result of CR retention and phosphate fertilization. In general, the desorption and availability of P was improved under a higher residue retention rate and 150% RDP, that was slightly less than or at par with 50% RDP+AM+PSB. Hence, CR retention of 4 ton ha^{-1} along with 50% RDP supplemented with AM and PSB is recommended and found to be beneficial in enhancing soil P availability as well as helps in reducing P fertilizer rate in sandy loam soils under CA based cropping system.

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Response of Cotton based Intercropping Systems on Cotton Productivity and Soil Health under Rainfed Vertisol

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The integrated use of organic along with chemical fertilizers and also only use of organic is a promising approach in preserving soil biological activities, which will ultimately show positive impacts on different soil physicochemical properties and nutrient uptake by cotton crop. In this regard the, the present investigation was conducted at Research Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, during year 2017-18 and 2018-19. The experiment was laid out in split plot design with three replications. The main plot treatments comprised of nutrient management *viz.*, INM (75 % RDF + compensation through NPS compost) and Organic (100 % NPK dose through NPS compost). Sub plot treatments consisted of cotton based intercropping systems *viz.*, Cotton + dhaincha (1:1), Cotton + sunhemp (1:1), Cotton + greengram (1:1), Cotton + blackgram (1:1) and Sole cotton. Results revealed that, the use of 75% RDF + compensation through NPS compost recorded highest cotton yield and improved the soil physical, chemical and biological properties. Build up of the total organic carbon, soil carbon pools and carbon pools indices *viz.* Lability of SOC, LI, CPI and CMI was recorded with the adoption of INM (75% RDF + NPS compost) and Organic (100 % NPK dose through NPS compost) with intercropping of cotton + dhaincha (1:1) which was at par with cotton + sunhump (1:1) followed by cotton + greengram (1:1) and cotton + blackgram (1:1) as compared with sole cotton. The magnitude of various carbon pools in respective of the treatments were in order non labile > very labile > less labile > labile, indicating dominance of non labile portion of carbon pools in Vertisol. Percent contribution of active pools recorded more under cotton + dhaincha (1:1), followed by cotton + sunhump, grain legume intercropping systems as compared with sole cotton.

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An Incubation Study with Zeolite and Rock Phosphate on P Availability in Rainfed Alfisols

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Phosphorus is a next key nutrient after nitrogen. Application of water-soluble P fertilizers is costly. The cost can be reduced with use of loW-grade rock phosphate. Yet, its use is limited due to poor dissolution rate. Thus, the effect of zeolite on improving soil available P content from rock phosphate (RP) in rainfed Alfisols was investigated in a laboratory incubation study. For this purpose, two sources of rock phosphate-Hirapur rock phosphate (HRP) and Udaipur rock phosphate (URP) was collected from Chhatarpur, Madhya Pradesh and Udaipur Rajasthan respectively. During incubation study. HRP and URP was amended with different rates of zeolite (5.10, and 20%) along with two different rates of RP@sgkg soil and 10 g kg^{-1} soil respectively. The treatments were arranged in three replicates using a completely randomized block design. The treatments were incubated for a period of 105 days with moisture level maintained at field capacity. During the study, soil samples were collected with an interval of 10 days and analysed for soil available P content by ascorbic acid blue colour method. The soil available P increased with zeolite addition compared to RP alone. The extent of dissolution is high with increase in zeolite dose. In comparison to HRP, URP performed better in maintaining soil available P. Also, when compared the two rates of RP (5 g kg^{-1} soil and 10 g kg^{-1} soil), 10 g kg^{-1} soil performed well. This study clearly shows that zeolite addition improved the P dissolution in rock phosphate.

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Influenced of Different Slow Release and Controlled Release Fertilizers on Nutrient Release Pattern and Nutrient Use Efficiency as in Soybean

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The pot culture experiment was conducted at Department of Soil Science and Agril. Chemistry, College of Agriculture, VNMKV, Parbhani during *kharif*- 2019 to study the response of soybean to individual slow release and controlled release fertilizers and periodical nutrient release. The pot culture experiments was conducted in CRD with three replications nine treatment combinations *viz;* absolute control, CDU, SCU, Karanj oil coated DAP, Polymer coated DAP, WDG-S, Bentonite S, RDF (SCU + Karanj oil coated DAP + Bentonite sulphur), RDF (CDU + Polymer coated DAP + WDG of Sulphur). The yield and yield attributes were significantly influenced in pot culture experiment with soybean due to different treatments. The significantly highest seed and straw yield, number of seeds per plant, test weight and oil content was recorded in the treatment with RDF through CDU + Polymer coated DAP + WDG of sulphur. The significantly highest seed protein content of soybean was recorded in the treatment with application of CDU (T_2). The treatment RDF through CDU + Polymer coated DAP + WDG of sulphur recorded significantly highest total nutrient uptake (N, P, K and S) and micronutrient uptake (Fe, Mn, Zn and Cu) in soybean at harvest. The effect of different slow release and controlled fertilizers on soil pH, EC and $CaCO_3$ content was found non significant at harvest of soybean. There was increase in organic carbon content in all the treatments over the initial values. The significantly highest soil available nitrogen was observed at 40 DAS and at harvest in the treatment RDF through SCU + Karanj oil coated DAP + Bentonite sulphur. However, the significantly highest soil available nitrogen was observed at 60 DAS and 80 DAS in the treatment RDF through CDU + Polymer coated DAP + WDG of sulphur. The treatment RDF through SCU + Karanj oil coated DAP + Bentonite sulphur recorded significantly highest soil available phosphorus at 40 DAS whereas, significantly highest soil available phosphorus was recorded at 60 DAS, 80 DAS and at harvest in the treatment RDF through CDU + Polymer coated DAP + WDG of sulphur (T_9). Soil available potassium was non significant at 40 DAS, 80 DAS and at harvest. The availability of sulphur was increased up to 60 DAS and thereafter decreased slightly at harvest in all the treatments. The results of soil available micronutrients (Fe, Zn, Mn and Cu) were found non significant at harvest of soybean. The highest partial factor productivity (PFP), agronomic efficiency (AE) and apparent nutrient recovery (ANR) for nitrogen was recorded in CDU (T_2). The highest PFP, AE and ANR for phosphorus was recorded in polymer coated DAP treatment (T_5). The highest PFP, AE and ANR for sulphur in Bentonite sulphur treatment (T_7).

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Identification of Compatible Water Soluble Salts for Efficient Foliar Application

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A new era of modern agriculture requires innovative approach and immediate results. The nutrient management is a concept where soil application was the only practice but since last two centuries foliar sprays for supplying additional nutrients has been widely employed. The foliar spray is used for the supplementation of nutrients and immediate response to overcome deficiency of specific nutrient. It is possible only when we are assured to supply the nutrients in soluble form through foliar application. The nutrient salts compatibility is an important factor in increasing efficiency of foliar applied nutrients. A laboratory study was conducted to check the compatibility of different water soluble salts. More than 100 combinations of different sources of macro as well as micronutrients like potassium nitrate, urea, phosphoric acid, sulphate of potash, borax and many more present in the market were used. The results showed that combination of calcium nitrate with monoammonium phosphate and potassium sulphate leads to the precipitation of calcium phosphate and calcium sulphate compounds. Further, it was also observed that the borax is not compatible with the copper sulphate and zinc sulphate. This study concludes that, neither phosphoric nor sulphatic salts are compatible with salts containing calcium.

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Effect of different Slow Release and Controlled Release Fertilizers on Soybean

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The field experiments were conducted at research farm, Department of Soil Science and Agril. Chemistry, College of Agriculture, VNMKV, Parbhani during *kharif*- 2019 and 2020 to study the response of soybean to different slow release and controlled release fertilizers on Vertisols. The field experiments were conducted in RBD with four replications and ten treatment combinations. The treatment consisted of absolute control, recommended dose of fertilizers through conventional fertilizers (urea, DAP, MOP and elemental S) and combinations of slow release and controlled release fertilizers (CDU, SCU, Polymer coated DAP, Karanj oil coated DAP, Bentonite S and WDG-S) along with FYM. The seed and straw yield of soybean was recorded significantly highest in the treatment with RDF through CDU + Polymer coated DAP + Bentonite sulphur. The total nitrogen, phosphorus, potassium, sulphur uptake and micronutrient uptake (Fe, Mn, Zn and Cu) was recorded higher in the treatment RDF through CDU + Polymer coated DAP + Bentonite sulphur. The soil pH, EC and $CaCO_3$ was not influenced significantly due to different slow release and controlled release fertilizers. The treatment RDF through CDU + Polymer coated DAP + Bentonite sulphur recorded significantly highest soil OC content. The significantly highest soil available N was found in the treatment RDF through SCU + Polymer coated DAP + WDG of sulphur. The RDF through CDU + Polymer coated DAP + Bentonite sulphur recorded the significantly highest soil available phosphorus and soil available sulphur. The effect of different slow release and controlled release fertilizers on soil available potassium was found non significant. The significantly highest GMR, NMR and B:C ratio was reported in the treatment RDF through CDU + Polymer coated DAP + Bentonite sulphur. Net soil available nitrogen balance was found positive in all the slow release and controlled release fertilizer treatments except RDF and absolute control treatments. Soil available phosphorus balance was positive recorded in all the treatment except in absolute control treatment. The maximum net positive balance of soil available potassium was found in the RDF treatment. Soil available sulphur balance was positive in all the slow release and controlled release fertilizer treatments over initial soil available sulphur. The significantly highest soil bacterial count, actinomycetes count was found in RDF through CDU + Polymer coated DAP + Bentonite sulphur however, treatment RDF through CDU + Polymer coated DAP + WDG of sulphur had recorded significantly highest fungal count. Thus, based on the results, application of CDU (20 kg ha^{-1}), Polymer coated DAP (130 kg ha^{-1}), Muriate of potash (50 kg ha^{-1}) and Bentonite coated sulphur (22 kg ha^{-1}) along with rhizophos 5 ml kg^{-1} seed, 5 t ha^{-1} FYM and micronutrients as per soil test is recommended for higher yields, improvement in soil fertility and economic returns in soybean production. These fertilizers are cost effective and easy to procure.

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Effect of Jeevamrutha Microbial Culture along with Organic and Inorganic Nutrient Sources on Yield and Nutrient Uptake by Chickpea

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Jeevamrutha is a low cost microbial culture, prepared especially from dung and urine of Indian cow is generally advocated for use in organic agriculture to promotes immense biological activity in soil and meets the nutritional requirement of crops. Laboratory studies and field experiment were carried out on chickpea crop in *Rabi* season of 2020-21 on Typic Haplusters at Research Farm of Department of Soil Science and Agricultural Chemistry, VNMKV, Parbhani to evaluate the nutrient content and microbial composition of Jeevamrutha prepared from different animal breeds and it's effect along with organic and inorganic nutrient source on yield and nutrient uptake by Chickpea crop. The field experiment was planned in a factorial randomised block design with twelve treatments and three replications. The experimental soil was clay in texture, slightly alkaline in reaction, low in nitrogen and phosphorus, very high in potassium, sufficient in Sulphur, copper, manganese and deficient in zinc and iron. Result of lab experiment indicated that microbial and chemical compositions were relatively higher in Jeevamrutha prepared from dung and urine of Indian cow followed by that of buffalo and hybrid cow. Further results of field experiment revealed that the application of 100% RDF + Jeevamrutha soil and foliar application significantly enhanced growth, yield and quality parameters of chickpea. The highest seed and straw yield was obtained with application 100% RDF + Jeevamrutha (soil and foliar application) followed by RDN through vermicompost + Jeevamrutha (soil and foliar application) and lowest seed and straw yield was recorded in absolute control. Combination of organic formulation (Jeevamrutha) and balanced chemical fertilizers, enhances the productivity of chickpea. The nutrient uptake of chickpea was significantly enhanced with application of chemical fertilizer, organic manures and Jeevamrutha. Application of 100% RDF + Jeevamrutha soil and foliar application showed highest value of N, P, K, Fe, Mn, Zn and Cu uptake in seed straw and total uptake followed by RDN through vermicompost along with Jeevamrutha soil + foliar application. Whereas lowest value was recorded in absolute control.

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Effect of Engineered Nano-titanium Dioxide Polymorphs Spraying on Nitrate Reductase Activity of French Bean (*Phaseolus vulgaris* L.) in an Inceptisol of Varanasi, Uttar Pradesh, India

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Nanotechnology is the understanding and manipulation of materials on molecular, atomic, or at subatomic level. Nanomaterials have a size between 1 to 100 nm. Titanium (Ti) has been considered as a beneficial element for plant growth. Titanium dioxide (TiO_2), which is being used in our daily life has emerged as an excellent photocatalyst. In this study, a pot experiment was performed to assess the effect of engineered nano-TiO_2 polymorphs *i.e.* anatase (14 nm) and rutile (52 nm) application on Nitrate Reductase (NR) activity of french bean (*Phaseolus vulgaris* L.) in an Inceptisol of Varanasi, Uttar Pradesh. The present investigation was carried out in net house where suspension of six different concentrations (in water) of sol-gel method lab synthesized nano-TiO_2 polymorphs *i.e.* anatase and rutile (0, 0.01, 0.02, 0.03, 0.04 & 0.05% respectively) were sprayed twice *viz*. during vegetative stage (28 days after sowing) & reproductive stage (57 days after sowing). The NR activity was assessed during three different stages of crop growth *i.e.* at 45, 60 and 90 days after sowing. The findings of our experiment indicated that the NR activity was significantly higher at 0.04% concentration of both anatase and rutile treated plants than the control. As nitrate is the prime source of N in fertilized soils, the reaction following reduction of nitrate to nitrite and then ammonia is crucial for the production of protein in most crop plants. Most importantly, the reaction for the conversion of nitrate to nitrite is a redox reaction, it is relatable that nano-TiO_2 which produces strong oxidizing agents should influence the activity of NR. Thus, nano-TiO_2 application to crop can improve crop yield together with quality produce.

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Elevated Temperature Affects Soil–Plant Phosphorus Dynamics and Yield of Chickpea (*Cicer arietinum* L.)

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The impacts of high temperature-mediated changes in soil-plant systems are crucial in sustaining the productivity of heat-sensitive crops like chickpea. Presently, the impacts of high temperature environment on soil processes and crop nutrition (particularly P) are uncertain in tropical alkaline soils. Therefore, an open-top chamber-based experiment with ambient temperature [a(Temp)] and elevated temperature [e(Temp)] (+2°C over ambient) aimed to investigate the impacts of high temperature environment on plant physiology, soil-plant P dynamics, and yield of chickpea in a moderately-alkaline Vertisol of sub-tropical India. The e(Temp) reduced Olsen-P (available-P) and $NaHCO_3$-Pi at the flowering stage by 12% and 32% respectively, as compared to a(Temp) treatment. The e(Temp) treatment markedly reduced $KMnO_4$-C (-25% to 42%, $p < 0.05$), but did not alter water-soluble carbon. The e(Temp) treatment reduced alkaline phosphatase and ß-glucosidase activities ($p < 0.05$), but not acid phosphatase activity. The elevated temperature significantly influenced chlorophyll-b content (+18%), stomatal conductance (+5%), transpiration rate (+8%), and photosynthetic rate (-22%) ($p < 0.05$). The e(Temp) treatment did not alter total P uptake rather altered its distribution in grain (-16%) and stover (+17%) parts leading to a lower internal P use efficiency (-12%) and phosphorus harvest index (+15%). The e(Temp) treatment caused 12% yield loss compared to a(Temp) treatment. Therefore, it can be concluded that retardation in P-mineralization along with terminal heat stress severely impaired P nutrition, physiological activity, and yield of chickpea.

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Developing Biochar-embedded Slow-release Nitrogen Fertilizers for Enhancing for Nitrogen use Efficiency, Growth and Yield of Rice

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Increasing consideration is being paid to sustainable slow release fertilizers (SRFs). Biochar is a novel carbon material and gaining momentum as a natural carrier for sustainable nutrient application and release and improved soil health. Accordingly, a recent biochar-embedded slow-release nitrogen (N) fertilizer has been prepared using acacia biochar, urea, ammonium chloride, starch and organic acid. This and other biochar-embedded slow release N fertilizers (BSRNFs) were characterized using Fourier transform infrared spectroscopy (FT-IR) and scanning electron microscope (SEM). BSRNFs were tested in the laboratory and field experiments for their N release pattern, nitrate (NO_3-N) leaching loss, N use efficiency (NUE), growth and yield of rice crops. Among the BSRNFs tested, the one with 75% urea-N (BSRNF-U75) released 109 mg kg^{-1} of N in an incubation study and the least NO_3-N leaching losses (8.8, 14.6, and 26.4 mg kg^{-1}) at 10, 20 and 30 cm depth in a column study, respectively compared to conventional urea. Application of biochar-embedded slow release N fertilizer 100% urea-N (BSRNF-U100) augmented plant growth to increase grain yield (6610 kg ha^{-1}), straw yield (9612 kg ha^{-1}) and NUE (12%) in rice. This study demonstrated that biochar could be used to load urea with organic acid and starch, which could improve N retention through surface adsorption, pore cavity and functional group interaction in the formed BSRNF granules. The BSRNFs from urea were shown to be capable of sustained N release and less NO3-N leaching loss compared to conventional urea and NH4Cl. Application of slow-release urea embedded in biochar improved N fertilization efficiency through sustained N release, resulting in increases in growth, yield traits and rice yield. Therefore, the biochar embedded urea N fertilizer could be a novel option to enhance the NUE in rice crops.

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Evaluate the Effect of different Levels of NPK and Zinc on Growth and Yield of Black Gram (*Vigna mungo* L.)

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An experiment was conducted during in *Zaid* season (March 2022-June 2022) on central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment was laid out in randomized block design with three levels of NPK (0% NPK, 50% NPK and 100% NPK), and three level of Zinc (0% Zinc, 50% Zinc and 100% Zinc). The result shows that application of different levels combination of inorganic fertilizers increased growth, yield of black gram and improved soil chemical properties. It was recorded from the application of NPK and Zinc fertilizers in treatment T_9 [NPK @ 100% + Zinc @ 100 %] maximum plant height 40.90 cm, 49.12 cm, and 60.16 cm at 30 DAS, 60 DAS and at harvest, number of branches plant^{-1} 9.35, 11.62, and 14.24 at 30 DAS, 60 DAS and at harvest, number of pods plant^{-1} 42.77, number of seeds pod^{-1} 10.54, test weight of 1000 seeds 54.65 g, grain yield 12.42 q ha^{-1} best from T_1 [(control) NPK @ 0% + Zinc @ 0 %].

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Comparative Evaluation of Sulphur Nano Particles and Elemental Sulphur on Productivity and Nutrient Use Efficiency of Groundnut under Inceptisols of middle Gujarat

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The pot trial was conducted to study the effect of sulphur nanoparticles through fertigation on growth, yield, nutrient content and uptake by groundnut using completely randomized block design with eleven treatments and four repetitions. Sulphur nano particles (SNPs) were synthesized using green synthesis method of nano particles preparation. Synthesized SNPs exhibited a mean size range of 94.52 nm. The zeta potential values ranged from -15.9to -21.2 mV. The synthesized SNPs had the 35% sulphur content on dry weight basis. The results indicated that the periodical plant height, chlorophyll content, pods plant^{-1}, pod and haulm yields plant^{-1} and pot^{-1} as well as nutrients content, uptake and sulphur utilization efficiency were found significant with the application of RDF + sulphur nanoparticles at 3 mg S/kg soil, 50% as basal and 50% at 30 DAS (T_{10}). The available nutrient in soil after harvest of groundnut were highest due to 4 mg S kg^{-1} soil (T_{11}). The lowest available nutrients were registered under control (T_1) with only RDF in soil after harvest of groundnut. The DTPA extractable micronutrients in the soil after harvest of groundnut were not significantly influenced by the application of sulphur nanoparticles and elemental sulphur. So, It can be concluded that for getting higher yield application of RDF + 3 mg S kg^{-1} soil (50% applied at the basal and 50% at 30 days after sowing) in the form of sulphur nano particles through fertigation can be a optimum dose of sulphur for the groundnut crop.

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Artificial Inteligence in Soil Science: A Review

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The development of the agricultural sector has been a top priority for the Indian government because it is one of the oldest sectors and the foundation of the nation. Many factors, including food security, population increase, and climate change, are causes for concern. The Indian government has begun to use this technology in the development of the agriculture sector after realizing the importance of artificial intelligence (AI), which has changed the game in other industries. As Soil science a major branch of agriculture, the AI has also left its influence on this. Soil testing and monitoring, soil fertilization assessment of soil quality, identification of nutrient deficiencies, carbon sequestration, and many other areas of interest are among the many sectors. Numerous AI-based innovations, including robotics, drones, predictive analysis, sensor-based soil monitoring tools, satellite images, automated irrigation systems, etc., have the potential to fundamentally alter Indian agriculture. These technologies will aid farmers in evaluating crop, weather, and soil conditions for increased output. The foliar nutrient status of mango using spectroscopy-based spectral indices and PLSR- combined machine learning models was evaluated by using an optical fiber of visible near-infrared spectroradiometer. In the study, a combination of linear and non-linear machine learning methods yielded the best predictions. The PLSR-combined machine learning models of the Cubist, SVR, and ELNET were found to be the most robust in predicting most of the nutrients and provided good to excellent prediction accuracy. The results of the study revealed that the hyperspectral sensing data could be employed to retrieve the foliar nutritional status of the mango. The presented approach is suitable for rapid and reliable estimation of the leaf nutrients at the laboratory level, however, field investigations are needed to upscale this research at the canopy level using ground-based or airborne hyperspectral remote sensing.

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Influence of Nano DAP on Yield Attributing Characters and Yield of Kharif Rice

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Field experiment involving different methods and amount of both conventional and nano-formulated DAP fertilizer applications to rice was conducted in a randomized complete block design with ten treatments along with three replications. These treatments were *viz.* T_1: Control (No N and P); T_2: 100% of Soil Test Dose (STD) for N and P; T_3: 75% of STD for N and P; T_4: 50% of STD for N and P; T_5: T_3 + Seedling root dipping (SRD) with nano-DAP@ 5 ml/liter + Once Foliar spray (FS) with nano-DAP@ 2 ml/liter at 25 Days after transplanting (DAT); T_6: T_3 + SRD with nano-DAP @ 5 ml/liter + FS with nano-DAP @ 4 ml/liter at 25 DAT; T_7: T_4 + SRD with nano-DAP @ 5 ml/liter + Once FS with nano-DAP @ 2 ml/liter of at 25 DAT; T_8: T_4 + SRD with nano-DAP @ 5 ml/liter + Once FS with nano-DAP @ 4 ml/liter at 25 DAT ; T_9: T_4 + SRD with nano-DAP @ 5 ml/liter + twice FS with nano-DAP @ 2 ml/liter at 25 and 45 DAT; T_{10}: T_4 + SRD with nano-DAP @5 ml/liter + twice FS with nano-DAP @ 4 ml/liter at 25 and 45 DAT. The result revealed that plant growth and yield attributing parameters such as root length, plant height, panicle length, no of tiller plant^{-1}, filed grain plant^{-1}, were maximum in T_{10} (50% of STD for N and P+ SRD with nano-DAP @5 ml/liter + twice FS with nano-DAP @ 4 ml/liter at 25 and 45 DAT). The highest mean grain yield of 41.2 and 40.5 q ha^{-1} was recorded with T_2 (100% of STD for N and P) and T_{10} respectively, but both the yields are not significantly different. Higher benefit: cost ratio of 2.26, agronomic use efficiency (AUE) of 31.5 and recovery efficiency (RE) of 94.2% was recorded for nitrogen where as the values of AUE and RE are 63.0 and 94.2% respectively was recorded for phosphorous with T_{10} followed by T_9. From this investigation it can be concluded that soil application of conventional fertilizer for N and P @ 50% of STD + SRD with nano-DAP @5 ml/liter + twice FS with nano-DAP @ 4 ml/liter at 25 and 45 DAT might be the good option for getting higher yield of rice.

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Evaluation of different Extractants for Available Potassium in Relation to Calcareous Soils for Wheat (*Triticum aestivum*)

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Potassium estimation by ammonium acetate in calcareous soils is criticized because of dissolution of ample amounts of free $CaCO_3$ from these soils, the metal ions locked up on $CaCO_3$ and also in these soils ammonium acetate overestimates the K content which is otherwise not available to plants owing to very low solubility of $CaCO_3$ under field conditions, necessitating the research of another extractant for calcareous soils. A screen house experiment investigated: How wheat responds to applied potassium (K) in calcareous and non-calcareous soils and the appropriate extractant for estimating available K for wheat in calcareous soil. The mean wheat grain and straw yield varied from 6.18-8.96 g pot^{-1} and 8.96-15.95 g pot^{-1}, respectively in both calcareous (CS) and non-calcareous soils (NCS) with the application of different K levels. A significant response of K application on wheat grain yield was recorded in CS, while insignificant response in NCS. About 8.9% higher straw K concentration was found in CS as compared to NCS. In both soils, K concentration and uptake by wheat grain and straw increased with increased level of applied K. The amount of available K extracted by different extractants ranged between 162.4-525 kg ha^{-1}, 226.2-407.7 kg ha^{-1}, 197.1-376.3 kg ha^{-1}, 869.1-1200.6 kg ha^{-1}, and 111.9-218 kg ha^{-1} by NH_4OAc (pH 7), NH_4OAc (pH 8.5), $CaCl_2$, $BaCl_2$ and Pb $(NO_3)_2$, respectively. Correlation and regression analysis between the K extracted by different extractants and grain yield has shown that barium chloride ($r = 0.87^{***}$ and $R^2 = 0.748$, respectively) was the best extractant for potassium estimation in CS. The critical concentration of soil K obtained by Cate and Nelson method was 964.3 kg ha^{-1} in calcareous soils and 1149.1 kg ha^{-1} for 0.1 M $BaCl_2$ in NCS. Critical limits in grain and straw samples of wheat grown in CS were 0.74% and 3.55%, respectively while 3.62% and 0.81% in non-calcareous soils. It can be conclude from the present study that CS showed response to different K levels in relation to all yield and yield attributes. And also found that $BaCl_2$ is best extractant for CS while ammonium acetate for NCS.

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Growth, Yield and Biochemical Attributes of Brinjal as Influenced by Enriched Compost and Foliar Spray of Humic Acids in Vertisol

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The present investigation was conducted to assess the effect of organics and foliar spray of humic acid on growth and yield and biochemical attributes of brinjal at Department of Horticulture, and laboratory analysis was conducted at Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi*, 2021-22. The experiment was laid out in randomized block design with nine treatments and three replications. The treatments comprised of foliar sprays of @ 0.5%, 1% and 1.5% of humic acid in combination with FYM and NPS compost along with recommended dose of fertilizers. The results indicated the number of fruits, fruit length and fruit weight of brinjal were found to be significantly influenced with the application of organics and foliar spray of humic acid. The highest fruit weight and fruit length were recorded with the application of 100% RDF + NPS compost @ 2.5 t ha^{-1} + 4 sprays of humic acid @ 1.5%. Higher number of fruits were recorded from the application of 100% RDF + NPS compost @ 2.5 t ha^{-1} + 4 sprays of humic acid @ 1%. Quality parameters *viz.* ascorbic acid and chlorophyll content were significantly influenced by the application of organics and foliar spray of humic acid. Application of 100% RDF + FYM @ 5 t ha^{-1} + 4 sprays of humic acid @ 1% recorded significantly higher ascorbic acid content whereas application of 100% RDF + NPS compost @ 2.5 t ha^{-1} + 4 sprays of humic acid @ 1% recorded higher chlorophyll index. Flavonoid, anthocyanin and Nitrogen Balance Index was higher with the application of 100% RDF + NPS compost @ 2.5 t ha^{-1} + 4 sprays of HA @ 1.5%.

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Effect of P and S Enriched Compost on Yields, Nutrients Content and Uptake by Maize-Mustard Cropping Sequence grown in Acidic Upland of Ranchi

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Upland acidic soils of Jharkhand are coarse textured, low content in organic matter, low retention in water and nutrients and poor in fertility status particularly deficient in available phosphorus and sulphur**.** Field experiments were conducted in Factorial Randomized Block Design with three replications at experimental area of the Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi during *Kharif* and *Rabi* seasons of 2022-23. The sixteen treatments consisted of recommended dose of N, P and K fertilizers (0%, 50%, 75% and 100%), two levels of each Phospho-enriched compost (2.5 and 5.0 q ha^{-1}) and Sulpho- enriched compost (2.5 and 5.0 q ha^{-1}) including control. These P and S enriched compost were applied only in maize and recommended dose of N, P and K fertilizers were applied to both direct and residual crops in maize-mustard cropping sequence. The recommended fertilizer dose for maize and mustard as per the treatments were applied (150:60:80 and 80:60:40 N, P_2O_5 and K_2O kg ha^{-1}, respectively) in the form of Urea, Di-ammonium phosphate and Muriate of Potash. Results reveal that grain yield, P and S uptake by maize was found significantly higher under the treatment T_{16}, where 2.5 t ha^{-1} Phospho-enriched compost (PEC), 2.5 t ha^{-1} Sulpho-enriched compost (SEC) along with 100% recommended dose of NPK were applied, as compared to all the other treatments.The grain yield, P and S contents and uptake by mustard were also found significantly higher when grown as a second crop on residual P and S fertility with T_{16} (supply of 100% recommended dose of N,P and K fertilizers only) over control.

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Effect of STCR based Integrated Nutrient Management on growth and Yield of Wheat (*Triticum aestivum* L.)

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A field experiment was conducted to evaluate the effect of STCR based Integrated Nutrient Management on growth and Yield of Wheat (*Triticum aestivum* L.). The experiment comprising of 9 treatments replicated three times *viz.* Control (Absolute) (T_1), 100% RDF (120-60-40) (T_2), STCR based NPK Fertilizer dose (T_3) , 75% RDF + Vermicompost (2 t ha^{-1}) (T_4), 50% RDF + Vermicompost (4 t ha^{-1}) (T_5), 75% STCR based NPK Fertilizer dose + Vermicompost (5 t ha^{-1}) (T_6), 50% STCR based NPK Fertilizer dose + Vermicompost (10 t ha^{-1}) (T_7), 100% RDF through Vermicompost + Azotobacter (T_8) and Integrated nutrient management (INM) - 50% of nutrients through organic (Vermicompost) + 50% of nutrients through inorganic Fertilizer + Azotobacter (T_9). Results revealed that wheat growth parameters *viz.* plant height at harvest (cm), total tillers per meter row length and effective tillers per meter row length were significantly higher by application of 75% STCR based NPK Fertilizer dose with 5 t ha^{-1} vermicompost (T_6). The yield attributes *viz.* grain and straw yield (q ha^{-1}), total dry matter (kg ha^{-1}), biological yield (kg ha^{-1}), test weight (gm) and harvest index were also recorded significantly higher by application of 75% STCR based NPK Fertilizer dose with 5 t ha^{-1} vermicompost (T_6) when compared to other treatments. The targeted yield in wheat was achieved with integrated nutrient supply through organic and inorganic sources using STCR approach.

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Assessment of Boron Distribution in Soils across Diverse Cropping Systems of Gurdaspur, Punjab

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Boron is an essential micronutrient and its availability significantly influences the crop growth and productivity. The intensive cropping system with minimum use of organic manures has led the deficiency of micronutrients in soils. In Punjab about 12 per cent of soils are deficient in boron. Hence, the study aims to investigate the effects of different cropping systems and nutrient management practices on soil boron status and its fractions. The soil samples were collected from seven distinct cropping systems: rice-wheat, maize-wheat, sugarcane-sugarcane, mango, litchi, cole crops, and barren land and analysed for soil properties and various boron fractions. The soils of Gurdaspur district were neutral to slightly alkaline in reaction with loam to silt loam in soil texture. The available boron content among different cropping systems varied 0.25-0.66 mg kg^{-1} with lowest value in barren lands and highest in cole crops. Among different fractions, the residual boron was predominant fraction, accounting for 80 to 87% of total boron across the systems followed by organically bound boron > oxide bound boron > specifically adsorbed boron > exchangeable boron > readily soluble boron. This hierarchy represents the varying degree of boron association with different soil components and its potential availability to plants. The most significant differences in boron fractions were observed in soils under cole crops and least in barren lands. Therefore, understanding the distribution and behaviour of boron in soil Top of Formbridges the knowledge gap between different cropping systems and effective nutrient management practices. The boron dynamics in soil helps for targeted and sustainable nutrient management practices, benefiting both agricultural productivity and environmental conservation.

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Impact of Long-Term Fertilizer Application and Manuring on Soil Quality, Crop Productivity and Sustainability of Major Crops and Soils of India

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A study was undertaken to observe the impact of imbalance, balance and integrated nutrient management (INM) on soil quality, crop productivity and sustainability under LTFEs. The field experiments comprised of control (without fertilizer and manure), 100% N, 100% NP, 50% NPK, 100% NPK, 150% NPK, 100% NPK + lime/Zn, 100% NPK + FYM. The LTFE treatments showed significant effect on crop productivity and soil quality. The 100% NPK + FYM gave the maximum crop yield at almost all the studied locations compared to the rest of the treatments. The LTFE treatments indicated the overall yield trend as 100% NPK+FYM > 150% NPK > 100% NPK+lime, 100% NPK > 100% N > control. Results on soil organic carbon (SOC) status at different LTFEs clearly demonstrated that INM *i.e.*, 100% NPK + FYM maintained maximum SOC than even super-optimal dose (150% NPK) as well as balance (100% NPK) and imbalance (control, 100% N, 100% NP) nutrient application. However, in Alfisols group of soils 100% NPK + lime found to be promising as far as soil quality and yield is concerned. The biological condition is also equally crucial for sustaining productivity. In this context, soil microbial biomass carbon (SMBC) is one of the key indicators of biological activities in soil. Results indicated that INM (100% NPK+FYM) recorded maximum SMBC status followed by 150% NPK, 100% NPK, 100% N, control. However, with imbalance dose of nutrients such as 100% N, a drastic reduction in soil quality as well as yield was noticed in Alfisols. Moreover, indiscriminate use of fertilizers adversely affected soil quality and crop productivity. Overall it was observed that the sustainability indices such as SYI (sustainable yield index) and SQI (soil quality index) improved with balanced and INM. Therefore, it is necessary to have a proper monitoring of soil health by rationalise use of chemical fertilizers and amendments. Results emanated from the long term fertilizer experiments illustrated the need for balanced and integrated nutrient application in order to improve soil quality and sustainable crop yield. Thus, balanced and integrated nutrient management is one of the soil and fertilizer management options across majority of LTFEs.

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Effect Consortium of Endophytic Nitrogen Fixing Bacteria on Yield and Quality of Sugarcane

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The field experiment was conducted at Agricultural Research Station, K. Digraj, Tal. Miraj, Dist. Sangli (M.S.). The sugarcane ratoon (III) *cv.* CoM 0265 was test crop. The experiment was conducted to study the effect of consortium of N fixing endophytic bacteria on yield and quality of ratoon sugarcane and economics of sugarcane. The experiment was laid out in randomized block design with four replications and six treatment combinations. The experimental soils come under Inceptisol. The results revealed that significantly highest ratoon cane yield (53.36 t ha^{-1}) was recorded in treatment with application of 50% N + set treatment of *Acetobacter diazotrophicus*. Similar trend was observed with the top yield of the ratoon sugarcane. Total uptake of N, P and K was recorded significantly higher (67.45, 26.97 and 68.23 kg ha^{-1}, respectively) in treatment T_2 (100% RDN) over rest of the treatments. The 100% RDN was at par with treatments 50% N + Set treatment of *Acetobacter diazotrophicus* and 25% N + consortium of endophytic bacteria for total uptake of N, P and K of ratoon sugarcane. The higher soil available nitrogen balance (170 kg ha^{-1}) was observed in the treatment RDF 100% N (T_2). The highest nitrogen use efficiency (569 kg kg^{-1}) was found in treatment 25% N + consortium of endophytic bacteria (T_4). The available nitrogen content showed decreasing trend over initial value in all the treatments except RDF (100% N). It was concluded that application of 50% N + Set treatment of *Acetobacter diazotrophicus* to ratoon sugarcane was recorded higher cane yield and nutrient uptake over rest of the treatments. The treatments 100% RDN and 25% N + consortium of endophytic bacteria were at par with each other for cane yield of ratoon sugarcane.

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Diversified Role of Potassium in Mango

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The mango (*Mangifera indica* L.) belongs to the family Anacardiaceae. Mango is known as king of fruits, so quality of mango is an important concern. The potassium is the nutrient which plays important role in the quality of mango. Potassium is always ionisable and is present in the solution of either soil or plant (Troeh and Thompson, 1993). The size, appearance, colour, soluble solids, acidity, vitamin content, taste, as well as shelf-life of mango fruit are significantly influenced by adequate supply of K. Shinde *et al.* (2018) reported that maximum ascorbic acid content in fruit (35.26 mg 100 g^{-1}) was recorded by recommended dose (1.5 kg N, 0.5 kg P_2O_5 and 0.5 kg K_2O $tree^{-1}$) of NP and K through muriate of potassium. Whereas minimum occurrence of spongy tissue was observed (4.28%) with application of K through SOP (1.8%). Sudha et al., 2012 reported that, maximum number of hermaphrodite flowers (282.5/panicle), fruit set (17.0%), number of fruits (146.0 $tree^{-1}$), fruit yield (43.8 kg $tree^{-1}$), chlorophyll content (1.7g mg^{-1}) and carbohydrate (14.5g $100g^{-1}$) was obtained with foliar spray of KNO_3 at 2 per cent concentration. The incidence and severity of stem-end rot was significantly decreased by 2 g l^{-1} KCl treatment without drastically affecting the physico-chemical properties of fruits (Nisansala et al., 2015). Laxmipriya *et al*. (2023) reported that maximum leaf N, P, K (1.78% N, 0.19% P, 0.82% K) was recorded in plants treated with KNO_3 @ 4 per cent. Azam *et al*. (2007) observed that, application of KNO_3 @ 3 per cent increased panicle length, hermaphrodite flowers, and fruit set in mango. The plants treated with KNO_3 at 4 per cent noted the highest number of fruits per plant and yield compared with other treatments (Sarker *et al.*, 2013). Therefore, it can be concluded that, application of KNO_3 @ 2-4 per cent foliar improves flowering, vegetative growth and nutrient content in mango. Foliar application of K_2SO_4 @ 2 per cent improves fruit quality and reduces occurrence of spongy tissue in mango fruits. Spraying of KCl @ 2 g l^{-1} reduces the incidence of stem end rot on mango fruits. Therefore, application of potassium is necessary for sustainable quality and yield production in mango.

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Increasing Cation and Anion Exchange Capacity of Rice Straw Biochar by Chemical Modification for Higher Plant Nutrient Retention

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Biochar produced from the pyrolysis of crop residues is gaining attention as a sustainable and green technology for revamping soil fertility via curtailing the nutrient leaching from soil. However, pristine biochars are ineffective due to low cation (CEC) and anion (AEC) exchange capacity as compared to the engineered biochars. Therefore, to accomplish the objective fourteen engineered biochar composites were prepared from rice straw biochar (RBC-W) by treating it with different chemical reagents with varying reactivity. Among them, three promising engineered biochars, namely RBC-W treated with ozone-hydrochloric acid-ferric chloride (RBC-O-Cl), sulfuric acid-nitric acid- hydrochloric acid-ferric chloride (RBC-A-Cl), and sodium hydroxide-ferric nitrate (RBC-OH-Fe), were selected from a screening experiment based on adsorption capacity of the biochar. These promising biochars were also underwent physicochemical characterization and were tested for retention of ammonium-nitrogen (NH_4^+-N), nitrate-nitrogen (NO_3^--N), phosphate (PO_4^{3-}-P) and potassium (K^+) in a soil leaching and nutrient retention study. As compared to the untreated one (RBC-W) all the engineered biochars (RBC-O-Cl, RBC-A-Cl, and RBC-OH-Fe) showed significantly higher CEC and AEC. Out of three, RBC-O-Cl recorded lowest leaching loss of the fore mentioned nutrients with higher retention of NH_4^+-N (+33.7%), NO_3^--N (+27.8%), PO_4^{3-}-P (+15.0%) and K^+ (+5.74%) over RBC-W. Thus, the application of engineered biochar could be a win-win strategy to improve nutrient use efficiency and avoid environmental degradation.

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Relationship between Root CEC and Nutrients in Various Crop

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Roots are crucial for anchoring plants, absorbing nutrients, synthesizing phytochromes and organic compounds. Cation exchange phenomena exist in both places *viz.* soil and root surfaces. Similarly, soil, plant roots also show cation exchange phenomena, that make them helpful for adsorption of nutrient. Plant roots make uptake of cations from soil solution in exchange, by secretion of an equivalent quantity of H^+ ions, this phenomenon is known as root cation exchange capacity. Cation-exchange capacity of roots varies widely with the nature of species, variety, time of sampling, age of crop, growth conditions, root zone, soil-nutrient level and soil type. The phosphorus plays a crucial role in plant energy storage and root development; whereas, uptake of phosphorus influenced by rhizosphere conditions. Potassium, iron and manganese content of shoots and grain were found significantly and positively correlated with the root CEC of the varieties of both, paddy and wheat crops. The field and pot experiment were conducted in maize; the highest root CEC (19.38 Cmol (p^+) kg^{-1}) was found with integrated application of nitrogenous, phosphatic fertilizer and biofertilizer (VAM), so the root morphology influence P uptake, with surface area, fineness, and hair intensity being significant factors. The synergy between biofertilizer and micronutrients (Zn) resulted in significantly maximum root dry weight, N content and CEC of the root. The highest root CEC (30.50 Cmol (p^+) kg^{-1}) was obtained at the knee-high stage with the application of FYM along with 100 % NPK followed by the plots (26.0 Cmol (P^+) kg^{-1}) treated with 100 per cent NPK. Therefore, it is concluded that, increasing root CEC increases the nutrient adsorption, dry matter accumulation of crops and availability of nutrients in slow-release fertilizer.

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Effect of Split Application of Fertilizers in Fruit Crops: A Review

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Irregular flowering, low fruit set and low fruit retention leading to low yield and poor quality fruits are the major constraints in fruit production. Balanced nutrition is very important for better yield and quality of fruits. So, it is paramount important to determine the number of splits for fertilizer application in fruit crop. Dividing the total fertilizer requirement of plant into two or more treatments can help growers to enhance the nutrient use efficiency, produce optimum yield and mitigate the losses of nutrient. Nutrient scheduling in fruit crop will provide knowledge of correct time and optimum quantity of fertilizer application at each stage to optimize crop yields with maximum fertilizer use efficiency and at the same time ensuring minimum damage to soil properties. Sarker and Rahim (2012) observed that fertilizer at the rate of FYM 37.5 kg, urea 1125 g, TSP 600 g, MOP 375 g, gypsum 375 g, and $ZnSO_4$ 22.5 g per mango plant may be applied in September, March and May in order to get superior yield and quality of fruits. Similarly, Bhosale *et al*. (2022) concluded that nutrient application of 50% NPK at initial stage, 50%P at one month before flowering, 20%NK at Peanut stage, 20%NK at Marble stage, 10%NK at Egg stage was found to be the best split application for yield of mango. Nadkarni *et al*. (2018) concluded that scheduling of nutrient *viz*., 50:40:25% NPK as a basal application,30:25:15%NPK at fruit set,20:25:30%NPK at fruit development stage,10:30%PK before harvest proved promising for increasing number of fruits and yield in pomegranate. Investigation of Jain *et al*. (2020) inferred that the application of fertilizer dose of 6kg each NPK+400kg FYM $tree^{-1}$ $year^{-1}$ in three splits *i.e.*, in June, in September and in January has enhanced yield with highest Benefit:Cost ratio. Thus, the case studies showed that the split application of fertilizers allows more targeted and efficient use of nutrients, resulting in improved plant growth, development and productivity with positive effects on yield, fruit quality and nutrient uptake, compared to single application.

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Enhancement of Rice Productivity through Improving NUE by Modified N Fertilizer

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Nitrogen is a key constituent of biomolecules such as proteins, nucleic acids and other vital components of rice. The deficiency of nitrogen is observed in most crops and widespread in the world mainly due to its poor availability. Experiment was conducted with eleven efficient and responsive rice genotypes with four nitrogen levels and three modified/coated urea fertilizers *viz.*, neem coated urea, gypsum coated urea and sand incubated urea in split-split plot design at Rice Research station, TNAU, Ambasamudram, Tirunelveli. Application of 100% recommended dose of neem coated urea superior in registering higher yield under the genotypes ASD16, ADT39, ADT45, TPS5, TM12077 and PM12009 whereas CB06803, ACK14001, TM10085 and EC725224, AD09206 followed by gypsum coated urea at 150% and 100%. Though the both neem and gypsum coated urea had higher efficiency of ANRE, agronomic N use efficiency and Physiological N use efficiency, ANRE was superior at 100% recommended dose of nitrogen as neem coated urea under the genotype TM12077, AD09206 and TM10085 and gypsum coated urea at 150% recommended dose by the genotype ASD16. It is concluded that application of coated / modified nitrogen fertilizers at 100% recommended dose of nitrogen as neem coated urea and 150% recommended dose of gypsum coated urea along with recommended P & K for N efficient and responsive genotypes to enhance the rice productivity with better grain quality to alleviate nitrate pollution besides sustaining soil fertility in tamirabarani river basin of tamilnadu.

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Impact of Long-Term Agroforestry Systems on Soil Nutrient Status and Soil Carbon Sequestration in Semi-Arid Region of Rajasthan

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To explore the impact of different tree-based agroforestry systems on soil nutrient status and carbon sequestration, a long-term field trial was conducted under three tree-based agroforestry systems consisting of tree species, namely *Acacia tortilis*, *Hardwickia binata*, and *Tecomella undulata*, along with fallow land at Agriculture Research Station, Fatehpur, Sikar, Rajasthan. The soil samples were collected from four different soil depths (0-15, 15-30, 30-60 and 60-90 cm) with three replications and analyzed for soil available macro nutrients, micronutrients and soil carbon stocks. The findings showed that under all agroforestry systems, a higher soil available N, P, K and micronutrients was recorded as compared to fallow land at all soil depths. The *Acacia tortilis* based agroforestry system had higher soil organic carbon than other agroforestry systems and fallow land. The soil available N, P, K and micronutrients were positively correlated with TOC and decreased with an increase in soil depth under all the agroforestry systems and fallow land. The *Acacia tortilis* based agroforestry system sequestered a higher amount of carbon (0-90 cm) 39.34 Mg C ha^{-1} followed by *Hardwickia binata* based agroforestry systems (37.86 Mg C ha^{-1}), *Tecomella undulata* based agroforestry systems (36.99 Mg C ha^{-1}) and fallow land (30.65 Mg C ha^{-1}). Based on current research findings, it may be concluded that long term agroforestry systems help improve soil available N, P, K and micronutrients status and soil carbon sequestration as compared to fallow land.

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Efficacy of Boron Fertilization for Improving the Cauliflower Productivity, Nutrient Uptake and Soil Nutrient Status in Soils of Trans-gangetic Plains of Punjab

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The intensive cropping system along with the overuse of high analysis fertilizers and minimum use of organic manures led to micronutrients deficiency in the soil of Indo-Gangetic plains. Boron is the 2nd most deficient micronutrient in Indian soils. Cauliflower is the third major vegetable crop in Punjab and rich source of proteins, minerals, carbohydrates, vitamins B and C with abundant potential to meet he nutritional requirement of the population. The deficiency of boron includes hollow stem, stem discoloration, leaf rolling, malformed buds, curd color changes into brown with marginal mottling of leaves and taste becomes bitter which results in high yield losses. The boron management is important to enhance the quality and productivity of cauliflower crop. Hence, the present study was undertaken in split plot design on cauliflower during 2022-23 at Micronutrient Research Farm, Department of Soil Science, Punjab Agricultural University, Ludhiana with 4 FYM and 4 boron levels, replicated thrice. Soil application of boron was done through borax before transplanting of cauliflower crop. The growth parameters and yield of cauliflower improved significantly with application of FYM and boron levels. The minimum days to curd initiation (56), maximum plant height (34.8cm), number of leaves (22), curd diameter (17.2 cm), TSS (8.0°B), marketable curd weight (702 g), curd weight (413 g) and curd yield (150 q ha^{-1}) was recorded with FYM application at 100 Mg ha^{-1}. The FYM levels 50 Mg ha^{-1} and100 Mg ha^{-1} were found statistically at par for the growth and yield parameters. Among boron levels, the minimum days to curd initiation, maximum plant height, number of leaves, curd diameter, marketable curd weight, curd weight and curd yield *i.e.* 57 days, 30 cm, 18, 17.1 cm, 660g, 388g and 131 q ha^{-1}, respectively were observed with the application of boron 1 kg ha^{-1}. Whereas, the maximum TSS (7.8°B) was obtained with the application of boron at 2 kg ha^{-1}. The improvement in growth parameters and yield in cauliflower were statistically similar at boron levels 1.0 and 2.0 kg ha^{-1}, respectively. Among treatment combinations, the maximum curd yield was obtained with the application at 100 Mg FYM ha^{-1} + boron 2 kg ha^{-1} which was statistically at par with treatment 50 Mg FYM ha^{-1} + boron 1 kg ha^{-1}. Overall, it is concluded that the application of boron at 1 kg ha^{-1} along with FYM at 50 Mg ha^{-1} is best treatment combination for ensuring crop productivity, quality and improving soil fertility in the cauliflower

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Effect of Integrated Nutrient Management on Soil Properties and Productivity of Blackgram (*Vigna mungo* L.) in Typic Haplustepts

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A field experiment entitled "Effect of Integrated Nutrient Management on Soil Properties and Productivity of Blackgram (*Vigna mungo* L.) in Typic Haplustepts" was conducted at Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur, which is located in Zone IVa (Semi-humid Southern Plain and Aravali Hills Zone) during *kharif* 2022. The experiment included nine treatments of integrated nutrient management, including one common control in blackgram. Three replications of the experiment were set up in a randomised block design. The soil at the experimental site was a clay loam with a slightly alkaline reaction (8.12 pH), medium inavailable nitrogen (284.43 kg ha^{-1}) and phosphorus (17.50 kg ha^{-1}) and high in potassium (352.17 kg ha^{-1}). Application of 25% RDF + 25% vermicompost + 25% enriched compost + 25% poultry manure + *Rhizobium* + foliar spray @ 0.5% Zn (T9) was recorded maximum plant height at harvest, number of branches $plant^{-1}$ at harvest, root nodules (effective and total) at 45 DAS, number of pods $plant^{-1}$, number of seeds pod^{-1}, test weight, seed (909 kg ha^{-1}) yield, haulm (1535 kg ha^{-1}) yield, biological (2444 kg ha^{-1}) yield, chlorophyll content at 45 DAS and protein content in seed, nutrient content *viz*., nitrogen, phosphorus, potassium, iron, zinc, manganese and copper content in seed & haulm and their uptake by seed, haulm & total uptake by cropfollowed by 75% RDF + 25% poultry manure + *Rhizobium* + foliar spray @ 0.5% Zn (T8). Maximum organic carbon, available macronutrients (nitrogen, phosphorus & potassium), micronutrients (iron, zinc, manganese and copper), microbial population (bacteria, fungi and actinomycetes population), dehydrogenase activity and alkaline phosphate activity in soil after harvest of blackgram was observed under integrated nutrient management *i.e*. application of 25% RDF + 25% vermicompost + 25% enriched compost + 25% poultry manure + *Rhizobium* + foliar spray @ 0.5% Zn. Highest net return (` 40380 ha^{-1}) and B C (2.59) were found with application of 25% RDF + 25% vermicompost + 25% enriched compost + 25% poultry manure + *Rhizobium* + foliar spray @ 0.5% Zn. It concluded that application of 75% RDF + 25% poultry manure + seed treated with *Rhizobium* with 0.5% foliar spray of Zn recommended with net return (Rs. 35206 ha^{-1}) and B C ratio (2.43).

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Role of Liquid Organic formulations in Vegetable Crops

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Vegetables are essential for nutrition, health, and disease prevention. The production level of 176.2 million metric ton of vegetables, India is the second largest vegetable producer globally, accounting for 14% of the total world vegetable production. We need to adopt such practices which will enable the production of more nutritionally rich vegetables from less land, less water, less chemicals and no detrimental effects on the soil and environment health. Through organic vegetable production, sustainability can be achieved in terms of maintaining the various beneficial properties of the soil. The use of organic fertilizers either bulky or liquid organics plays an important role to sustain the soil health as well as productivity of the crops. In particular the use of liquid organic manures not only helps to achieve higher yield but also a low-cost production approach, thus helps to realize higher returns by the farmers. The performed experiment involving sixteen treatment combinations which were replicated thrice. The investigation found that treatment T7 (T1 + foliar application of vermiwash @ 0.06 per cent N content) significantly improved nutrient uptake, nutrient content and green pod yield of chilli followed by T6, T4, and T10. An experiment with five treatments *viz.*, T1 (control), T2 (Compost only), T3 (Compost + 1% sea weed extract), T4 (Compost + 2% sea weed extract), T5 (Compost + 3% sea weed extract). In general, it is concluded that the liquid organic formulations are eco-friendly, environmentally safe and of low cost. The use of liquid organic formulations helps to enhance the bio-chemical properties of soil resulting in maximizing crop productivity and sustaining soil quality.

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Phosphorus Acquisition in Relation to Root Dynamics of Wheat with Long Term Nutrient Management under Sorghum- Wheat Cropping Sequence in Vertisol of Central India

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The present investigation was conducted to study the effect of long-term nutrient management on rooting behavior and root chemical properties of wheat under sorghum-wheat cropping sequence during *rabi* 2016-17 at Dr. PDKV, Akola. The experiment was laid out in RBD with twelve treatments replicated thrice. The experiment comprised twelve treatments *viz*; 50% NPK, 100% NPK, 150% NPK, 100% NPK (S), 100% NPK + Zn, 100% NP, 100% N, 100% NPK+FYM @ 5 t ha^{-1}, 100% NPK + S, FYM @ 10 t ha^{-1} (to sorghum and wheat), 75% NPK + 25% N through FYM and control. The results revealed that root length and root volume at 30, 60, 90 DAS and at harvest was influenced significantly with the application of 100% NPK + FYM @ 5 t ha^{-1}. The root acid phosphatase activity did not follow consistent trend irrespective of various fertilizer treatments. However, the application of sub optimal P (50% NPK) and application of 100% N devoid of P noted higher value of root acid phosphatase activity. The root CEC and root oxidase activity was influenced significantly with the combined application of 100% NPK + FYM @ 5 t ha^{-1}. The nutrient content of plant and root was influenced significantly with the increase in the level of NPK, the higher value was observed with the application of 100% NPK + FYM @ 5 t ha^{-1}. In general, the nutrient use efficiency was increased with the decreasing levels of NPK fertilizers. However, higher N (37.93), P (28.96%) and K (126%) use efficiency was noted with the application of 100% NPK + FYM @ 5 t ha^{-1}. The rooting behavior of wheat was correlated significantly and positively with root oxidase acting at 30 and 60 days.

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Impact Evaluation of Integrated Nutrient Management through in Situ Green Manuring Demonstrations on Rice (*Oryza sativa*) Yield in North Western India

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The present study was carried out with the objective to demonstrate and evaluate the impact of integrated nutrient management (INM) through green manuring on rice yield in Gurdaspur district of Punjab. Krishi Vigyan Kendra, Gurdaspur conducted a total of sixty-five demonstrations on green manuring before the transplanting of rice at 10, 10 and 45 farmers' fields in the district during 2018-19, 2020-21 and 2021-22 on area of 4.0, 4.0 and 18 hectares (ha) respectively. The treatments were: Demonstration Plot: 50% N through chemical fertilizer + green manure and Famers' Practice: 100% N through chemical fertilizer. Sunhemp variety PAU 1691 was sown as green manuring crop in second fortnight of April by broadcasting seed @ 50 kg ha^{-1}. Sunhemp was incorporated in soil at 50-55 days after sowing when it attained height of 170-210 cm. Rice was transplanted in the second fortnight of June. The results revealed that the demonstrations with INM produced on an average 73.9, 63.8 and 65.0 q ha^{-1} yield of rice during 2018-19, 2020-21 and 2021-22 respectively which are 5.6, 6.2 and 5.2 percent more than the farmers' practice yield during the three years of study. The demonstration plots of 50% N through chemical fertilizer + green manure also resulted in higher net returns and B:C ratio. Farmers were also convinced about the cost effectiveness and profitability of the demonstrated technology. Therefore, INM through green manuring proved to be a better supplement of chemical fertilizers to achieve higher yield as well as sustainable soil health.

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Soil Test-based Nutrient Application for Achieving Targeted Yield of Pigeon pea (var. TJT 501) in Soils of Madhya Pradesh

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Field experiments were carried out for development of adjustment equation for Pigeon Pea under All India Coordinated Research Project on "Soil Test Crop Response" at Department of Soil Science and Agricultural Chemistry, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). Soil of experimental filed was medium black soil Vertisol (*Typic Haplustert),* and is located at 23^0 13' North latitude, 79^0 57' East longitudes and at an elevation of 393 meter above Mean Sea Level. The fertilizer adjustment equation for target yield of on Pigeon pea (var. TJT 501) was developed as FN = 7.00T-0.32SN-0.41ON, FP_2O_5 = 11.10 T-5.44SP-0.84OP and FK_2O = 7.81T-0.32 SK-0.32OK which also maintain the soil health. The results of verification trials on pigeon pea under, all the pre-fixed targets of 10, 12 and 14 q ha^{-1} were achieved with the deviation of + 10.7, +2.25 and -1.71 percent respectively. The highest pigeon pea yield of 1376 kg ha^{-1} was recorded with fixed target of 14 q ha^{-1} which was significantly superior to control, GRD and TY 10 q ha^{-1} treatments but it was found at par with TY 12 q ha^{-1}. The pigeon pea seed yield at TY 12 q ha^{-1} was also found significant over control and GRD but it was found at par with TY (10 q ha^{-1}). However, TY 14 q ha^{-1} increased the seed yield by 102.06, 39.70, 24.30 and 12.14% over control, GRD TY (10 q ha^{-1}) and TY (12 q ha^{-1}), respectively. Full exploitation of the genetic potential of Pigeon pea requires STCR fertilizer recommendation is unique in attaining target yield along with the maintenance of soil fertility.

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Assessment of Changes in Soil Fertility of Benchmark Sites of Haryana

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The impact of intensive cropping systems on changes in soil fertility of some benchmark sites of Haryana was periodically assessed since 2001. These sites are located at research farm of different KVKs and regional research stations of CCSHAU under different cropping systems. Application of fertilizers and other management practices were followed as per our university recommendation at all the locations. Soil samples were collected in May 2022 from all the locations and organic carbon content, available N, P and K along with pH and EC was determined by adopting standard procedures. Soil organic carbon and available phosphorus was found increased over the initial values at all the locations. The improvement in organic carbon content was more under rice-wheat system as compared to other system. The available potassium was observed decreased over the initial values. The percent increase of organic carbon and available P varied from 6 to 88% and 7 to 93% respectively over initial values at different location. Contrary to this the percent decrease of available K varied from 5 to 49% respectively at different locations. Higher build up of C and available P was observed under heavy textures soil as compared to medium and light textured soils. The pH and EC was not followed similar trend at all the locations, however slightly increase or decrease in values was observed.

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Soil Organic Carbon Threshold for Sustaining Wheat Yield in Semiarid Condition

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The present investigation was conducted in the screenhouse by collecting samples from on-going long-term fertilizer experiment initiated in the year 1967 and 1995 by adopting complete randomized design (CRD). It was planned with 7 different organic carbon (OC) soils (0.36, 0.59, 0.88, 1.14, 1.38, 1.62 and 1.90%), 4 doses of FYM (0, 5, 10 and 15 t ha^{-1}) along with nitrogen application 150 kg ha^{-1} and 3 levels of replication. Wheat was grown in the pots during 2021-22 and 2022-23. The mean grain yield as influenced by different organic carbon levels ranged between 8.75 to 10.81 and 8.67 to 10.70 g pot^{-1} in 0.36 and 1.14% OC soil during 2021-22 and 2022-23, respectively. Grain yield increased with increase in dose of FYM upto OC level of 1%. In soils having OC 1.14%, grain yield increased with increase in FYM dose to 10 t ha^{-1}. For 1.38% OC soil, grain yield increased with increasing dose of FYM upto 5 t ha^{-1} application. Increasing OC status beyond 1.5% decreased the grain yield at all doses of FYM application. It can be concluded that OC level should be maintained to the range of 1.14% for maximum grain yield. Beyond 1.25% OC, the grain yield as well as biological yield were observed to decrease. The relative yield was observed to increase upto the threshold value of 1.15% OC which was at par with the yield at 1.37% OC. This range should be maintained to obtain maximum relative yield. Beyond this range, wheat yield was observed to decrease.

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Evaluation of Potential of Indian Glauconitic Shale as Source of Potassium for Maize-Wheat Sequence

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To reduce the reliability of developing countries on import of potassic fertilizers, the utilization of glauconite can be potential option to substitute the costly muriate of potash. Hence, we attempted to evaluate the potential glauconite as source of potassium (K) in agriculture by using physical, chemical and biological approaches in Alfisol by using maize as test crop. The glauconite rock mineral was collected from Singrauli District of Madhya Pradesh. The bulk soil sample of Alfisol (Vijaypura soil series) at 0-15cm soil depth was collected from Research Farm of University of Agricultural Sciences, Bangalore. The results of pot experiments suggest that the application of glauconite more particularly clacined glauconite and acidulated glauconite showed higher growth and K uptake by maize. The calcined glauconite was found superior over acidulated glauconite and glauconite. The application of glauconite/treated glauconite along with FYM was more beneficial rather than their sole application. Among the different treatments, the application of calcined glauconite along with FYM @ 0.5% of soil weight recorded highest values of biomass yield of maize, K uptake and residual K fertility after harvest of maize. Similarly, the application of acidulated glauconite along with FYM and glauconite along with FYM also showed similar kind of results.

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Integration of Biochar with Chemical Fertilizers for Improvement of Economic Yield and Quality of Holy Basil (*Ocimum sanctum* Linn) and Soil Health

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Holy basil (*Ocimum sanctum* Linn) is an important medicinal and aromatic herbs and leaf is riche source essential oil having many bioactive compound. An attempt was made to improve the use efficiency of chemical fertilizer through integration of biochar prepared from distillation waste biomass of holy basil in a pot culture experiment by growing holy basil. The main objective was to study economic yield and quality of holy basil as well as soil properties as influenced by integrated application of biochar and recommended dose of chemical fertilizers (RDF) in different combinations. Application of 100% RDF and biochar (5 t ha^{-1}) recorded the highest plant growth parameters. The same treatment combination also recorded the highest fresh (320.5 g $plant^{-1}$) and dry (95 g $plant^{-1}$) herbage yield of holy basil. Essential oil, total phenol and flavonoid content as well as anti-oxidant potential were found highest in the treatment receiving biochar 5 t ha^{-1} + 50% RDF which is at per with treatment receiving 5 t ha^{-1} + 100 % RDF. However, significantly higher total essential oil yield (0.8 g $plan^{-1}$) recorded in the treatment *receiving* 5 t ha^{-1} + 100% RDF. Treatment receiving biochar significantly improved cation exchange capacity (CEC) and organic carbon in soil as compared to control and RDF application. Further, combined application of biochar and 100% RDF significantly improved soil fertility (available nutrients) and biochemical (microbial biomass and enzymes) properties as compared to individual application of biochar and 100% RDF. Thus, co-application of biochar (5 t ha^{-1}) along with 100% RDF significantly increased the economic yield (herbage and essential oil) of holy basil by improving soil fertility status.

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The Nitrogen Paradox in Crop Production: Innovative Solutions that Enhance use Efficiency and Fix Environmental Leakages

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Nitrogen fertilizers to enhance crop yields can lead to positive and negative outcomes for the environment and agricultural systems. Addressing the nitrogen paradox requires balancing crop yields and minimizing negative environmental impacts. It can involve implementing more efficient fertilizer application practices, utilizing precision agriculture techniques, integrating crop residue in nutrient management, and improving nitrogen use efficiency. Promoting approaches that consider the interconnectedness of ecosystems and agricultural systems while supporting the biological and chemical processes in the rhizosphere can lead to better nitrogen management for enhanced crop productivity and ecosystem functions. Several long-term (20 years) and short-term (5-6 years) projects on efficient nitrogen management using innovative solutions at the ICAR-Central Soil Salinity Research Institute (CSSRI), Karnal, exploited the potential of in-situ crop residue retention and incorporation, rice straw composting and soil incorporation, incremental replacement of urea with nano-nitrogen application, and biological nitrogen inhibition to enhance N use efficiency while improving the yield of rice-wheat systems. We analyzed these practices for N mineralization potential, impacts on crop growth characteristics, impacts on physiological traits, changes in soil properties, yield, and nitrogen use efficiencies. The experiment's findings showed that integrating rice straw compost and green manuring, significantly improved grain yields, nitrogen mineralization, and N use efficiency. These INM modules considerably improved soil health and afforded fertilizer reduction up to 50%. In situ crop residue incorporation necessitated recommended or even enhanced chemical fertilizer application to achieve yield gains. Replacement of prilled urea with nano-urea up to 33% in rice (1 split application) and 50% in wheat (1.5 split application) significantly improves achievable NUE. Growth and physiological responses supported yield gains. The emerging Biological Nitrification Inhibition (BNI) technology opens prospects for further NUE gains. It would further enhance the NUE in rice-wheat systems with an immense impact on nitrogen use in agroecosystems.

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Integrated Assessment of Nutrient Management Technologies for Improved Productivity and Profitability from the Soybean-wheat Systems in Madhya Pradesh

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Legume-Cereal crop rotation systems are one of the sustainable agricultural intensification practices worldwide. Soybean-wheat system widely adopted in central Indian farmlands is a good example of profitable legume-cereal crop rotation. Ability of the leguminous oilseed crop soybean, in boosting the grain yield of subsequent wheat crop made this cost-effective cropping system popular among the farmers of Madhya Pradesh and Maharashtra. In Madhya Pradesh, unscientific crop production practices over the years caused a noticeable yield reduction in soybean crop even to below 1 t ha^{-1}. A study carried out by ICAR-IISS Bhopal during 2013-16 identified nutrient management practices adopted by soybean-wheat farmers were not enough to keep the system economically viable in the long run. In order to formulate on-farm resource based soil health management strategies to make the cropping system profitable a Participatory Technology Development programme was carried out in nine farmers' fields. The nutrient management technologies evaluated under varying farmer field conditions were integrated plant nutrient supply system (IPNS) using farmyard manure, bio-fertilizers and NPK fertilizers (IPNS-I), IPNS using phospho-sulpho-nitro compost, bio-fertilizers and NPK fertilizers (IPNS-II) and soil test based nutrient application through NPK fertilizers (STCR). The additional cost involved with IPNS-I, IPNS-II and STCR over farmers' practices (FP) were 1400 Rs. ha^{-1}, 3000 Rs. ha^{-1}, 3500 Rs. ha^{-1}, respectively. Results of field trials showed significant differences in yield levels among the nutrient management practices. The system yield increase over FP in the three practices was 12.3% for IPNS-I, 23.5% for IPNS-II and 18.2% for STCR. This also resulted in a net income increase of 8417 Rs. ha^{-1} for IPNS-I, 16097 Rs. ha^{-1} for IPNS-II and 10412 Rs. ha^{-1} for STCR. Also, populations of fungi and actinobacteria were highest in the plots receiving IPNS-II treatment.

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Effect of Integrated Plant Nutrient Sources on Rainfed Cotton Productivity and Soil Fertility under Cotton Based Intercropping Systems in Vertisols of Central India

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The experiment was conducted to study the effect of integrated plant nutrient sources on rainfed cotton yield and soil fertility under cotton based intercropping systems in Vertisols at Dr. PDKV, Akola during 2021-22. The experiment was laid out in split plot design with three replications. The main plot treatments comprised of nutrient management *viz.*, INM (75% RDF + compensation through NPS compost) and Organic (100% NPK dose through NPS compost). Sub plot treatments consisted of cotton based intercropping systems *viz.*, Cotton + dhaincha (*Sesbania aculeata*) (1:1), Cotton + sunhemp (1:1), Cotton + greengram (1:1), Cotton + blackgram (1:1) and Sole cotton. The results revealed that the soil organic carbon and availability of macronutrients (N, P, K and S) and micronutrients (Zn, Fe, Mn and Cu) increased with the application of 75% RDF and 25% Compensation through NPS compost over only organic. While under cotton based intercropping systems, cotton + dhaincha recorded highest organic carbon and available macro (N, P, K and S) and micronutrients (Zn, Fe, Mn and Cu) followed by cotton + sunhemp over rest of the treatments. The lowest available macro and micronutrients content was recorded in sole cotton only. The seed cotton (16.25 q ha^{-1}) and cotton stalk yield (28.33 q ha^{-1}) were recorded higher under INM treatment as compared to only organic treatment. Whereas, in cotton based intercropping systems, the significantly highest seed cotton (16.75 q ha^{-1}) and stalk yield (29.52 q ha^{-1}) of cotton were observed with cotton + dhaincha (1:1) followed by cotton + sunhemp (1:1) and lowest was observed under sole cotton (control). Hence, it can be concluded that the application of organics along with chemical fertilizers resulted in improvement in soil fertility and yield of cotton when intercropped with dhaincha.

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Spectral Libraries of Indian Soils and System for On-line Soil Spectroscopy

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A large number of soil samples are required to be analyzed in laboratories to support different projects related to agriculture and climate studies. One major example in recent times is soil health card where approximately 180 million soil samples were analyzed chemically. To reduce the time and other resources involved, use of soil reflectance spectroscopy is advocated as a rapid and low-cost complement to traditional wet chemical analyses. For operational use of this technique, however, we need to build large reference training datasets (soil spectral libraries) of different kinds of soils. A system is designed which will host spectral libraries of different types of soils of India with large sample sizes and robust machine learning models to predict soil properties from the spectral data. The system will provide an online service to predict soil properties based on the spectral libraries. The system for online spectroscopy wherein the user needs to provide the soil spectra and it will provide the soil properties, predicted based on soil spectral library of the particular type of soils. User have to select the soil type and the system internally will run the best fit model as decided by our analysis and will predict soil properties. Provisions for selection of user defined pre-processing and modelling techniques are also made for researchers. The system can be used operationally to reduce resources in preparation of soil health card.

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Innovations in Nutrient Management: A Case Study on Sampoorna KAU Multimix from Kerala

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Crop specific multi-nutrient mixtures were developed at Regional Agricultural Research Station, Pattambi, Kerala Agricultural University for foliar application in different crops to address the micronutrient deficiencies observed commonly in Kerala Fields. Experiments were conducted to evaluate their suitability for improving yield by correcting nutrient deficiencies. The multi-nutrient mixtures were developed for rice, banana and vegetables by considering the crop nutrient uptake pattern, crop sufficiency- deficiency ranges and available nutrient status of the soils of the state. The mixture, released as Sampoorna KAU multimix contain potassium, magnesium, sulphur, zinc, copper, boron and molybdenum. The recommendations were asfollows: Sampoorna KAU multimix (banana) - foliar application @10 g per litre at 2, 4, 6 and 8 months after planting in banana, Sampoorna KAU multimix (Vegetables) - foliar application @0.5% at 30, 45 and 60 DAS (days after sowing) in direct sown vegetables and at 15, 30 and 45 DAP (days after planting) in transplanted vegetables and Sampoorna KAU multimix (Rice) - Foliar application @ 5g/litre in nursery (1-2 days before pulling out) and @10g per litre in main field at tillering and panicle initiation stages. The Front line demonstrations conducted in different locations in the state indicated that the foliar application of the mixtures could increase the productivity by more than 20%. The fertilizer mixtures were notified by the state government as per the Fertilizer Control Order. The technologies had been transferred to different stations and Krishi Vigyan Kendras of the state and to some private agencies for adoption by setting proper norms for technology transfer.

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Effect of different Levels of Zinc Application on Yield, DTPA- Zn and Zinc Uptake by Wheat in An Acid Alfisol under Maize-wheat Cropping System

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Zinc (Zn) is the most deficient soil micronutrient in the world as well as in India which adversely affects the yield and uptake of wheat crop. In this view, an experiment was conducted during *kharif* 2020 with four sets of zinc treatments (T_1: RDF without Zn; T_2: Zn @ 2.5kg ha^{-1}, T_3: Zn @ 5.0 kg ha^{-1} and T_4: Zn @ 10.0 kg ha^{-1}) in acidic soil of Himachal Pradesh. The results revealed that both grain and straw yield of the wheat crop harvested after the maize crop were significantly affected by different treatments. Grain yield of wheat varied from minimum of 2.56 t ha^{-1} in T_1 (no zinc) to maximum of 2.88 t ha^{-1} in T_4 (Zn @ 10 kg ha^{-1}). Straw yield varied from 3.41 to 4.04 t ha^{-1} in T_1 and T_4, respectively. The T_4 treatment (Zn @ 10 kg ha^{-1}) significantly increased grain yield over T_3, T_2 and T_1 by 5.11, 8.27 and 12.5%, respectively. DTPA- Zn content of soil after the harvest of wheat was significantly affected by different treatments. Its value varied from minimum of 0.48 mg kg^{-1} in T_1 (without zinc) to maximum of 0.60 mg kg^{-1} in T_4 (Zn @10 kg ha^{-1}). Zinc uptake in case of wheat grain ranged from 99 g ha^{-1} in without zinc (T_1) to 128 g ha^{-1} in Zn @10 kg ha^{-1} (T_4) with highest uptake value significantly superior to rest of the treatments. Similar trend in total Zn uptake by wheat straw was observed as that in case of Zn uptake by wheat grain. The present study thus concluded that Zn application significantly influences wheat yield, DTPA-Zn and zinc uptake with the best result registered with treatment T_4 (Zn @ 10.0 kg ha^{-1}).

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Assessment of Elevated CO_2 levels on Yield and N, P, K Uptake by Pigeon Pea and Black Gram

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Elevated atmospheric CO_2 concentrations can enhance photosynthetic rates in plants and therefore act as a carbon fertilizer to induce an increase in net ecosystem CO_2 exchange and contribute to an increase in net primary productivity. A field experiment was conducted at research farm of Department of Soil Science and Agricultural Chemistry, College of Agriculture, Gwalior, Madhya Pradesh. There were eight treatment combinations (2 crops (Pigeon pea and Black Gram) and 4 CO_2 levels [Ambient 395 ppm, 450 ppm, 500 ppm, and Natural]) laid out in randomized block design with three replications under the technological development in order to maintain accurate CO_2 concentration inside the open-top chambers (OTCs) automatically. The result showed that the highest seed yield (120.67 g plant^{-1}) of pigeon pea and black gram, (11.80 g plant^{-1}) was observed with a 500 ppm CO_2 level, which was significantly higher than ambient and 450 ppm levels. Lower levels of CO_2 (450 ppm) also produced significantly higher seed per plant as compared to ambient and natural conditions treatments CO_2. Similarly, trends recorded for the pigeon pea crop noticed higher NPK up take per plant as compared to black gram. Maximum total NPK uptake was recorded with 500 ppm CO_2 level, which was significantly higher to rest of the levels whereas minimum NPK uptake was noticed with ambient CO_2 conditions in both crops. We can conclude that increasing the elevated CO_2 level up to 500 ppm in OTC may be beneficial in terms of increasing the productivity of pulses (Pigeon pea and Black gram) in semi-arid regions of Gwalior district of Madhya Pradesh.

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To Evaluate the Effect of Levels of Nitrogen, Phosphorus, Potassium and Vermicompost on Growth and Yield of Carrot

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An experiment was conducted during in *Rabi*season (December to March 2021-22) on central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment was laid out in randomized block design with three levels of NPK (0, 50 and 100% NPK), and three levels of vermicompost (0, 50 and 100% vermicompost). The result showed that the growth and yield of carrot were significantly affected by application of NPK and vermicompost. The highest growth and yield were observed in T9 (NPK @ 100% + vermicompost @ 100%). It was recorded from the application of NPK and vermicompost in treatment T_9 [NPK @ 100% + vermicompost @ 100%] maximum plant heightof carrot19.44 cm, 37.86 cm, and 46.27 cm at 30 DAS, 60 DAS and at harvest,number of leaves plant^{-1}of carrot3.92, 5.80 and 13.41 at 30 DAS, 60 DAS and at harvest, root length of carrot 20.74 cm, root diameter of carrot 29.46 mm, fresh root weight of carrot 65.64 g, root yield of carrot 162.56 q ha^{-1} best from T_1 [(control) NPK @ 0% + vermicompost@ 0%].

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Effect of Long Term Integrated Nutrient Management on Soil Organic Carbon Storage under Maize-chickpea Cropping Sequence in Vertisols

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A field experiment to study the effect of long term integrated nutrient management on soil organic carbon storage under Maize-Chickpea cropping Sequence in a Vertisols was conducted during 2019-20 at the research farm, ICAR-Indian Institute of Soil Science, Bhopal (23°18´N, 77°24´E,), Madhya Pradesh, India. The experiment was following in a randomized block design consisting of 12 different treatment combinations of organic manures and soil test crop response (STCR) based fertilizers and integrated nutrient management practices with three replications. The soil of experimental field was a deep black in texture with 24.5, 23.5 and 52.0% of sand, silt and clay, respectively. The soil of the experimental site was follows: soil organic carbon 0.53%, available N 68.8 mg kg^{-1}, available P 12.8 mg kg^{-1} available K 237 mg kg^{-1}, soil pH 7.8 and electrical conductivity (EC) 0.48 dSm^{-1}. Results showed that the integrated nutrient management practices increased the soil organic carbon contents and their stocks with application of higher amount of FYM (25 t ha^{-1}) followed by 75% NPK based on STCR along with 5 t ha^{-1} FYM improved the TOC storage in soils. Integration of only organic manures i.e. FYM along the chemical fertilizers also improved the higher amount of WBC as compared to GRD and 100% STCR based fertilizers in both the soil layers. Furthermore, results showed that the application of higher amount of FYM at 25 t ha^{-1} every year were also recorded the higher values of different carbon fractions (*C*frac I, *C*frac II, *C*frac III, and *C*frac IV) in respective of soil depth as compared to GRD and 100% NPK based on STCR. Among the SOC pools, active pools of carbon storage (C_{frac} I $_{and}$ C_{frac} II) contributed nearly 56% and passive pools (C_{frac} III $_{and}$ C_{frac} IV) represent about 44% in the upper layer (0-15 cm) while at lower layer (15-30 cm) of soil the active pools of carbon storage was reported about 46% and passive registered about 54% carbon storage in Vertisols. Adoption of FYM @ 25 t ha^{-1} was significantly increased the available soil N, P and K concentration as compared to rest of treatments. Adoption of STCR based 75% NPK along with FYM @ 5t ha^{-1} enhanced the crop productivity, nutrient uptake of maize; while, residual fertility higher quantity of FYM improved the yield of chickpea.

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Effect of Fertilizer and Cropping on the Responses of Soil Microbial Biomass and Dehydrogenase Enzyme to Herbicide Metsulfuron Methyl

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Chemical weed control is important for reducing production cost of crops and also for overcoming the challenges being faced by the agriculture sector due to shortage of labour force. However, a concern is often raised about their fate in the environment and their impact on soil biological properties. In the present study, the responses of soil microbial biomass carbon (SMBC) and soil dehydrogenase activity (DHA) to the application of the herbicide metsulfuron methyl were evaluated in wheat. The combinations of 3 levels of metsulfuron methyl (control, recommended dose and double of recommended dose) and 3 levels of nutrient management practices (control, RDF and RDF+crop residue) and two levels of planting (cropped and crop/weed free) were imposed in field by following RBD with 3 replications. Soils adhered to the crop roots were collected and considered as rhizospheric soil and the samples collected from crop/weed free plots were considered as non-rhizospheric soil. No adverse effect of metsulfuran methyl was observed on DHA in both rhizospheric and non-rhizospheric soil. Rather, in absence of nutrient application metsulfuron methyl significantly increased DHA in both of these samples. Fertilizer application increased SMBC in rhizospheric soil. But in non-rhizospheric soil MBC increased when both fertilizer and crop residue were applied. At a given level of fertility management, metsulfuran methyl showed a depressing effect on MBC as observed at 15 days after its application. However, compared to the plots not receiving applications fertilizer and herbicide, MBC was significantly higher in the rhizospheric soils of plots receiving recommended levels of fertilizer and herbicide applications. This showed that the fertilizer application and cropping nullified the adverse effect of metsulfuran methyl on SMBC.

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Mitigation of Methane Emission from Submerged Rice by Application of Different Nutrient and Mitigation Sources

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The pot culture experiment was carried out comprising factorial randomized block design with three replications. The first factor consisting sources for primary nutrients *viz.* 100:50:50 N:P_2O_5:K_2O kg ha^{-1} through straight fertilizers, 100 kg N ha^{-1} through vermicompost and RDN through Konkan Annapurna Briquette (34:14:06 N:P_2O_5:K_2O) (KAB). The second factor consisting mitigation sources, comprising control, silica @ 150 kg ha^{-1}, azolla culture @ 1 ton ha^{-1}, rice husk biochar @ 5 ton ha^{-1} and potassium sulphate @ 50 kg ha^{-1}. The methane flux were determined at critical growth stages of rice by static closed chamber technique. The findings revealed that, methane flux was minimum up to tillering stage; increased from maximum tillering stage, reached peak (76.04 mg m^{-2} hr^{-1}) at panicle initiation stage and thereafter drop down towards grain filling and harvest stage. The significant lowest methane flux was noticed by application of KAB. The significantly lowest flux reported by potassium sulphate @ 50 kg ha^{-1} at early growth stages; whereas by silica @ 150 kg ha^{-1} at late growth and peak emission stages. The combine application of KAB and silica @ 150 kg ha^{-1} significantly reduce flux (45.67 mg m^{-1} hr^{-1}) at peak emission stage. The lowest cumulative methane emission was achieved by sole as well as combine application of KAB and potassium sulphate @ 50 kg ha^{-1}. The methane flux showed significant negatively correlation with soil reaction (pH), available phosphorus and silica content in soil. However, the available potassium content correlated positively with methane flux. The grain and straw yield; number of panicles, tillers and plant height at harvest correlated significantly and negatively with cumulative methane flux. It is concluded that, application of KAB in combination with silica @ 150 ka ha^{-1} was suitable for reduction of methane emission from rice fields of Konkan region.

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Bio-accessibility of Arsenic in Cooked Rice Grain Grown in Steel Slag Amended Arsenic Contaminated Soil

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Arsenic (As) pollution in soil poses a significant danger to human health. There is growing interest in utilizing inorganic amendments, especially those arising from industrial waste products, to address metal and metalloid contamination in the environment. Recognizing that steel slag naturally contains elements like iron (Fe), silicon (Si), aluminum (Al), and calcium (Ca), which could make it a viable option for adsorbing and immobilizing soil arsenic, this study aimed to assess the effectiveness of steel slag in remediating arsenic-contaminated soil. Further, the bio-accessible As fraction in cooked white rice grown in steel slag amended soil was assessed using *in-vitro* gastrointestinal method. Results show that steel slag could notably reduce the extractable As content in the soil compared to the unamended soil (control). The rice grain yield was recorded significantly higher in steel slag amended soil compared to control. Bio-accessibility study shows that saliva extracts/dissolved more As compared to gastric and intestinal juices. The percentage of bio-accessible As in all treatments across all the soils types, remained consistently within a narrow range of ~66 to 71%.

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Impact of Foliar Application of Nano Nitrogen on the Nitrogen use Efficiency of Rice Crop in a Vertisol of Chhattisgarh

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Nano fertilizers are innovative products that are changing the face of plant nutrition in agriculture, with main focus on sustainable nutrient management. A field experiment with test crop as rice was conducted on the research farms of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the *kharif* seasons of 2020 and 2021. The twelve treatment combinations which were laid down in randomized block design (RBD) were 0% N (Control), 50% RDN, 75% RDN, 100% NPK (RDF - 120:60:40 kg ha^{-1}), 0% N + 2 sprays of nano N @ 4 ml l^{-1}, 0% N + 2 sprays of nano N @ 8 ml l^{-1}, 50% N + 2 sprays of nano N @ 4 ml l^{-1}, 50% N + 2 sprays of nano N @ 8 ml l^{-1}, 75% N + 2 sprays of nano N @ 4 ml l^{-1}, 75% N + 2 sprays of nano N @ 8 ml l^{-1}, 50% N + 2 sprays of 2% urea and 50% N + 3 sprays of 2% urea. All the treatments with 50 and 75% RDN in combination with foliar application of nano N, 50% RDN + 3 sprays of urea and 100% RDF obtained significantly higher grain yield. The highest total N uptake (98.12, 94.25 and 94.09 kg ha^{-1}) was obtained in 100% RDF, 75% RDN + 2 sprays of nano N @8 and 4 ml l^{-1}, respectively. The nitrogen use efficiency (NUE) in rice crop intensified as 47.49%, by the application of 50% of conventional urea with 2 sprays of 4 ml l^{-1} of nano N and other treatment combinations with foliar sprays also obtained higher NUE than 100% RDF. Therefore, conventional urea in combination with foliar application of nano N helped in achieving higher NUE and hence higher ecological sustainability.

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Effects of Crop Residue Return, Placement and Nutrient Application on Nitrous Oxide Emissions in Alfisol

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Although crop residue return and nutrient applications are extensively practiced in agriculture, large uncertainties remain about their impacts on nitrous oxide (N_2O) emissions. The responses of N_2O emissions in the Alfisol to four wheat residue application rates (R0: no straw; R5: @5 Mg ha^{-1}; R10: @10 Mg ha^{-1}; R15: @15 Mg ha^{-1}) and two management levels (surface and incorporated) under three nutrient (NPK) application rates (N0: no nutrient and NL: nutrient addition to achieve 30% humification in residue level @ 5 t ha^{-1}: NH: 3 × NL) were investigated in laboratory-based soil incubation study. The results demonstrated a significant ($p<0.05$) interaction effect of residue, nutrient application rate, and residue placement on N_2O emission. The N_2O fluxes ranged from -2.3 µg N_2O-N kg^{-1} soil (R5 N0 surface) to 43.8 µg N_2O-N kg^{-1} soil (R10 NH incorporated). The nutrient and wheat residue application rates influenced the direction and magnitude of N_2O emission under the two residue placement treatments. Surface return of crop residue (cf. incorporation) decreased the N_2O emission by 171% (N0), 101% (NL), 90% (NH) in R5, 49% (N0), 81% (NL), 90% (NH) and 32% (NH) in R15, respectively. In contrast, higher residue application rates (R10 and R15) and no/low nutrient application rates (N0 and NL) enhanced the magnitude of N_2O emission by 49 to 88% in surface return residue (cf. incorporated). The N_2O emission was significantly ($p<0.05$) quadratically correlated with residue application rates. Our study showed that residue return rates (@ 5, 10, and 15 Mg ha^{-1}) surface application or incorporation decreased the N_2O emission across nutrient treatments except in treatment receiving residue rates (@ 5, 10, and 15 Mg ha^{-1}) incorporation under high nutrient application rate (NH). The increase in nutrient application had an inconsistent effect on N_2O emission and varied with residue application rates and placement. For example, in R0 (no residue) treatment, NL (cf. N0) increased the N_2O emission by 101%, and there was no difference between N0 and NH. However, in R5 and R10, surface retention of residue decreased the N_2O emission with increasing nutrient application (NL and NH) compared with N0. Irrespective of wheat residue rates, the incorporation of residue and nutrient application (cf. N0) significantly enhanced the N_2O emission in Alfisol. In conclusion, our study underscores the need for a holistic approach to agricultural management, wherein residue application, nutrient strategies, and residue placement techniques are considered to optimize N_2O emissions. Our findings advocate for a nuanced and context-specific approach to residue management and nutrient application to mitigate N_2O emissions while ensuring optimal soil health and crop productivity.

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Potential Impact of Microplastics on Selected Soil Enzyme Activities and Bacterial Community Composition in a Vertisols of Central India

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In India, plastic mulching is mostly used for the vegetable crops however, the use of plastic mulch films for the field crops cultivation is still at its developmental stage. In the environment, plastics gradually converted into smaller particles through the physical, chemical and biological activities *viz.* weathering and erosion, photo-oxidation by ultraviolet radiation and degradation by soil microbes and insects. According to the European Food Safety Authority, plastic particles having a diameter of 0.1 to 5000 micrometres (μm) are known as microplastics. In addition to the benefits of plastic mulching, the use of plastic mulch films in agricultural fields is the chief source of microplastic (MP) accumulation in soil. The processed soil (100 g) was filled into each of the 45 earthen cups (5 treatments × 3 sampling times × 3 replicate = 45 cups) with the MPs (<4 mm) in the 0, 0.25, 0.5, 1 and 2%, w/w concentrations. All treatments were in three replicates and destructive sampling was carried out at 0, 50 and 100 days. After sampling, soil samples were divided into two parts: one for air dry for enzyme activity analysis while another one for bacterial community composition analysis stored at -20°C. The soil dehydrogenase and urease activities were significantly reduced and increased, respectively with incubation time. On 0th day of incubation, no significant difference in the soil dehydrogenase as well as urease activities among treatments were documented. On 50th day of incubation, thesoil dehydrogenase activity decreased with 18.73%, 24.87%, 33.01%, 34.81% however, on 100th day it reduced with 25.66%, 36.57%, 37.54%, 38.39% in 0.25%, 0.5%, 1% and 2% microplastic treatments, respectively compared to control soil. Contrary to dehydrogenase, on 50th day of incubation, the microplastics significantly increased soil urease activity with 3.09%, 21.71%, 19.79%, 32.91% whereas, on 100th day it increased with 9.11%, 15.79%, 12.35%, 16.61% in 0.25%, 0.5%, 1% and 2% microplastic treatments, respectively in comparison with control soil.

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Carbon Footprint Studies in the Selected Land Uses of Temperate Mountainous Ecosystem of Nilgiris in the Western Ghats in Southern India

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Carbon dioxide fluxes from the Eddy Covariance tower data and CO_2 emission from the soils of various land uses were studied in the Nilgiris of Westernghats to understand the carbon footprints. Our results indicate that the net average CO_2 fluxes in the winter, pre- monsoon, monsoon and post monsoon, are observed as -1.6, -1.62, -1.58 and -1.60 $\mu mol \cdot m^{-2}s^{-1}$ respectively. Positive values are observed at night time between 6 pm to 6 am. Negative values are observed during day time (6 am to 6 pm). The mean monthly variation of the carbon dioxide fluxes indicates net assimilation of CO_2 by the vegetation. From the Alkali trap method it was found that CO_2 evolution was the highest at one day intervals irrespective of the treatments. T1 (100% organic) and T2 (100% inorganic) treatments recorded the maximum value of CO_2 evolution (mg) under open conditions, whereas T3 (50% organic + 50% inorganic) recorded the peak value of CO_2 evolution under polyhouse condition at one-day interval. The study also reveals that CO_2 emissions were found to be low in intercropping and considerably high in monoculture ecosystems. It implies that the intercropping system helps in reducing Greenhouse gas emissions. The proportion of NLC in comparison with other carbon pools was higher in Compost, Biochar and Natural Farming site. Among the land uses forests showed a positive contribution on C dynamics and the carbon fractions studied, spectroscopic analysis, humic and fulvic acid fractions of forest soils, C dynamics, and aggregate stability in comparison to other agricultural land uses.

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Carbon Dioxide Emission from Coconut with Different Mulching Practices from Humid Tropical Region of Western Ghats, Southern India

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Mulching offers a number of benefits such as enhancing soil structure, limiting weed development, moisture retention, temperature moderation and soil improvement. Mulching might be particularly advantageous in coconut production because it can play a crucial role in the growth and productivity of coconut trees. Different mulching practices can have varying effects on coconut trees and their CO_2 emission may also vary. By considering this, a field experiment was conducted in the Centre for Water Resources Development and Management, Calicut with the different mulching material which includes Husk, Coco Peat, Sawdust, Azolla, Bone Meal Powder, Glyricidia leaves, Compost, Dried coconut leaves applied in the coconut basin along with the growing of Cow pea and Green gram in the basin. In this experiment, Carbon dioxide emission from the soil was determined using Alkali Trap Method apart from the measurement of soil moisture and soil temperature. Carbon emission was monitored and recorded simultaneously at two different regular intervals (i) Increasing interval of 1, 3, 5, 7, 9,11 and 13days (exactly 1, 4, 9, 16, 25, 36 and 49 days of the experiment) (ii) constant 5 days interval. Results showed that there is a significant variation between mulching materials used, and increasing intervals; however it was non-significant in constant intervals. CO_2 emission monitored at increasing interval of days was highest in mulching with dried leaves (225. 36 mg of CO_2) and lowest in Bone meal powder (43.47 mg of CO_2). At 5 days interval, CO_2 emission was found highest in Azolla (154.44 mg of CO_2) and lowest in Bone meal powder (57.2 mg of CO_2). The emission values increased steadily with increasing interval of days from 1 to 13 days interval and it was almost constant without significant variations at 5 days interval. Temperature and moisture levels affect the rate of decomposition and CO_2 emissions from dry leaves in the soil and soil moisture and soil temperature results confirmed the same. Warmer and moist conditions tend to accelerate microbial activity and decomposition rates, leading to higher CO_2 emissions. Dry leaves and Azolla are not inherently increasing CO_2 emissions. In fact, Azolla's photosynthetic activity has the capacity to sequester CO_2 from the environment, however, in the current experiment, it showed higher emissions, since the soil moisture as well as temperature conditions might have been apt for decomposition and which might have resulted in higher emissions. But these mulching materials will increase the accumulation of soil organic matter, thereby resulting in improvement of soil health and coconut productivity.

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Efficacy of Heavy Metals-tolerant Plant Growth Promoting Bacterial Consortium for Alleviating Heavy Metals Toxicity in Spinach

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Contamination of heavy metal in soil poses a serious threat to both the ecosystem and human and requires very expensive cleanup costs. Use of microorganism, hyper accumulator plants, or other biological systems offers cost-effective and environment friendly metal clean-up methods. Studies on bacterial diversity in heavy metal contaminated sites have demonstrated a high diversity of microorganisms that are adapted to the new environment. The pot experiment entitled "Efficacy of heavy metals-tolerant plant growth promoting bacterial consortium for alleviating heavy metals toxicity in spinach" was undertaken at net house of the Micronutrient Research Centre, Anand Agricultural University, Anand. Bulk of the surface soil samples from 0-20 cm depth was collected for conducting the pot experiment on spinach crop. The experiment was laid out in completely randomized design (Factorial) with three replications. Three heavy metals (Cd, Cr and Pb) are used individually in different level of concentration, that is - cadmium (Cd,1.5, 3.0 and 6.0 mg kg^{-1}), chromium (Cr, 25, 50 and 100 mg kg^{-1}) and lead (Pb, 25, 50 and 100 mg kg^{-1}). Efficacy of bacterial inoculation (consortium of *Pseudomonas azotoformans*, *Bacillus infantis*, *Bacillus megaterium* and *Micrococcus terreu* and FYM was under studied with different combination of tested heavy metals. The inoculation of spinach plants with bacterial inoculation (consortium of *Pseudomonas azotoformans*, *Bacillus infantis*, *Bacillus megaterium* and *Micrococcus terreu*) and FYM under study gave higher records of all estimated growth parameters, shoot fresh dry weight, root fresh and dry weight, shoot and root length, to respective un-inoculated heavy metal (controls). Bacterial inoculation was also found to be evaluated for alleviation of Cd, Cr and Pb toxicity in shoot, root of spinach as well as in soil under the study. All estimated heavy metals (Cd, Cr, and Pb) were generally found greater in root as compared to shoot of spinach. Calculated translocation factor (TF) in present study showed that metals taken up by spinach crop were largely retained in soil and roots, as shown by general TF values. Hence it revealed that different microbes consistently reduced TF in spinach crop. Overall bacterial inoculation (consortium of *Pseudomonas azotoformans*, *Bacillus infantis*, *Bacillus megaterium* and *Micrococcus terreu* and FYM were found to promote growth and reduce the respective heavy metal toxicity in spinach plant.

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Arsenic Distribution in Ground Water of Ballia District, Uttar Pradesh: Assessing Contamination and Implications for Public Health

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This study investigates the distribution of arsenic in ground water sources within the Ballia district of Uttar Pradesh, India. Arsenic contamination in water is a growing concern due to its adverse health effects on human populations. The research involves the collection and analysis of water samples from various locations across Ballia to assess the levels of arsenic present. The findings of this study highlight the spatial distribution of arsenic concentrations in different water sources. The total of 50 samples the results indicated that, the arsenic (As) concentration ranged from 0.002 to 0.189 mg L^{-1} with an average of 0.0542 mg L^{-1}. The results contribute to understanding the extent of arsenic contamination in Ballia's water resources and provide crucial information for formulating strategies to mitigate its potential health impacts on local residents. Efforts to monitor and manage arsenic levels in water are essential for safeguarding public health and ensuring access to safe drinking water in the region. This study investigates the distribution of arsenic in ground water sources within the Ballia district of Uttar Pradesh, India. Arsenic contamination in water is a growing concern due to its adverse health effects on human populations. The research involves the collection and analysis of water samples from various locations across Ballia to assess the levels of arsenic present. The findings of this study highlight the spatial distribution of arsenic concentrations in different water sources. The total of 50 samples the results indicated that, the arsenic (As) concentration ranged from 0.002 to 0.189 mg L^{-1} with an average of 0.0542 mg L^{-1}. The results contribute to understanding the extent of arsenic contamination in Ballia's water resources and provide crucial information for formulating strategies to mitigate its potential health impacts on local residents. Efforts to monitor and manage arsenic levels in water are essential for safeguarding public health and ensuring access to safe drinking water in the region.

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Development of Long-term SMAP Root Zone Soil Moisture through Machine Learning for Agricultural Drought Assessment over India

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Soil moisture is a vital parameter for monitoring agricultural drought. SMAP L4 root zone soil moisture (RZSM) product due to its comparatively higher spatial resolution (9 km), can be used for this purpose. But its availability from 31st March, 2015 onwards limits its capability for agricultural drought assessment which requires long-term dataset. Therefore, a study was conducted to predict the SMAP L4 data for India from 2001 to 2015 using a widely used machine learning algorithm known as random forest regression. The prediction was achieved by developing season-specific random forest models trained with data from 2016 to 2020, and validated against 2021 data. Several predictor variables were utilized, including actual evapotranspiration, Normalized Difference Water Index, CHIRPS precipitation data, ESA CCI surface soil moisture, GLDAS-Noah root zone soil moisture, and soil static parameters data. The prediction model was reasonably accurate, with an R^2 value between 0.66 and 0.84 and an RMSE varying from 2.8% to 4.7%. The ESA CCI surface soil moisture and GLDAS-Noah data had the highest importance. Using this predicted data from 2001 to 2015 along with the original SMAP L4 RZSM data from 2016 to 2021, the Standardized Soil Water Deficit Index (SSWDI), an enhancement of the existing Soil Water Deficit Index (SWDI), was computed for agricultural drought assessment. The SSWDI identified 2002, 2009, 2012, 2014, and 2015 as major drought years in India, in agreement with records by the Indian government. SSWDI correlated better with the 3-month Standardized Precipitation Index (SPI-3) and NGPPCY-IN dataset of Agricultural Gross Primary Productivity, especially during the late *kharif* season. This emphasizes that the SSWDI is a reliable index for agricultural drought assessment in India. The research emphasizes the potential of combining predicted and actual SMAP L4 RZSM data to enhance agricultural drought assessment.

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Effect of Heavy Metal Contaminated Municipal Solid Waste Cmpost and Co-composted Product Application on Soil Quality

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Generation of municipal solid waste in rural areas, small towns and bigger cities poses a great problem in its management. To overcome this problem, concerned department has come up with tremendous solutions, one among which is the composting of municipal solid waste. The addition of municipal solid waste composts in agricultural soils may however help maintain and improve the soil properties. On the other hand, the heavy metals present in the compost are mobilized through the soil fractions once the compost is introduced in the soil. To overcome the negative impacts of MSW compost, mixing of different raw materials during the process of composting, which is known as co-composting, is regarded as the most economical way for the treatment and final disposal of solid waste. An incubation study was conducted under controlled laboratory condition to evaluate the effect of relatively uncontaminated municipal solid waste compost (MSWC), contaminated municipal solid waste compost and co-composted product of MSW with biochar, zeolite and lime application on heavy metal dynamics and its mobility. The results from the incubation studies revealed that at the end of 60 days after incubation (DAI), the pH was significantly reduced following the application of uncontaminated and contaminated MSWC at both levels of application (80 and 120 t ha^{-1}) over control. The pH and EC value varied from 8.04 to 8.73 and 0.492 to 1.03 dSm^{-1} with highest value (8.73 and 1.03 dSm^{-1}) recorded in soil amended with municipal solid waste Zeolite physical mixture product (MSWZC) at 120 t ha^{-1}. The 1M $CaCl_2$ extractable Cd, Pb and Ni varied from 0.06 to 0.80, 0.23 to 0.55, and 0.23 to 0.49 ppm, respectively. Similarly, DTPA extractable Cd, Pb and Ni varied from 0.04 to 1.7, 1.14 to 27.94 and 0.35 to 6.93 ppm, respectively at the end of 60 DAI. The average per cent reduction in 1M $CaCl_2$ extractable Cd, Pb and Ni was highest in soil amended with co-composed product of zeolite SMSWZC (37, 32 and 25%) followed by SMSWBC (20, 14 and 10%) and SMSWLC (17, 10 and 7%), respectively.

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Enhancing Crop Productivity and Mitigating Greenhouse Gas Emissions through Treated Sewage Water Irrigation and Organic Amendments

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Treated sewage water (TSW) could be a source of crop irrigation with increasing municipal sewage water generation with the growing city population. A pot experiment was conducted to study the effect of treated sewage water (cf. freshwater; FW) with the co-application of inorganic fertilizers, vermicompost, biochar, and fly ash (a byproduct of the thermal power plant) on spinach leaf yield and greenhouse gas emission. There were nine treatments T1: FW+100% RDF (100:50:50); T2: FW+50% RDF + Biocar@10 t ha^{-1}; T3: FW+50% RDF + Fly Ash@20 t ha^{-1}; T4: FW + 50% RDF + Fly Ash@40 t ha^{-1}, T5: FW + 50% RDF + VC@5 t ha^{-1}; T6: TSW + 50% RDF + Biocar@10 t ha^{-1}; T7: TSW + 50% RDF + Fly Ash@20 t ha^{-1}; T8: TSW + 50% RDF + Fly Ash@40 t ha^{-1}; T9: TSW + 50% RDF + VC@5 t ha^{-1}) with a completely randomized block design at three replications. The pot experiment showed that 100% TSW irrigated soils plus 50% RDF plus vermicompost@5 t ha^{-1} significantly enhanced the spinach fresh leaf weight by 95% over 100% FW irrigated soils at 100% RDF (100:50:50). Across irrigation, a significant positive effect of Fly ash @ 20 and 40 t ha^{-1} plus 50% RDF was observed over 100% RDF on spinach leaf yield. Positive effects of biochar in enhancing spinach leaf yield were observed in TSW-irrigated soils with 50% RDF. In addition, TSW (cf. FW) irrigation significantly reduced the soil greenhouse gas emissions (nitrous oxide and methane) with 50% RDF (cf. 100% RDF). The co-application of biochar/fly ash/vermicompost with 50% RDF reduced N_2O emission by 88% compared with 100% RDF in TSW-irrigated soils and 75% in FW-irrigated soils. Similarly, the methane emissions were negative, indicating consumption in co-application of biochar/fly ash/vermicompost with 50% RDF (cf. 100% RDF). The methane consumption was 3.2 times higher in 50% RDF plus biochar/fly ash/vermicompost in TSW-irrigated soils compared with 100% RDF + FW. The FW-irrigated soils with 50% RDF plus biochar/fly ash/vermicompost increased methane consumption by 2.5 times compared with 100% RDF + FW.

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Effect of Yellow Gypsum from Steel Slag on Soil Health and Tomato Yield

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Gypsum from LD slag is unique industrial gypsum which is alkaline in nature having good amount of calcium and sulphur with appreciable amounts of micronutrients such as Fe, Ni, Cu, and Zn. In this study we evaluate the efficiency and response of both industrial and natural gypsum towards soil fertility, quantitative and qualitative yield parameters of tomato. Along with this effect of both gypsum in different soil depth *viz.* surface (0-15 cm) and sub surface (15-30 cm) also studied. Field experiments were conducted with 11 treatments which include different combinations of two doses of RDF and two doses S in the form of natural and industrial gypsums. Among this combination of higher dose RDF and S in the form of natural gypsum T9 (RDF+40 kg S ha^{-1} as Natural Gypsum) shows significantly higher improvement in organic carbon content, MBC primary nutrient status soil while combination of higher dose RDF and S in the form of industrial gypsum shows betterment towards EC, secondary and micro nutrient status of soil. Effect of gypsum on soil fertility more pronounce in surface depth (0-15 cm) of soil than sub surface (15-30 cm).Quantitative yield parameters of tomato such as number of primary branches, the number of fruits per plant, average weight per fruit, average fruit yield per plant and average fruit yield are better responded to natural gypsum treatments while qualitative parameters like reducible sugar content, pectin content, vitamin C content and lycopene content of tomato are better responded to industrial gypsum treatments. However, soil pH, TSS content, fruit pH, Titrable acidity of fruits are not significantly affected by a gypsum treatment.

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Quality of Irrigation Water of Gurgaon Canal and Underground Tubewells in Haryana

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A field survey-based study was conducted during the year 2022 entitled "Effect of wastewater irrigation on soil properties in Gurgaon canal area" in Department of Soil Science, CCS HAU, Hisar taking six blocks in Haryana to observe the effect of Gurgaon canal wastewater irrigation on physical, chemical and biological properties of soils in comparison to the tube-well water. The water samples of Gurgaon canal and surrounding underground tube-well were collected from six blocks *ie*. Sohna, Nuh, Punhana, Ferozepur Jhirka, Hathin and Hodal. The mean value of pH (7.90) of Gurgaon canal wastewater from all the sites was found higher as compared to mean pH value (7.68) in tube-well water indicating slightly alkaline nature of the water. The mean value of EC (2.25 dS m^{-1}) of wastewater collected from Gurgaon canal was found higher than mean EC value (1.40 dS m^{-1}) of tubewell water. Total dissolved solids were relatively higher (1416 mg L^{-1}) in Gurgaon canal water and lower (877 mg L^{-1}) in tubewell water. The overall mean BOD value of wastewater was recorded 39 mg L^{-1} whereas it was found 13 mg L^{-1} in tube-well water. The overall mean COD of Gurgaon canal water was recorded 96 mg L^{-1} whereas it was found 29 mg L^{-1} in tubewell water. This might be due to higher organic load in wastewater. The overall mean value of water-soluble cations *viz.* Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} in wastewater was recorded 3.66, 6.37, 17.28 and 1.83 meq L^{-1} whereas it was found 1.52, 3.39, 10.23 and 0.68 meq L^{-1} in tubewell water, respectively. The overall mean value of water-soluble anions like HCO_3^{-}, Cl^{-} and SO_4^{2-} in wastewater was recorded 4.98, 17.41 and 4.55 meq L^{-1} whereas it was found 1.49, 10.42 and 1.63 meq L^{-1} in tubewell water.

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Modeling the Distribution of Soil Heavy Metals using Geostatistical Methods in Jajmau Industrial Area, Kanpur

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A study was conducted to interpolate the analysis of spatial variability of soil chromium, cadmium, lead and zinc in Jajmau industrial area, Kanpur district. A total of 120 soil samples (0-25 cm) were collected grid wise at an interval of 250 m using GPS. After normalization, data were interpolated by Ordinary Kriging (Spherical, Exponential and Gaussian). The performance of methods was evaluated using Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and Goodness of prediction (G) obtained from a cross-validation procedure. The best model is selected based on low MAE, low RMSE and highest G percentage. Spatial variability maps for different heavy metals revealed high concentration of metals near tannery zones. The results showed that Spherical Model was best for chromium and zinc (RMSE value 582.65 and 57.12) whereas Guassian Model was best fitted for lead and cadmium (RMSE value 13.79 and 2.86). Geostatistical analysis with Ordinary kriging interpolation method revealed strong spatial dependency for chromium (N:S ratio 21.6%) and moderate spatial dependency for lead, cadmium and zinc (N:S ratio 52.9%, 51.5% and 28.7%). Cross validation of kriged map showed that spatial prediction of soil properties using semi variogram parameters is better than assuming mean of observed value for any un-sample location. Therefore, it is a suitable alternative method for accurate estimation of soil properties in unsampled positions as compared to direct measurement which has time and costs concerned.

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Synthesis of PVA/Starch/Bentonite and Oil-formulations for Fertilizer Encapsulation

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Fertilizer is inevitable for intensive agriculture. Since 'green revolution' fertilizer production vis-à-vis consumption has increased tremendously. Nitrogenous (N) and phosphatic (P) fertilizer has occupied correspondingly first and second position in the global fertilizer market. But most of the fertilizers available in the market is highly soluble in nature and resulted uncontrolled dissolution of nutrients, which fails to synchronize with crop nutrient demand. Hence, controlled release fertilizer (CRF) has come. Among different techniques surface coating is mostly practiced and convenient. In first setup biodegradable clay-polymeric (starch/PVA) blended encapsulating films (CPSBs) from starch/PVA and clay-fractioned bentonite were developed for CPSB-encapsulated diammonium phosphate (DAP) production; in another setup four oil-based formulations were developed from different combinations of double-boiled linseed (*Linum usitatissimum*) and mustard (*Brassica juncea*) oils for DAP encapsulation. The XRD, TEM and FTIR spectroscopy recognized the compatibility of bentonite with starch/PVA blend; several micropores in CPSB surface was visible through SEM. Relative crystallinity index, density of CPSBs increased with increasing bentonite content (0-20 wt%); but, porosity, water absorption was decreased. Half-life of CPSB-10 was 37.4, 40.1 and 51.9 days with Aspergillus awamori, Trichoderma viride and uninoculated soil, respectively. The binary threshold images directed Oil-1 had lowest surface wrinkle and SEM images also depicted Oil-1 coated DAP had smooth surface morphology. Nitrogen (N) and phosphorus (P) release data from CPSB encapsulated-DAP and uncoated DAP fitted well to Korsmeyer-Peppas model. Soil incubation data indicated that N is more temperature sensitive than P, and surface coating with oil formulation could extend the period of nutrient release. Overall, greater bentonite content stabilizes the CPSB structure and CPSB-encapsulation reduced the N and P release from DAP. Therefore, CPSB- and double-boiled linseed and mustard oil-based Oil-1 formulation-encapsulation could be an alternative option to produce cost effective controlled release fertilizers.

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Performances of Dry- and Fresh- Municipal Sludge in Mesocosm Column Experiment with Spinach

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In India, urban population shared 10.84% of total population in 1901; whereas, this figure is 35.69% in 2021. Increased operationalization of sewage treatment plants (STPs) has generated huge quantity of municipal sludge and extracted sludge are reportedly dumped in the open field, which get dried subsequently. On the other hand, sludge contain good quantity of nutrient sources. This demand proper urban waste management. Hence, this article emphasized to assess the performances of dry- (DS) and fresh- (FS) municipal sludge in mesocosm column experiment (in presence of biochar and lime) with spinach. The scanning electron microscopic (SEM) images revealed that biochar had several structural micro-pores. The treatments comprised of graded doses of DS and FS (equivalent of 0, 20 and 40 t ha^{-1}), biochar (equivalent of 0, 5 and 10 t ha^{-1}) and lime (0.8 t ha^{-1}). Results revealed, compared to control all the plant (major-, micro-, and toxic metals), soil and leachate parameters (pH, EC, micro-, and toxic metals) have significantly increased. Performances of DS and FS were statistically at par in most of parameters assessed. But effect of biochar and lime were significantly and positively visible. With higher doses of biochar germination (%), leave, root dry weight and chlorophyll contents significantly improved; whereas, NO_3^--N, Fe, Mn, Zn, Cu and Pb content decreased in the leachate. Interestingly, decreased activities of dehydrogenase (DHA) and Fluorescein diacetate (FDA) were recorded under DS than the FS. Metal uptake by spinach were below permissible limits and calculation of hazard quotient (HQ) also indicate safe utilization of municipal sludge (40 t ha^{-1} with 10 t ha^{-1} biochar) for spinach production without hampering the environmental sustainability and human food-chain. In long run, application of municipal sludge may enhance the crop-soil performances, may further trigger soil C sequestration.

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Thermodynamic Approaches to Remove Pb and Cd from Wastewaters using different Adsorbents

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Water shortages and water pollution have become key challenges for sustainable development, as heavy metal ion removal in wastewater become the bottleneck of wastewater purification and recycle. The objective of this study is to investigate the adsorption thermodynamics of Pb and Cd from aqueous solutions by wheat straw biochar, modified- fly ash and bentonite. To explore the effect of temperature, the adsorption percentage was determined at 298, 308, and 318 K maintaining solution pH: 5.0, adsorbent dose: 10 g L^{-1}, contact time: 60 min, and metal ion concentrations: 50 ppm and 10 ppm for Pb and Cd, respectively in each case. The fact that Pb adsorption efficiencies of wheat straw biochar, modified- fly ash and bentonite decreased from 97 to 95%, 75 to 60% and 98 to 96%, respectively on increasing the solution temperature from 298 to 318 K. Further, Cd adsorption efficiencies of wheat straw biochar and modified fly ash decreased from 73 to 59% and 98 to 93%, respectively on increasing the solution temperature from 298 to 318 K; however, temperature had no effect on Cd adsorption efficiency of modified bentonite (~99% at all temperature). Thermodynamic parameters including changes in Gibbs free energy (ΔG), entropy (ΔS), and enthalpy (ΔH) are the indicators of the possible nature of adsorption. The ΔG values are negative at all temperatures, indicating the spontaneous nature of Pb and Cd adsorption on the adsorbents. As the temperature increases, an increase in the ΔG value indicates that the adsorption process is more favorable at lower temperatures. The $\Delta S > 0$, indicating that the process by which Pb and Cd are adsorbed on the adsorbents are spontaneous and irreversible. A negative value of ΔH indicates that the adsorption process is exothermic in nature.

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Agricultural Appraisal of Mine Drainage and Residues around Coal and Copper Mine Areas, Madhya Pradesh

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The study aims to assess the quality of mine drainage in view of agricultural uses and to evaluate the impacts of mine drainage on surrounding agricultural ecosystems. Singrauli coal mine drainage water was moderately to highly alkaline in nature. Lower EC and TDS in mine and drainage water indicates very low dissolved ions are present in higher pH. The average concentration of sulfate and Mn in mine and surrounding water exceeded the permissible limit by USEPA, while Cu, Fe, Zn, Ni and Pb fall behind their respective critical limit in water. Coal mine and agricultural soils are slightly acidic to neutral and non-saline in nature. Higher organic C and available P are found in mine soil compared to the agricultural soil. Besides, Malanjkhand copper mine water extremely to slightly acidic and water in nearby villages acidic to slightly alkaline in nature and electrical conductivity ranges between 250-4250 μS cm^{-1}. Fe, Ni, Pb and Zn concentrations were within safe limit in copper mine water; but Mn, Co and Cu were in higher concentration. Malanjkhand copper mine area soil extremely to slightly acidic in nature based on pH dependent acidity, total acidity and exchangeable acidity; and EC ranges between 176-802 μS cm^{-1}. Copper mine soils were high in organic carbon, low in available P and low to medium in available K, however nearby village area soils were low to medium in organic carbon, low to medium in available P and medium to high in available K. It has been concluded that, no detrimental effect on soil fertility was found in nearby agricultural soils as their soil is the sink of organic C. Moreover, mine drainage can be used for the irrigation in nearby agricultural fields by modifying the sulfate, Mn, Co and Cu concentration.

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Potential Health Risk of Heavy Metals via Consumption of Rice, Pulses and Vegetables Grown in the CKDu Endemic Areas of Cuttack District, India

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Chronic kidney disease of unknown etiology (CKDu) is a emerging public health concern in India. The present study was carried out to investigate the concentrations of potentially toxic heavy metals (Cd, Pb, Ni, Cr, Hg and As) in locally grown food crops (rice, pulses and vegetables) in CKDu prevalent areas of Cuttack district, India. Exposure risks from food crops were analysed, including estimated daily intake, hazard quotient, hazard index, and carcinogenic risk. The overall heavy metal concentrations in the crop samples were in the following order: Pb>Ni>Cd>Cr>As>Hg. The mean concentration of heavy metals in different crops were as follows: spinach> rice> okra> mustard> potato> carrot> tomato> green gram> black gram. A statistical multivariate analysis revealed that the primary sources of Cd, Pb, Ni, Cr, Hg, and As in crop samples were both natural and human activities. For lead, target hazard quotient (THQ) values in rice were greater than 1, indicating significant noncarcinogenic health risks to both adults and children. While the majority of the crop samples had Pb levels below the permissible level (10^{-5}), the target carcinogenic risk of Cd was higher than the USEPA threshold level (10^{-4}), showing a cancer risk to adults and children. This study concluded that long-term intake of locally grown food crops may produce a significant health risk to the local inhabitants, and that of regular heavy metal monitoring is strongly recommended in this region.

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Effect of Tillage and Residue Management on Soil Nutrient and Carbon Dynamics under Jute Based Cropping Systems in Indo-Gangetic Plains

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Long-term effect of tillage systems *i.e.,* conventional tillage (CT), no tillage (NT) and no tillage with additional crop residue retention (NT+R) on soil nutrient and organic carbon dynamics were evaluated under most predominant jute based cropping systems (jute-rice-wheat; J-R-W, jute-rice-lentil; J-R-L and jute-rice-mustard; J-R-M) in Lower Indo-Gangetic plains. Additional crop residues were applied as *Sesbania* spp. during sowing of jute @ 2 t ha^{-1}. Available nutrient (N, P and K) contents in soil and crop uptakes after completion of 6th year of crop cycle showed that highest amount of nutrient availability was found in NT+R (N: 338.01; P: 44.21 and K: 179.24 kg ha^{-1}, respectively) as compared to NT and CT. Similarly, the crop uptake was also highest in NT+R (N: 84.72; P: 28.90 and K: 77.28 kg ha^{-1}, respectively). The nutrient balance sheet showed that there was a positive nutrient balance in all the tillage treatments with highest positive balance in NT+R (N: 195.89; P: 28/02 and K: 134.17 kg ha^{-1}, respectively). The soil organic carbon (SOC) density and SOC stock, indices for estimating the SOC accumulation/status in the soil system varied significantly under various treatments from an initial SOC density of 234.24 g m^{-2}. Among the tillage treatments, SOC density varied in between 242.17-330.03 g m^{-2} whereas it is ranging from 273.92 to 303.43 g m^{-2} under cropping systems treatments. NT+R contributed the highest SOC stock (3.30 Mg C ha^{-1}) followed by NT (2.94 Mg C ha^{-1}), and CT (2.42 Mg C ha^{-1}). NT+R contributed the highest SOC stock (3.30 Mg C ha^{-1}) followed by NT (2.94 Mg C ha^{-1}), and CT (2.42 Mg C ha^{-1}). Addition of crop residue improved soil bulk density, soil organic carbon (SOC), particulate SOC content (PSOC) and aggregate stability irrespective of tillage, promoting a better root-zone hydro-physical regime. Thus, no tillage with residue incorporation (NT+R) under Jute-rice-lentil system is highly beneficial in maintaining sustainability and improving soil nutrient and organic carbon status in Lower Indo-Gangetic plains.

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Impact of Soil Mining on Soil Quality in Bundelkhand Region

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Bundelkhand region of central India is covers thirteen districts of Uttar Pradesh and Madhya Pradesh. The local soils of Bundelkhand region are categorized into two broad groups *i.e.* Black soil and Red and yellow soil which further sub grouped into Mar, Kabar, Paruwa and Rakar which is complex and highly variable. Soil, one of the most valuable thing for every living being on earth. So if top soil is removed it will definitely affect the soil composition. In recent few years harvesting of soil is done for various purposes as in construction brick making, governmental projects etc. Top Soil harvesting in Bundelkhand region is emerging trend for their farmers and needy peoples. A million tonnes of soil were lifted from the ground to build the recently constructed Bundelkhand Expressway, shaping of canal and making of bricks. Farmers are creating the pond in their agricultural field and about 50-60% of the mined soils are sold to contractor to earn money. This adversely affected the entire landscape causing irreversible damages to soil, hydrology and ecological balance. Keeping these points, this experiment was conducted to explore the impacts of soil harvesting on soil quality in Bundelkhand region.

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Water Quality and Risk Assessment

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India makes up more than 18% of the world's population but only possesses 2.4% of the planet's land area and 4% of its renewable water resources. The availability of utilisable water will be increasingly strained in the future, with the prospect of escalating water disputes among various user groups, due to a growing population, increasing needs of a rapidly developing country, and the influence of climate change. Poor awareness of the quality, value, and scarcity of water leads to ineffective management, waste, and mismanagement of resources. Water quality and agriculture interactions are many and complex. Large irrigation schemes contributed to global food security, particularly in arid areas, but it has also developed land and water salinity problems. Both, expansion and intensification of agriculture with increased and injudicious use of fertilizers and pesticides, has degraded the water quality of rivers, lakes and marine water bodies. Intensification of livestock farming systems increased the potential transmission of pollution from both animal waste and fodder production resulted in eutrophication of freshwater bodies. Water scarcity has driven millions of farmers worldwide to irrigate with marginal quality water such as wastewater from urban or industrial areas or saline water. Maintaining environmental and human health by minimizing safety risks and, at the same time, maximizing benefits when using such water is an enormous challenge. The use of naturally occurring arsenic-laden groundwater in agriculture are growing and, therefore, this emerging issue will need special attention. These examples elaborate the complex interactions between agriculture and water quality. The share of water resources and its quality is deteriorating day by day that requires attention. A systematic study to identify the risk and its proper mitigation or adaptation is the need of the hour. Stringent policy guidelines to be framed in convergence with all the stakeholders associated with irrigation water management.

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Assessment of Arsenic contamination in a water-soil-plant Continuum of Nadia district of West Bengal, India

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Arsenic (As) contamination in soil and water is one of the global threats to food security, environment and human health. Arsenic contamination in environment directly or indirectly impedes barriers in achievement of sustainable development goals *viz.* zero hunger, poverty, clean water and sanitation, life below water, life on land *etc.* In this present investigation, 22 water samples and 201 soil and plant samples from Nadia West Bengal were collected to assess the status of As in water-soil-plant continuum and risk imposed by As to human health. Result revealed that As content in water samples varied from 12.7 to 91.9 µg L^{-1} with a mean value of 24.3 µg L^{-1}. Arsenic content in all groundwater samples exceeded the permissible limit (<10.0 µg L^{-1}) for drinking as prescribed by world health organization (WHO). Life time cancer risk (LCR) calculation based on As content in water indicated that over all LCR was much higher (1.09×10^{-3}) than prescribed permissible limit of 10^{-6}. On an average total and extractable As content in soil was 19.3 and 1.45 mg kg^{-1}, respectively. Arsenic content in straw ranged from 0.88 to 11.1 mg kg^{-1} while grain As content varied from 0.20 to 0.61 mg kg^{-1} with an average value of 0.43 mg kg^{-1}. Hazard quotient (HQ) as an index of health hazard to human for consumption of As though rice grain calculated based on As content in brown rice ranged from 0.27 to 0.83 with a mean value of 0.58. Present investigation revealed that contaminated water may pose risk to human health and enhanced health related expenditure and use of As-contaminated groundwater over the year led to an increase in As levels in the soil and food-chain beyond acceptable limits.