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Methodology Used

Sample collection

A total of 9,067 soil samples were collected from the lowland rice fields in Sri Lanka before the beginning of *Maha* season 2019/2020 using a stratified random sampling approach. Selection of locations and collection of soil samples were made as described in Kadupitiya *et al*. (2021). In brief, the total land area in Sri Lanka was divided into 1 km × 1 km grids using ArcGIS software. A reference number (*i.e*. grid identification number; Grid-ID) was given to each grid. Out of the

total number of grids in the country (65,610), the total rice cultivated extent was distributed only in 35,537 grids while the rest had other land uses. A total of 9,067 grids consisting of paddy fields were selected (out of 35,537 in total) using a stratified random sampling approach, based on the administrative districts. Paddy fields in each grid were recognized using the Google Earth software. The Google map was used as the base map to facilitate the finding of paddy lands. The grids were overlaid on the paddy land map using ArcGIS software. Grid ID, district, divisional secretariat division (DSD), and the village name of each grid were recorded. From each village, one rice track (*i.e*. geographically confined lowland area usually owned and managed by a group of farmers) was selected randomly for sample collection. One sample was a composite of six subsamples collected at 0-15 cm depth from a paddy track considering the field-level heterogeneities. Soil samples were air-dried, and debris was removed, homogenized, and sieved using a 2 mm sieve.

Laboratory analysis

Element concentrations were determined after extracting into 0.01 M $CaCl_2$ solution (Salomon 1998; Houba *et al*. 2000; Bibiso *et al*. 2015), except for exchangeable K and available P in soil. The extraction was made with a soil/solution ratio of 1:10 (w/v) i.e. 5 g soil was dissolved in 50 mL 0.01 M $CaCl_2$. Samples were shaken for 2 hours on an orbital shaker at 200 rpm, at room temperature, and then the solution was centrifuged at 3,600 rpm for four minutes. The supernatant was filtered through a 0.45 µm cellulose acetate syringe filter. Element concentrations in the soil solution was determined using an inductively coupled plasma mass-spectrometry (ICP-MS) (Thermo iCapQ). Forty samples were tested at once in each round. It consisted of 36 soil samples, two laboratory standard soil samples, and two blanks with 0.01 M $CaCl_2$ solution without soil samples for quality control.

For the determination of soil pH and EC, 10 g of soil was measured from each sample and mixed with 50 mL of distilled water. Samples were shaken for two hours in an orbital shaker at room temperature. After resting for 15 minutes, soil pH was measured using a pH and EC meter (Eutech WC PC 650, Singapore). Two laboratory standard soil samples and two blanks only with distilled water were used in each batch (i.e. 36 samples) for internal quality control. Moreover, the pH electrode was calibrated daily using the manufacturer's standards (Eutech WC PC 650, Singapore).

Determination of available P concentration

Available P concentration in soil samples was determined using Olsen method (Olsen, 1954). Dried, homogenized and sieved soil samples of 4 g were measured into clean and dry conical

flask of 250 mL. Soil samples were treated with 50 mL of 0.5 M sodium bicarbonate ($NaHCO_3$) and allowed to shake for one hour on an orbital shaker at room temperature. Then the solution was filtered using Whatman® filter papers (No.40; D=110mm). From the extract, 5 mL was pipetted out in to 25 mL of volumetric flask and 4 mL of Nitro-Vando Molybdate colour development reagent was added. Available P concentration was determined using spectrophotometer at 880 nm (A & E, AE-S70-2U, England) and expressed as mg P kg^{-1} soil.

Determination of exchangeable K concentration

Exchangeable K concentration in soil was extracted using 1 M ammonium acetate (NH_4OAc-AA) (Van Ranst et al., 1999). Here, 4 g of air dried, homogenized and sieved soil sample was treated with 50 mL of 1 M AA solution, buffered at pH 7 and shaken for two hours on an orbital shaker at room temperature. Then the solution was filtered using Whatman® filter paper (No.40; D=110mm) and K concentration was determined using a flame photometer at 766.5 nm wavelength (Jenway, Sussex, England) and expressed as mg K kg^{-1} soil.

Preparation of spatial maps

Since, each sampling point was tagged with Grid-ID, which was coded with distance (km) coordinate X-Y, the same ID was maintained from field data collection to laboratory analysis and data analysis. This procedure allowed easy spatial reference for data set development and facilitate user-friendly GIS map production using ArcGIS software.

References:

Kadupitiya, H.K., Madushan, R.N.D., Rathnayake, U.K., Thilakasiri, R., Dissanayaka, S.B., Ariyaratne, M., Marambe, B., Nijamudeen, M.S., Sirisena, D. and Suriyagoda, L. (2021) Use of Smartphones for Rapid Location Tracking in Mega Scale Soil Sampling. *Open Journal of Applied Sciences*, 11, 239-253.