Research Article

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Potential of soil resources of Coconut Research Station, Aliyarnagar, Tamil Nadu, India for agro-technology generation

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Abstract

Potential of soil resources of Coconut Research Station, Aliyarnagar of Tamil Nadu Agricultural University and one of the Centers of ICAR-AICRP (Palms), was assessed by soil profile examination and spatial variability mapping. Three soil profiles were examined, one each in A, B and C blocks of the farm horizon wise samples were collected, and fertility parameters were analyzed. Spatial variability of primary nutrients was mapped employing GIS techniques. Soil profile examination revealed the presence of canker nodules in the lower horizons and the depth of the soil was not a constraint for the cultivation of perennial crops. The texture of the soil varied from loamy sand to sandy clay loam. pH was alkaline and electrical conductivity was less than 2 dSm^{-1}. The content of $KMnO_4$-N was low, and Olsen P, $NNNH_4OAc$-K and organic carbon were medium. Land capability class was IIIew and was highly suitable (S1) for coconut, moderately suitable (S2) for cocoa and marginally suitable (S3) for pepper. The soil taxonomic class is fine-loamy mixed, isohyperthermic *Fluventic/Typic Haplustepts*. Rock outcrops were noticed over 5 per cent of the area. Top soil erosion and seepage problems resulting in temporary water logging are the major fertility constraints associated with this farm. Scrupulous application of organic manures, split application of fertilizers, providing trenches in areas of water logging, *etc*., are the strategies to overcome the constraints, which are existing in the farm.

Keywords: Coconut Research Station, constraints, soil fertility, soil profile, spatial variability

Introduction

Optimal land, use according to its capability, forms the basis for sustainability whilst exploitation of land beyond the yield potential leads to land degradation. Soils are indispensable resources, but their multipurpose and continuous exploitation have serious impacts on the ecology of a particular region (Gorai *et al*., 2013). Soils are characterized by a high degree of spatial variability due to the combined effect of physical, chemical and biological processes that operate with different intensities and at different scales (Gooverts, 1998). Today is the era of climate-smart and site-specific farming, in which the nutrient inputs are tailored in accordance with the soil fertility status to meet the crop demand. Variability in soil fertility across farm fields causes spatial variability in crop yields (Rockstrom *et al*., 1999; Gaston *et al*., 2001). Information of the soil with respect to its genesis, characteristics, classification and extent of distribution, potentials and problems are imperative for land use planning in a specific area (Mahapatra *et al*., 2005). For strategic agricultural planning in research stations, the most relevant agricultural issues of a given region have to be identified, and conflicts between the increase in productivity and degradation of natural resources addressed.

Assessing soil variability, irrigation water quality and profile exploration in research institutes dealing with principal crops is crucial for the correlation of data generated from various field experiments, to understand the existing soil fertility

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constraints, to bring out its interaction with the environment and to extrapolate the obtained results to the farmers of the region for effective land use. Coconut Research Station at Aliyarnagar is one of the crop-oriented research stations of Tamil Nadu Agricultural University located in the Western Zone of Tamil Nadu and a prominent research centre of the ICAR - All India Co-coordinated Research Project on Palms. The station is vested with the regional and national responsibilities of evolving new varieties of coconut, assessing the suitability of crops to adapt to the cropping pattern of Western Zone of Tamil Nadu and to develop integrated pest and disease management strategies for coconut and coconut-based intercrops. Hence, the present study was undertaken to examine the soil profiles of various blocks of the farm in which coconut and coconut-based intercrops are cultivated, characterize the horizons, assess the quality of irrigation water to devise comprehensive land use plan and to develop agricultural technologies for maximizing farm income.

Materials and methods

Coconut Research Station is located near Western Ghats (10^0 29’ 499" N and 76^o 58’ 821" E) in the Western zone of Coimbatore district of Tamil Nadu, at an elevation of 260 m above MSL with undulating topography. The average annual rainfall of the tract is 802 mm, of which nearly 300 mm is received during South-West monsoon, 333 mm during North-East monsoon and 169 mm during summer. The station owns 22 hectares of land, of which nearly 18.8 hectares are under cultivation. It is divided into three blocks *viz.,* A, B and C for ease of management. Parambikulam Aliyar canal (supplemented by one open well) serve as the source of irrigation. The soil type of the station is sandy clay loam (*Typic/Fluventic Haplustepts*). The major and predominant geological formations of Aliyar are of granite gneiss, biotite gneiss and charnockite in general. Massive gneissic outcrops are observed along the Aliyar river. The foliation trend is North-East to South-West with a south-easterly dip. The thickness of the weathered zone ranges from 3 to 4 meters in general. The fissured hard rock formations are of the peninsular gneissic complex of Archean age.

Three master profiles were examined (Bhattacharya *et al*., 2009) one each in the three blocks, soil samples of each horizon of representative pedons were collected, processed and analyzed for important physico-chemical properties employing standard procedures (Sarma *et al*., 1987). Surface (0-15 cm) and sub-surface (15-30 cm) samples were collected from all the 43 fields of the farm. Soil fertility parameters *viz.,* pH, electrical conductivity, $KMnO_4$-N, Olsen P and $NNNH_4OAc$-K were analysed in the soil samples as per the procedures outlined by Black (1965). The soil map was overlaid over Quick Bird Satellite Imagery and digitized (Fig. 1). A database file consisting of data for X and Y coordinates was created in Microsoft Excel. A shape file showing the sampling locations was created in Arc GIS software. The database file was joined to the point data. Thematic maps on available nutrient status (N, P and K) were generated

Fig. 1. Farm map overlaid over Quick Bird Satellite Imagery

by categorizing the fertility status as ‘low’, ‘medium’ and ‘high’ by kriging.

Results and discussion

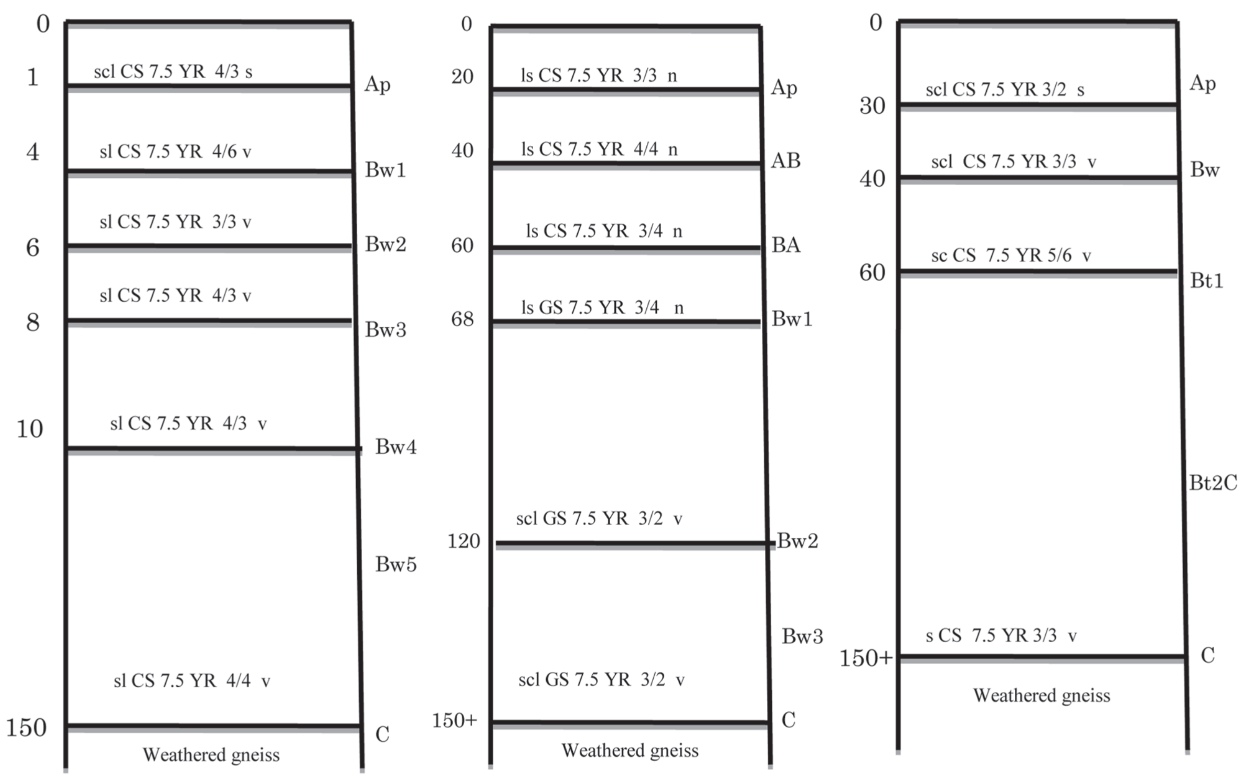
Morphological characteristics of soils

The morphological characteristics of the horizons of diverse pedons are presented in Tables 1, 2 and 3. The horizonation of the soil profiles with hue, value and chroma is depicted in Figure 2.

Pedon 1 explored in field A5 of A block is brown to dark brown, sandy loam to sandy clay loam in texture, sub-angular blocky in structure; slightly hard, slightly firm exhibiting strong effervescence on testing with HCl. The depth is 150 cm, and the parent material is weathered gneiss. Research trial on the comparative evaluation of Niu Leka Green Dwarf, Chowghat Orange Dwarf and Malayan Green Dwarf varieties of coconut is undertaken in this field. Pedon 2 excavated in field B8 is brown to dark brown, loamy sand in the surface and sandy clay loam in the subsurface, non-sticky and non-plastic in the surface horizons, moderately sticky and plastic in the subsurface with brisk effervescence on testing with dilute HCl. The land use of the field in which the pedon was excavated is multiple cropping with cocoa clones CCRP 1-7, coconut and pepper. Pedon 3 was opened in field C8 in which exotic breeds of coconut is being maintained. The texture varies from sandy clay loam to sandy clay and exhibits strong to violent effervescence throughout the profile.

Analysis of horizon wise soil samples

Physical and chemical properties in the horizons of soil profiles are depicted hereunder.



Coarse-loamy mixed, calcareous isohyperthermic, Fluventic Haplustepts

Coarse-loamy, mixed, calcareous isohyperthermic, Typic Haplustepts

Fine – loamy, mixed, calcareous isohyperthermic, Typic Haplustalfs

Fig. 2. Horizonation of the soil profiles

Table 1. Description of the soil profile 1 (Field A5)

Taxonomic Class: Coarse-loamy mixed, calcareous, isohyperthermic, *Fluventic Haplustepts*

Land Use: Coconut cultivars: Niu Leka Green Dwarf, Chowghat Orange Dwarf and Malayan Green Dwarf

Horizon	Depth	Description
Ap	0-18 cm	Brown (7.5YR 4/3), sandy clay loam; moderate medium sub-angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; very fine, common roots; common fine, very fine pores; strong effervescence; strongly alkaline (pH 8.84) and clear smooth boundary.
Bw1	18-44 cm	Brown (7.5YR 4/6), sandy loam; weak medium sub-angular blocky; slightly hard, slightly firm, slightly sticky and slightly plastic; fine, common roots; common fine, very fine pores; violent effervescence, strongly alkaline (pH 8.57) and clear smooth boundary.
Bw2	44-65 cm	Dark brown (7.5YR 3/3), sandy loam; weak medium sub-angular blocky; slightly hard, slightly firm, slightly sticky and slightly plastic; fine, common roots; many fine, very fine pores; violent effervescence, strongly alkaline (pH 8.50) and clear smooth boundary.
Bw3	65-75 cm	Brown (7.5YR 4/3), sandy loam; weak medium sub-angular blocky; slightly hard, slightly firm, slightly sticky and slightly plastic; fine, many roots; common fine, very fine pores; violent effervescence; strongly alkaline (pH 8.75) and clear smooth boundary.
Bw4	75-85 cm	Brown (7.5YR 4/3), sandy loam; weak medium sub-angular blocky; slightly hard, slightly firm, slightly sticky and slightly plastic; fine, many roots; common fine, very fine pores; clear smooth boundary; violent effervescence, strongly alkaline (pH 8.67) and clear smooth boundary.
Bw5	85-108 cm	Brown (7.5YR 4/4), sandy loam; weak medium sub-angular blocky; slightly hard, slightly firm, slightly sticky and slightly plastic; fine, few roots; common fine, very fine pores; clear smooth boundary; violent effervescence; strongly alkaline (pH 8.67) and clear smooth boundary
Cr	108-150 cm	Weathered gneiss

Table 2. Description of the soil profile 2 (Field B8)

Taxonomic Class: Coarse-loamy, mixed, calcareous. isohyperthermic *Typic Haplustepts*

Land Use: Multi-storeyed cropping with coconut, cocoa and pepper.

Horizon	Depth	Description
Ap	0-20 cm	Dark brown (7.5YR 3/3), loamy sand; granular, loose, friable, non- sticky and non-plastic; medium, many roots; common fine and very fine pores; slightly alkaline (pH 7.63) and clear smooth boundary.
AB	20-40 cm	Brown (7.5YR 4/4), loamy sand; granular, loose, friable, non-sticky and non-plastic; medium, many roots; common fine and very fine pores; clear smooth boundary; slightly alkaline (pH 7.42) and clear smooth boundary.
BA	40-60 cm	Dark brown (7.5YR 3/4), loamy sand; granular, loose, friable, non- sticky and non-plastic; fine, many roots; common fine and very fine pores; moderately alkaline (pH 8.11) and clear smooth boundary.
Bw1	60-88 cm	Dark brown (7.5YR 3/4), loamy sand; granular, loose, friable, non- sticky and non-plastic; fine, few roots; common fine pores; moderately alkaline (pH 8.34) and gradual smooth boundary.

Bw2	88-120 cm	Dark brown (7.5YR 3/2), sandy clay loam; moderate, medium sub- angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; fine, few roots; few fine and very fine pores; strongly alkaline (pH 8.61) and gradual smooth boundary.
Bw3	120-150 cm	Dark brown (7.5YR 3/2), sandy clay loam; moderate, medium sub- angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; fine, many roots; common fine and very fine pores; gradual smooth boundary; violent effervescence; strongly alkaline (pH 8.52).
Cr	150+	Weathered gneiss

Table 3. Description of the soil profile 3 (Field C8)

Taxonomic Class: Fine- loamy, mixed, calcareous isohyperthermic *Typic Haplustalfs*

Land Use: Coconut - Exotic varieties

Horizon	Depth	Description
Ap	0-30 cm	Dark brown (7.5YR 3/2), sandy clay loam; moderate medium sub- angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; very fine few roots; few fine and very fine pores; clear smooth boundary; strong effervescence; moderately alkaline (pH 8.31) and clear smooth boundary.
Bw	30-40 cm	Dark brown (7.5YR 3/3), sandy clay loam; moderate medium sub- angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; fine few roots; few fine and very fine pores; violent effervescence; strongly alkaline (pH 8.53) and gradual smooth boundary.
Bt1	40-60 cm	Dark brown (7.5YR 4/4), sandy clay; moderate medium sub-angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; fine few roots; few fine pores; patchy thin clay skins; violent effervescence; moderately alkaline (pH 8.43) and gradual smooth boundary.
Bt2C	60-150 cm	Dark brown (7.5YR 3/3), gravelly sand; moderate medium sub-angular blocky; slightly hard, slightly firm, moderately sticky and moderately plastic; few fine roots; few fine and very fine pores; patchy thin clay skins; violent effervescence; strongly alkaline (pH 8.65).
Cr	150+	Weathered gneiss

Physical properties

Bulk density of the horizons varied from 1.34 to 1.74 Mg m^{-3} across different profiles. Bulk density was remarkably less in the clay dominant horizons and was higher in the sandy textured layers. In the A block profile, the surface horizon had lower bulk density compared to the sub-surface horizons, which may be attributed to compaction of the soil because of the recurrent use of machineries. In B block profile, bulk density was less in Bw2 and Bw3 horizons compared to the upper layers. In the profile of C block, bulk density was higher in Bt2C compared to other horizons. Particle density ranged from 2.31 to 2.76 Mg m^{-3} and the porosity from 24.7 to 51.4 per cent across different horizons. Coarse fragments on volume basis ranged from 1.8 to 19.0 per cent in different horizons (Table 4). Percentage of coarse fragments in the soil was less in the cocoa intercropped fields of B block and was the highest in C block of the farm wherein exotic varieties of coconut is cultivated.

Electrochemical properties

The pH of the soil samples collected in the soil profile of A block was strongly alkaline, and an inconsistent trend was observed with respect to the variation in pH among the horizons. In the soil

Table 4. Physical properties of the horizon samples of soil profiles

Sl. No.	Horizon with depth range	Bulk density ($Mg\ m^{-3}$)	Particle density ($Mg\ m^{-3}$)	Porosity (%)	Sand (%)	Silt (%)	Clay (%)	Coarse fragments on a volume basis (%)
	Profile - A Block							
1.	Ap (0-18 cm)	1.44	2.52	38.9	51	17	24	5.2
2.	Bw1 (18-44 cm)	1.60	2.43	34.2	65	12	09	8.8
3.	Bw2 (44-65 cm)	1.65	2.43	32.1	62	10	11	10.3
4.	Bw3 (65-75 cm)	1.55	2.36	34.3	58	11	09	14.2
5.	Bw4 (75-85 cm)	1.60	2.73	41.4	60	12	10	11.3
6.	Bw5 (85-108 cm)	1.55	2.73	43.2	59	09	11	13.5
	Profile - B Block							
7.	Ap (0-20 cm)	1.65	2.56	35.5	75	9	6	6.1
8.	AB (20-40 cm)	1.65	2.62	37.0	80	8	7	3.0
9.	BA (40-60 cm)	1.65	2.58	36.0	77	9	8	3.6
10.	Bw1 (60-88 cm)	1.70	2.61	34.9	81	10	6	1.8
11.	Bw2 (88-120 cm)	1.42	2.56	36.7	48	15	28	5.6
12.	Bw3 (120-150 cm)	1.48	2.64	38.6	50	18	24	4.9
	Profile - C Block							
13.	Ap (0-30 cm)	1.48	2.61	41.0	48	17	15	13.0
14.	Bw (30-40 cm)	1.60	2.59	38.2	50	18	16	10.0
15.	Bt1 (40-60 cm)	1.34	2.76	51.4	42	17	30	8.2
16.	Bt2C (60-150 cm)	1.74	2.31	24.7	50	12	5	

profile of B block, pH of the horizons 1 and 2 was neutral whilst the rest were slightly alkaline. In ‘C’ block, pH of all the horizons hovered around 8.3-8.6. The increased pH in specific horizons may be attributed to the calcareous nature of the soils in certain depths. This was further confirmed by effervescence with HCl. Electrical conductivity was <2 dS m^{-1} irrespective of the depth of sampling. The results are in close compliance with Selvamani and Duraisami (2014), who reported 95 per cent of the soil samples of Coimbatore district are non- saline in nature. The inconsistent trend in variation of EC along the horizons restricts drawing a valid conclusion. The cation exchange capacity of the soil was higher in the horizons with clay texture and was the least in the horizon with sandy texture (Table 5). The results are in close compliance with Yunan *et al.* (2018) who established a positive correlation between the contents of clay, silt and organic matter and negative correlation with sand. Per cent base saturation was high in the top horizons of C block and was the lowest in Bt2C horizon of C block.

Primary nutrients

$KMnO_4$-N content of all the soil samples of the horizons was low in status, and a gentle gradation was observed with increasing depth of the profile. The surface horizons recorded comparatively higher $KMnO_4$-N content than the sub-surface horizons. The results are in close compliance with Sudhalakshmi *et al.* (2017), who reported 92 per cent of the surface soils of the farm to have the low status of $KMnO_4$-N. Olsen-P content was low to medium irrespective of the horizonation. The very low content of phosphorus in the horizons of C block may be attributed to the fixation of P as calcium phosphate. The status of $NNNH_4OAc$-K content was low to medium across the horizons, and exchangeable sodium content was beyond the threat for developing any chemical constraint (Table 6).

Table 5. Electrochemical properties of the horizon samples of soil profiles

Sl. No.	Horizon with depth range	pH	Electrical conductivity ($dS\ m^{-1}$)	Cation exchange capacity (cmol (+) kg^{-1} soil)	Base saturation (%)
	Profile - A Block				
1.	Ap (0-18 cm)	8.84	0.13	12.2	72.2
2.	Bw1 (18-44 cm)	8.57	0.09	10.8	65.6
3.	Bw2 (44-65 cm)	8.50	0.09	10.8	65.6
4.	Bw3 (65-75 cm)	8.75	0.11	11.8	68.4
5.	Bw4 (75-85 cm)	8.67	0.07	10.4	70.4
6.	Bw5 (85-108 cm)	8.67	0.07	10.4	70.4
	Profile - B Block				
7.	Ap (0-20 cm)	7.63	0.08	7.8	60.8
8.	AB (20-40 cm)	7.42	0.04	8.2	56.8
9.	BA (40-60 cm)	8.11	0.05	9.1	57.8
10.	Bw1 (60-88 cm)	8.34	0.07	8.6	57.8
11.	Bw2 (88-120 cm)	8.61	0.08	11.9	69.6
12.	Bw3 (120-150 cm)	8.52	0.10	10.6	66.8
	Profile - C Block				
13.	Ap (0-30 cm)	8.31	0.09	12.8	79.2
14.	Bw (30-40 cm)	8.53	0.10	12.8	76.4
15.	Bt1 (40-60 cm)	8.43	0.11	13.2	74.2
16.	Bt2C (60-150 cm)	8.65	0.10	3.4	50.2

Table 6. $KMnO_4$-N, Olsen-P, $NNNH_4OAc$-K and exchangeable Na (kg ha^{-1}) in the horizon samples of soil profiles

Sl.	Horizon with	$KMnO_4$-N	Olsen-P	$NNNH_4OAc$-K	Exch. Na
No.	depth range	kg ha^{-1}			
1.	Ap (0-18 cm)	232.1	11.6	198.0	73.7
2.	Bw1 (18-44 cm)	178.8	8.1	107.8	73.7
3.	Bw2 (44-65 cm)	112.9	15.8	106.7	73.7
4.	Bw3 (65-75 cm)	97.2	15.5	105.6	73.7
5.	Bw4 (75-85 cm)	106.6	9.5	106.7	73.7
6.	Bw5 (85-108 cm)	97.2	9.1	107.8	73.7
7.	Ap (0-20 cm)	244.6	17.8	107.8	73.7
8.	AB (20 – 40 cm)	188.2	14.8	130.9	75.9
9.	BA (40-60 cm)	125.4	7.6	125.4	73.7
10.	Bw1 (60-88 cm)	144.3	17.5	128.7	73.7
11.	Bw2 (88-120 cm)	166.2	13.1	113.3	73.7
12.	Bw3 (120-150 cm)	163.1	8.4	107.8	73.7
13.	Ap (0-30 cm)	250.9	16.1	107.8	73.7
14.	Bw (30-40 cm)	250.9	5.9	105.6	78.1
15.	Bt1 (40-60 cm)	244.6	9.1	110.0	73.7
16.	Bt2C (60-150 cm)	241.5	4.8	107.8	73.7

Table 7. Organic carbon (%), exchangeable Ca, Mg (meq per 100 g) and available sulphur (ppm) in the horizon samples of soil profiles

Sl. No.	Horizon with depth range	Organic carbon (%)	Exch. Ca (meq per 100 g)	Exch. Mg (meq per 100 g)	Available S (ppm)
1.	Ap (0-18 cm)	0.63	8.1	7.4	15.6
2.	Bw1 (18- 44 cm)	0.59	9.0	10.1	13.4
3.	Bw2 (44-65 cm)	0.45	4.5	10.9	12.7
4.	Bw3 (65-75 cm)	0.38	4.5	12.9	12.3
5.	Bw4 (75-85 cm)	0.69	5.0	13.8	14.2
6.	Bw5 (85-108 cm)	0.55	4.3	8.7	13.9
7.	Ap (0-20 cm)	0.34	4.4	2.8	12.8
8.	AB (20-40 cm)	0.34	2.1	3.5	12.6
9.	BA (40-60 cm)	0.27	2.1	5.1	11.8
10.	Bw1 (60-88 cm)	0.22	2.0	7.1	12.7
11.	Bw2 (88-120 cm)	0.25	2.8	11.8	12.4
12.	Bw3 (120-150 cm)	0.37	5.2	12.5	11.9
13.	Ap (0-30 cm)	0.22	3.9	10.1	12.7
14.	Bw (30-40 cm)	0.17	5.1	12.1	13.4
15.	Bt1 (40-60 cm)	0.15	3.7	14.7	14.1
16.	Bt2C (60-150 cm)	0.09	10.5	8.3	13.9

Organic carbon and secondary nutrients

Irrespective of the horizons, exchangeable calcium, magnesium and available sulphur were sufficient. This may be due to the calcareous nature of the soil, magnesium bicarbonate rich irrigation water and addition of sulphur through various sources of fertilizers like SSP, gypsum and micronutrient fertilizers. Organic carbon content was low to medium except for the surface horizon of A block profile in which a high content was observed which may be attributed to the incorporation of groundnut haulms over years of cultivation (Table 7).

Water-soluble chloride (meq per kg), free $CaCO_3$ (%) and hot water soluble boron (ppm)

The water-soluble chloride content of all the samples was well within the non-hazardous limits, which may be due to the sandy texture of the soil. All the soil samples except those collected from C block were moderately calcareous. Hot water-soluble B was sufficient in the surface horizons but was deficient in the sub-surface horizons witnessed by calcareous patches (Table 8). A plethora of

Table 8. Water-soluble chloride (meq kg^{-1}), free $CaCO_3$ (%) and hot water soluble boron (ppm) contents in the horizon samples of soil profiles

Sl. No.	Horizon with depth range	Water-soluble chloride (meq kg^{-1})	Free $CaCO_3$ (%)	Hot water-soluble B (ppm)
1.	Ap (0 -18 cm)	4.0	3.06	0.5120
2.	Bw1 (18-44 cm)	2.0	3.10	0.4070
3.	Bw2 (44-65 cm)	3.0	2.94	0.3090
4.	Bw3 (65-75 cm)	3.0	3.04	0.4045
5.	Bw4 (75-85 cm)	8.0	2.98	0.9045
6.	Bw5 (85-108 cm)	8.0	2.70	0.4070
7.	Ap (0-20 cm)	7.5	1.75	0.5215
8.	AB (20-40 cm)	7.0	1.55	0.5090
9.	BA (40-60 cm)	6.5	1.56	0.2260
10.	Bw1 (60-88 cm)	6.0	1.65	0.3165
11.	Bw2 (88-120 cm)	7.0	3.06	0.2285
12.	Bw3 (120-150 cm)	8.0	3.10	0.3120
13.	Ap (0-30 cm)	4.0	2.93	0.3045
14.	Bw (30-40 cm)	5.5	3.11	0.2020
15.	Bt1 (40-60 cm)	5.5	3.10	0.2265
16.	Bt2C (60-150 cm)	9.0	3.10	0.2070

Table 8. Water-soluble chloride (meq kg^{-1}), free $CaCO_3$ (%) and hot water soluble boron (ppm) contents in the horizon samples of soil profiles

Sl. No.	Horizon with depth range	Water-soluble chloride (meq kg^{-1})	Free $CaCO_3$ (%)	Hot water-soluble B (ppm)
1.	Ap (0 -18 cm)	4.0	3.06	0.5120
2.	Bw1 (18-44 cm)	2.0	3.10	0.4070
3.	Bw2 (44-65 cm)	3.0	2.94	0.3090
4.	Bw3 (65-75 cm)	3.0	3.04	0.4045
5.	Bw4 (75-85 cm)	8.0	2.98	0.9045
6.	Bw5 (85-108 cm)	8.0	2.70	0.4070
7.	Ap (0-20 cm)	7.5	1.75	0.5215
8.	AB (20-40 cm)	7.0	1.55	0.5090
9.	BA (40-60 cm)	6.5	1.56	0.2260
10.	Bw1 (60-88 cm)	6.0	1.65	0.3165
11.	Bw2 (88-120 cm)	7.0	3.06	0.2285
12.	Bw3 (120-150 cm)	8.0	3.10	0.3120
13.	Ap (0-30 cm)	4.0	2.93	0.3045
14.	Bw (30-40 cm)	5.5	3.11	0.2020
15.	Bt1 (40-60 cm)	5.5	3.10	0.2265
16.	Bt2C (60-150 cm)	9.0	3.10	0.2070

evidences speaks about the negative correlation between hot water-soluble boron and calcareous nature of the soil.

Land suitability and land capability classification

Based on soil analytical properties, all the three pedons are classified into IIIew wherein limitation exists due to top soil erosion and high water table. Considering the suitability of the soil (Sys, 1985), for the cultivation of coconut and coconut-based intercrops, the soils are highly suitable (S1) for the cultivation of coconut and moderately suitable (S2) for the cultivation of cocoa and marginally suitable (S3) for the cultivation of pepper.

Soil constraints and recommendation

The pH of the soil samples across A Block is slightly alkaline. Application of gypsum may be followed for the groundnut growing soils of A Block. In B Block, the sporadic occurrence of calcareous patches was witnessed. Application of green manures may be adopted to tone down the harmful effects of $CaCO_3$ on crop productivity. In the highly calcareous C Block of the farm, crops sensitive to high $CaCO_3$ may be avoided.

The soils are prone to top soil erosion and leaching owing to the sandy texture of the soil. In the surface soil, about 84 per cent of the soil samples recorded low status of $KMnO_4$-N, and in the subsurface, about 92 per cent of the soil samples had low status (Fig. 3). This may be attributed to the leaching losses of nutrients and the high water table which warrants split application of nutrients and use of slow-release nitrogenous fertilizers. Available phosphorus status was low to medium in the surface soils of the farm which may be attributed to the fixation of phosphorus as calcium phosphate. Scrupulous application of organic manures and biofertilizers might enhance the phosphorus availability in the soil. Across the farm, about 34 per cent of the soil samples were low, 53 per cent were medium, and 12 per cent were high in exchangeable potassium content. The station is located in the region, which is highly weathered and rich in kaolinitic clay mineral, which has hardly any binding site for potassium (Venkatesan and Murugesan, 2006).

Moreover, the prevalence of eriophyid mite is alarming in the coconut plantations of the region.

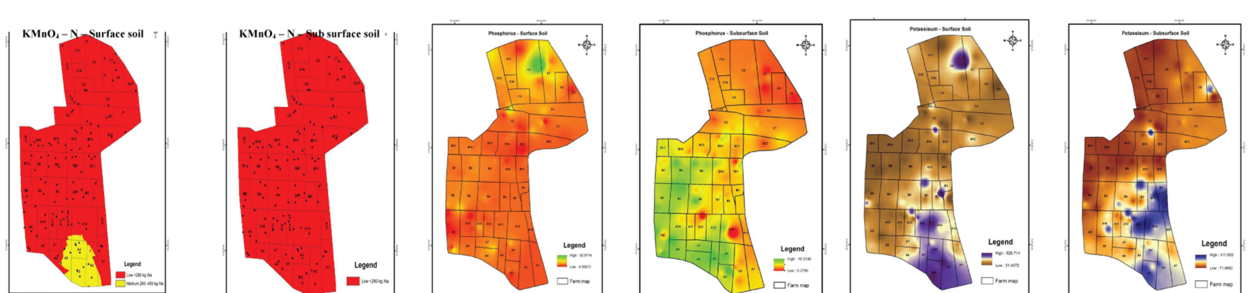


Fig. 3. Spatial variability of soil macronutrients at CRS, Aliyarnagar

Table 9. Water quality of different irrigation sources of CRS, Aliyar Nagar

Sl. No.	Parameter	Canal	Open well - A Block
1.	pH	6.90	7.58
2.	Electrical conductivity (dS m^{-1})	0.08	0.44
3.	Phosphorus (meq L^{-1})	0.0253	0.0270
4.	Potassium (meq L^{-1})	0.0282	0.0487
5.	Sodium (meq L^{-1})	0.2565	0.3913
6.	Calcium (meq L^{-1})	0.0723	0.0114
7.	Magnesium (meq L^{-1})	0.0	4.4
8.	Carbonate (meq L^{-1})	0.0	0.0
9.	Bicarbonate (meq L^{-1})	2.4	6.0
10.	SO_4 -S (meq L^{-1})	0.2147	0.2764
11.	Boron (meq L^{-1})	0.4137	0.4188
12.	Chloride (meq L^{-1})	0.0016	0.0021
	Derived parameters		
13.	Total dissolved solids (ppm)	51.2	281.6
14.	Sodium adsorption ratio	1.35	0.2635
15.	Residual sodium carbonate (meq L^{-1})	2.3277	1.5886
16.	Residual sodium bicarbonate (meq L^{-1})	2.3277	5.9886
17.	Soluble sodium percentage	78.0	8.15
18.	Permeability index	5.4917	0.5915
19.	Magnesium adsorption ratio	0.0	0.9974
20.	Potential salinity (meq L^{-1})	0.1089	0.1403
21.	Sodium ratio	3.5477	0.0887
22.	Sodium to calcium activity ratio	0.9539	3.6649
23.	Puri's salt index	-19.9676	-6.389

Hence the application of an enhanced dose of potassic fertilizers and split application of potassium can help in protecting the crops from K deficiencies. About 33 per cent of the soil samples analysed had a low status of organic carbon. Application of organic manures and biomass recycling of coconut fronds and wastes may be practised to step up the organic carbon content of the soil across the farm.

Rock outcrops are commonly witnessed in the C Block of the farm. Those areas may be used for pasture development, and split application of fertilizers may be practised in the adjacent areas owing to the shallow depth of the soil. In the zones where seepage problems persist, appropriate engineering measures like digging of trenches may be adopted.

Quality of irrigation water

Water samples were collected from two irrigation sources of the farm *viz*., canal and open well in A Block. Quality parameters of the irrigation sources are furnished in Table 9.

Irrespective of the sources of irrigation, pH of the water samples were neutral in reaction whilst electrical conductivity was non-saline. Total dissolved solids were non-detrimental in both the sources. However, as the soils are sandy in texture, salt accumulation is not a major concern on the farm. A high concentration of sodium is undesirable in water because sodium adsorbs onto the soil cation exchange sites, causing soil aggregates to break down (deflocculation) sealing the pores of the soil and making it impervious to water flow. The tendency of sodium to increase in proportion on the cation exchange sites at the expense of other types of cations is estimated by the ratio called sodium adsorption ratio (SAR). Although SAR is not a constraint in all the irrigation sources, residual sodium carbonate and sodium ratio were high in canal water and water collected from an open well. Residual sodium bicarbonate was high in open well while it was within the prescribed limits in the canal water depicting that open well water is bicarbonate rich.

Soluble sodium percentage, permeability index, magnesium adsorption ratio and Puri's salt index of all the sources do not pose a threat for irrigation. As potential salinity of all the sources of irrigation was <1 meq L^{-1}, they do not pose any restriction for irrigation. As far as sodium to calcium activity ratio is concerned, both the sources are well within the permissible limits for irrigation. Individual ion toxicities *viz.*, chloride, boron and sulphur were not observed in all the sources. Thus it can be concluded that canal water is sodium dominant soft water while the other source is magnesium bicarbonate rich hard water.

Conclusion

Although Coconut Research Station, Aliyarnagar is endowed with the rich potential of irrigation water, soil-related constraints *viz.,* widely prevalent deficiencies of macronutrients *viz*.,

$KMnO_4$-N, Olsen-P, $NNNH_4OAc$-K exist, warranting split application of fertilizers to prevent sand drown effect of the nutrients. Continuous application of organic manures is imperative for improving the soil organic matter content and to enhance the fertilizer use efficiency in all the blocks of the farm. The soils are highly prone to top soil erosion and seepage problems. Appropriate engineering measures such as providing trenches are essential to avoid temporary waterlogging. Rock outcrops and calcareous patches sporadically occur in the farm and nutrient management should be altered accordingly to reap better yields. Thus an appraisal of potentialities and problems of a centre of agro-technology generation like Coconut Research Station, Aliyarnagar is purposeful in the context of improving the system productivity, increasing the economic returns of the farmers, without deteriorating the natural resources.

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