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# ANALYSIS OF SOIL SAMPLES FROM MAJOR TREE CROPS AND AGROFORESTRY SYSTEMS OF THRISSUR DISTRICT, KERALA

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## ABSTRACT OF PROJECT PROPOSAL

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|---|---|---|---|
| 1 | Project No. | : | KFRI 606/10 |
| 2 | Title of project | : | Analysis of soil samples from major tree crops and agroforestry systems of Thrissur district, Kerala |
| 3 | Objective | : | To analyse 13745 soil samples for macro and micro nutrients and online entry of the data generated |
| 4 | Duration | : | 2years |
| 5 | Funding Agency | : | State Planning Board |
| 6 | Project Team | | |
| | Principal Investigator | : | M.P. Sujatha |
| | Associates | : | S. Sandeep |
| | Research Fellows | : | C. Kavitha<br>E.B. Remya |
| | Technical Assistants | : | T.S. Saiju<br>E.S. Bincy<br>P. Preeja,<br>K. Shinila<br>Ninu Mary Thomas<br>R. Ambili<br>R. Sabu |

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## ABSTRACT

This study was carried out as part of a new programme initiated by the State planning board for developing soil based plant nutrient management plan for agro-ecosystems of Kerala. This was implemented through the State agricultural department and coordinated by National Bureaux of Soil Survey and land use Planning, Banglore. The institutions involved in this venture were KVKs, KAU, ICAR institutes ( IISR, Calicut; CTCRI, Trivandrum) KFRI, Peechi; ICRI, Pambadum para; Department of Agriculture etc. As part of this programme, KFRI was given the responsibility of analyzing 13,745 soil samples from various agro ecosystems of Thrissur Dt. for macro, secondary and micronutrients and on line transmission of the data generated through the web site to enable the preparation of soil health cards for the farmers by the State department of Agriculture. Results revealed that the soils of the district, in general, were in the acid range and relatively more acidity was in rice and vegetables growing areas. Extremely acid soils of the district was concentrated mainly in pokkali and to some extent in kole lands also. Among the nutrients, excess levels of P were well pronounced in all the crops and agro ecological units. Even though, deficiency of available Ca was not well dominant in the district, soils from all the vegetable growing-areas were deficient in this nutrient. Deficiency of Mg was well pronounced in the district and was severe in all the cropping systems and the severity was more in vegetable growing areas. Similarly all the agro ecological units of the district was also with acute deficiency of this nutrient. Deficiency of B was well pronounced in the district in general as well as in all the crops and agro ecological units. However, based on the study it is concluded that soil fertility status of the district in general is depleting with imbalanced content of nutrients caused by the indiscriminate use of chemical fertilizers.

## 1.INTRODUCTION

Soil, the source of infinite life is the most vital and precious natural resource across the globe. But the quality of soil is being depleted day by day due to adverse agricultural practices in modern agriculture, such as,indiscriminate use of chemical fertilizers, improper irrigation,continuous and intense cropping (Medhe *et al.* 2012). So the evaluation of fertility status of the soils of an area or a region is an important aspect in the context of sustainable agriculture (Singh & Misra 2012). Soil fertility is a dynamic natural property and it can change under the influence of natural and human induced factors. The site specific nutrient management practices reduce the cost of cultivation and environmental pollution caused by the imbalanced application of chemical fertilizers.

Though soil research and soil test based advisory services started in Kerala decades back, their effectiveness was not realized in terms of maintenance of soil health and enhancing crop productivity. In order to have effective intervention to restore soil health, Kerala State Planning Board initiated a new programme for developing soil based plant nutrient management plan for agro-ecosystems of Kerala. This was implemented through the State Agricultural Department and coordinated by National Bureau of Soil Survey and Land Use Planning, Banglore. The institutions involved in this venture were KVKs, KAU, ICAR institutes ( IISR, Calicut; CTCRI, Trivandrum) KFRI, Peechi; ICRI, Pambadumpara and Department of Agriculture.

KFRI was provided with 13,745 soil samples from various agro ecosystems of Thrissur district with the objective of analyzing all the macro and micronutrients and for on line transmission of data generated through the web site created and thus to enable the preparation of soil health cards for the farmers by the State Planning Board.

## 2. STUDY AREA AND METHOD

*Agricultural scenario of Thrissur District*

Agriculture is an important livelihood activity among the people in Thrissur district. Major agro ecosystems in Thrissur district are paddy, rubber, mono and poly cultures of coconut, banana, tapioca, pineapple, arecanut, cashew, mango, vegetables among this. On assessing the land utilization pattern in the district from 1960 to 2009 ( Figure 1), it was found that, there was a

gradual increase in the land area put to nonagricultural use, and this indicates the preference given to nonagriculture than agriculture during this period. Gross cropped area remain almost constant throughout the period while net area sown and area sown more than once indicated a decline after an initial hike during 1970s (Figure 2).

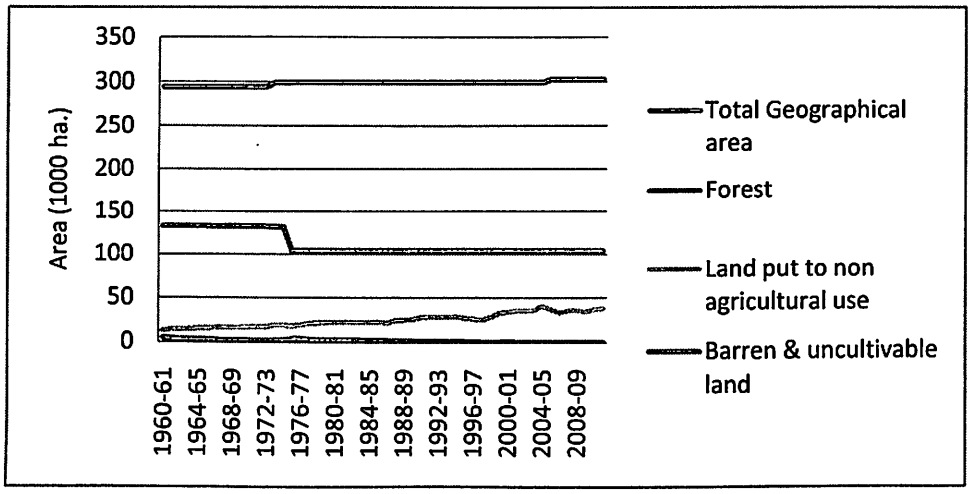



Figure 1. Variation in the land use pattern over four decades

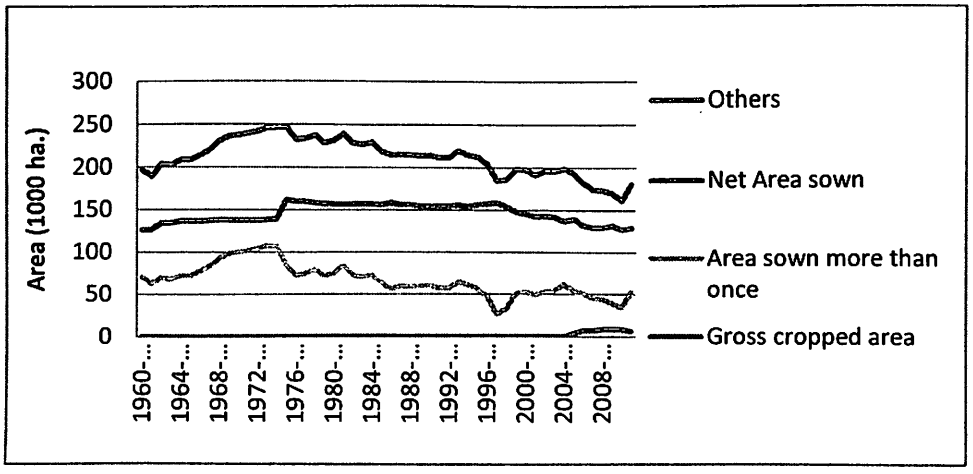



Figure 2. Variation in the agricultural land use over four decades

Among the major crops (Figure 3), paddy occupied more area followed by coconut during the initial period. But after that, area under coconut gradually increased (more than two times) and became dominant while paddy cultivation drastically (five times) reduced. There was an increase in the area under rubber (more than two times) after 1993 while that of tapioca and

cashew remained almost constant throughout the period. Rice production (Figure 4) reduced drastically (50 %) , while rubber production depicted an increase (10 times) after 1993.

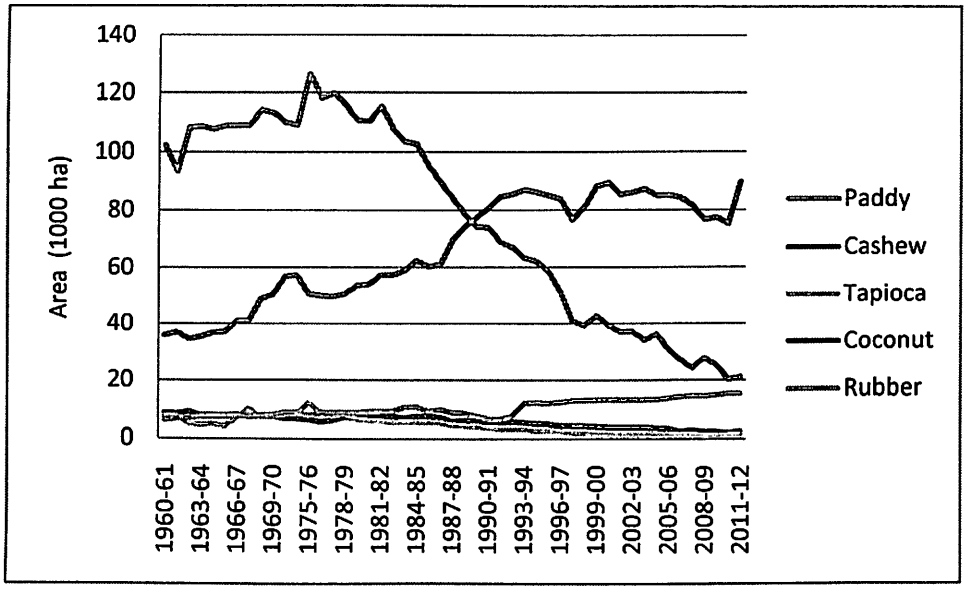



Figure 3. Variation in the area under important crops over four decades

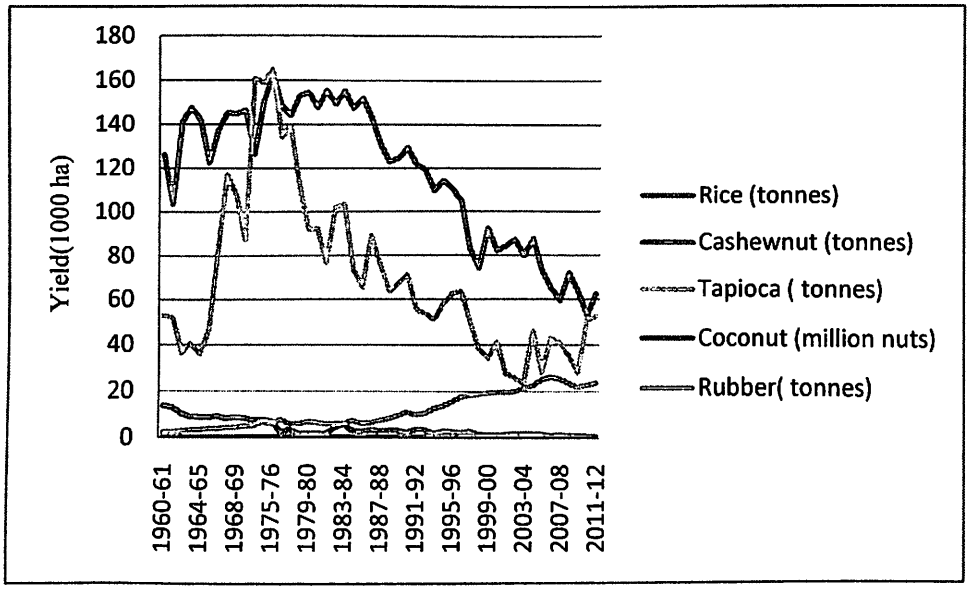



Figure 4. Variation in production of major crops over four decades

*Study area*

Thrissur district, situated in the central part of Kerala came into existence in 1949. Lying between north latitudes 10° 31′ and 10° 52′ and east longitudes 76° 13′ and 76° 21′, the district is bound on the north by Malappuram and Palakkad districts, east by Palakkad district, south by Ernakulam district and west by Lakshadweep Sea. Administratively, the district is divided into 5 taluks, one corporation, 6 municipalities, 254 villages, 17 block panchayats and 92 grama panchayats covering a geographical area of 3032 $km^2$.

Descending from the heights of the Western Ghats in the east, the land slopes towards the west forming three distinct natural divisions, the highland, the mid land and sea board. The lowlands or the sea board have elevation ranging from two metres below sea level to as much as 8 metres above sea level. The Kole lands, which is one to two metres below sea level is waterlogged for most part of the year. Midland region comprises flat lands, occasional mounds, undulating terrain and narrow valleys. The hill ranges of the Western Ghats with rugged terrain constitute the high lands. The high lands exhibit typical topography with steep hills dissected by 'V' shaped valleys.

The district has a tropical humid climate with an oppressive hot season and plentiful seasonal rainfall. Annual rainfall is about 3000 mm. The hot season is from March to May. South-west monsoon is received during the period June to September and north-east monsoon during October and November. The maximum temperature ranges from 29.3 °C to 36.2 °C and the minimum temperature ranges from 22.1 °C to 24.9 °C.

Archaean crystalline formation (gneiss, schist and charnockite), tertiary formation, sub-recent laterite and recent riverine alluvium are the major geological formations of the district. Five rivers and their tributaries drain the district: Periyar, Chalakkudy, Karuvannur, Karumali and Bharathapuzha. They all take their origin from the mountains in the east, flow westward and discharge into the Kole lands or sea.

Major soil types in the district include laterite soil, brown hydromorphic soils, hydromorphic saline soils, coastal alluvium, riverine alluvium and forest loamy soil. Sandy loam soil is found in the part of Mukundapuram,Thrissur and Chavakkad taluks. Laterite soil is common in eastern part of Thrissur and western part of Thalappally taluks. Clayey soil is found in Mukundapuram

taluk and portions of Chavakkad taluk. Hydromorphic saline soil is seen in coastal tracts of Thrissur, where during rainy season the fields are flooded leaving the area almost free of salt.

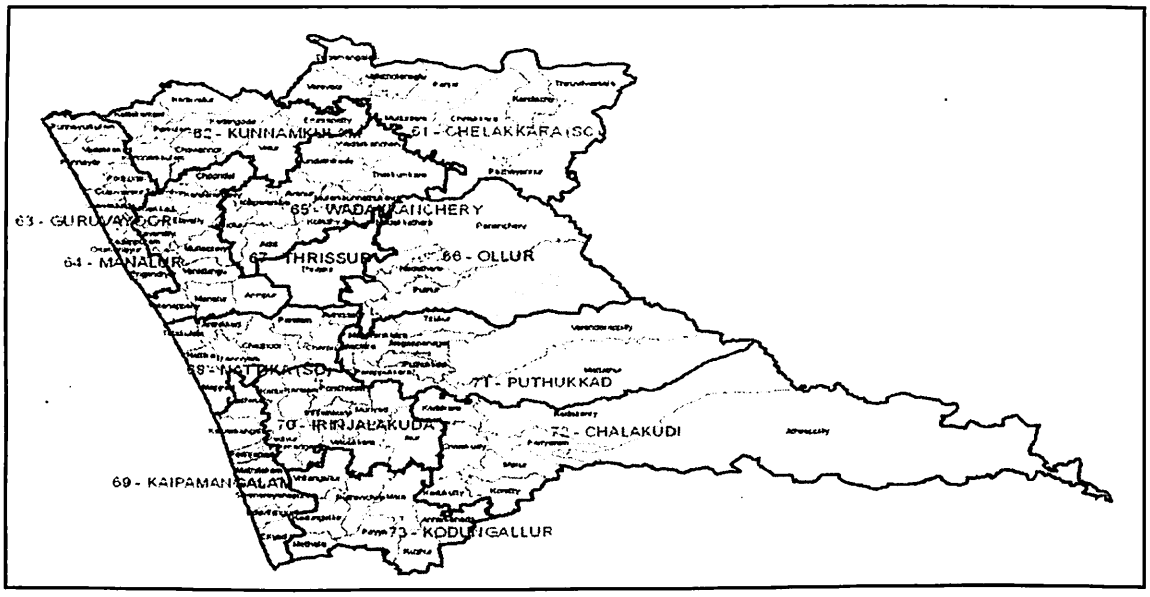



Figure 5. Map of the study area

Thrissur district is spread over agro-ecological zones (AEZ) namely coastal plain, midland laterites and high hills.The coastal plain agro-ecological zone comprises of nearly level to gently sloping lands along the coast at elevation below 30 metres and lying between the sea and the midlands. It includes sandy beaches, sandy plains, coastal laterites and lowlying areas such as estuaries, backwaters, submerged lands, swamps, marshes, *kayal lands*, and broad valleys. This zone covers 90,512 ha (29.87 %) in the district.

Midland laterites agro-ecological zone comprises undulating to rolling lands interspersed with narrow valleys between the coastal plain on the west and foothills and hills on the east, extending from the southern end to the northern end of the state. The elevation ranges from 30 to 300 metres. This zone covers 85,335 ha (28.17 %) in the district.

The hilly region comprising Western Ghats and plateaus extending from south to north and constitute the high hills Agro-Ecological Unit (AEU). The Western Ghats and highland plateaus rise 600 metres above mean sea level, with a number of peaks well over 1800 metres. The Western Ghats comprise Central Sahyadri, the Nilgiris and South Sahyadri. The mountains are

essentially plateau remnants of two or three altitudinal zones. Slopes of hill ranges can be as high as 80 per cent. This zone covers 1,10,508 ha (36.48 %) in the district.

Five AEUare delineated in the district. They are briefly described in the following sections.

AEU 2: Northern coastal plain

The Northern coastal plain represents the coastal plain north of Ernakulam district. The unit with tropical humid monsoon climate (rainfall 3183 mm; mean annual temperature 27.6 °C) has dominantly sandy soils on nearly level lands. It is similar to the southern counterpart, except for the longer dry period of nearly six months. Coconut plantations on uplands and rice in lowlands are the major land use. This unit covers 22,228 ha (7.34 %) in the district.

AEU 5: Pokkali lands

Pokkali lands, another special AEU, is delineated for the lowlands, often below sea level, in coastal areas of Ernakulam district and extending to parts of Thrissur and Alappuzha districts. Climate is tropical humid monsoon type (mean annual temperature 27.8 °C; rainfall 3359 mm). Hydrology and soils are similar to those in Kuttanad. However, seawater inundation is not controlled and hence soils are acid-saline. Coconut is raised on uplands and a special kind of rice cultivation, locally known as *Pokkali cultivation,* is done in lowlands. This unit covers an area of 11,704 ha (3.86 %) in the district.

AEU 6: Kole lands

The Kole lands agro-ecological unit is spread over the coastal part of Thrissur district and extends to southern coastal parts of Malappuram district. Climate is tropical humid monsoon type (mean annual temperature 27.6 °C; rainfall 2,902 mm). These lands too are, for most part, below sea level. Seawater ingress into these lands is controlled through barrages and weirs to facilitate rice cultivation. The soils are hydromorphic acid clays, often underlain by potential acid-sulphate sediments. Coconut is grown on the uplands of the unit and bunds and rice in lowlands. This unit covers 56,580 ha (18.67 %) in the district.

AEU 10: North Central Laterites

The North central laterites AEU is delineated to represent midland laterite terrain with longer dry period than its southern counterpart, but less than the one in the North. The climate is tropical

humid monsoon type (mean annual temperature 27.6 °C; rainfall 2934 mm) with dry period of around four and half months. The uplands have strongly acid, gravelly, lateritic, low-activity, clay soils, often underlain by plinthite. The lowlands have strongly acid, non-gravelly clay soils with impeded drainage.Coconut intercropped to a variety of annual and other perennial crops is the major land use on uplands and rice, tapioca, banana and vegetables on lowlands. This unit covers 85,335 ha (28.17 %) in the district.

AEU 14: Southern High Hills

The southern high hills AEU extending from Thiruvananthapuram to Nelliyampathy in Palakkad district has elevation more than 600 metres. Besides elevation, the steep slopes of the terrain and lower temperatures distinguish the high hills from the foothills and midlands. The climate is tropical humid monsoon type, but lower temperatures than in coastal plain and midlands (mean annual temperature 21.6 °C; rainfall 4034 mm). Length of dry period is only two months. The steeply sloping hilly terrain has deep, well drained, strongly acid, organic-matter-rich clay soils. While forests cover major part of the unit, plantations of rubber, coconut, pepper, tea and coffee are not uncommon. This unit covers 51,022 ha (16.84 %) in the district.

AEU 15: Northern high hills

The Northern high hills agro-ecological unit extending from Thrissur to Kannur is similar to its southern counterpart except for the longer dry period. The climate is tropical humid monsoon type (mean annual temperature 27.6 °C; rainfall 2963 mm) with dry period of nearly four months, much longer than in the southern counterpart. The hilly terrain has deep, well drained, strongly acid, organic-matter-rich, clay soils. The valleys have deep, imperfectly drained, acid clay soils. While forests cover major part of the unit, plantations of rubber, coconut, pepper and coffee are not uncommon. This unit covers 59,486 ha (19.64 %) in the district.

Forested hills: The land unit is delineated on the basis of land cover. Most lands are steeply sloping hills and have organic-matter-rich soils. Forested hills cover 94,539 ha (31.20 %) area in the district.

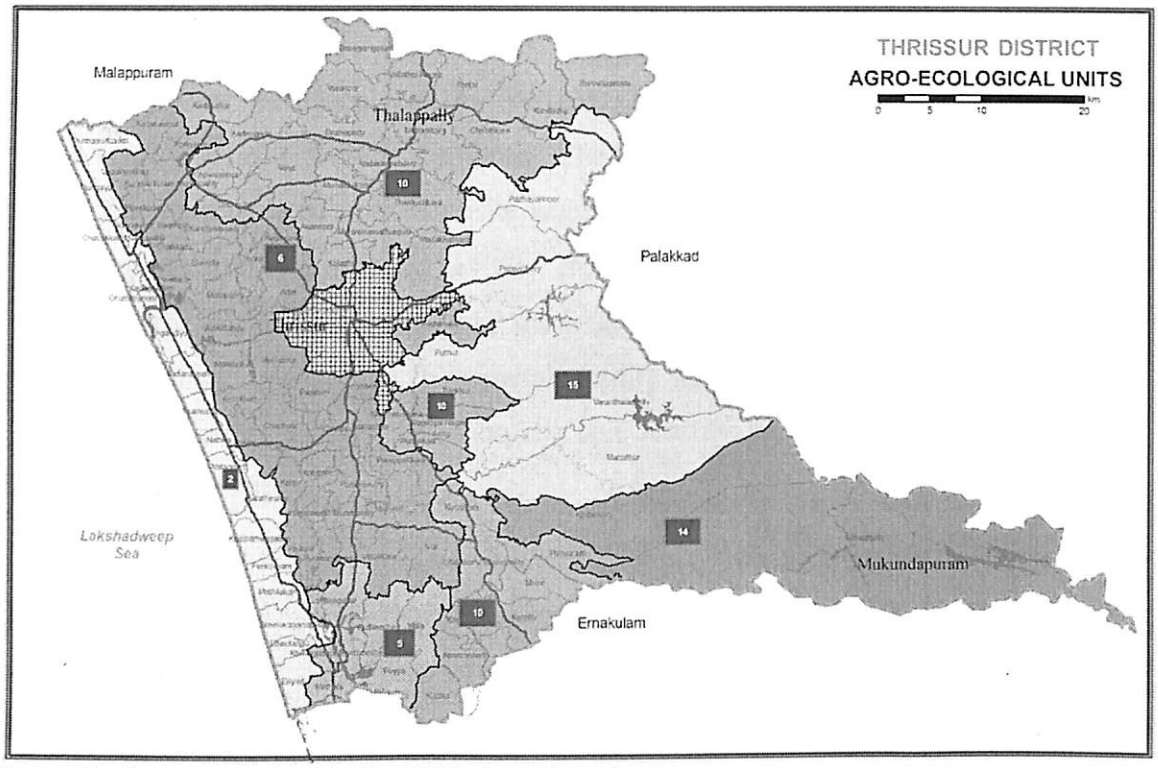


Figure 6. Agro ecological units of Thrissur District

*Soil sampling and laboratory analysis*

In order to assess the soil fertility status of the district, composite surface samples (0-15 cm ) from farmer's fields were collected @ 50-300 samples/panchayath, depending on the size of the land under cultivation. These samples represented different crop production systems and various AEU prevalent in the district. There were a total of 13,523 soil samples to represent the whole district. Major agroecosystems in Thrissur district were paddy fields, rubber plantations, mono and poly cultures of coconut, banana, arecanut, vegetables among others. along with the details regarding farmer's name, soil type, fertilizer details and irrigation. The collected samples were then air dried and sieved through a 2mm sieve. The processed soil samples were analyzed for pH (1:2.5::soil water suspension), electrical conductivity ( by using conductivity meter), organic carbon (Walkley & Black 1934), available phosphorous (Bray & Kurtz 1945), available potassium (flame photometry), available calcium, magnesium, sulphur and micronutrients such as copper, iron, manganese and zinc using AAS (Varian AA 240)and boron(hot water extraction) by uv – vis spectrophotometer.

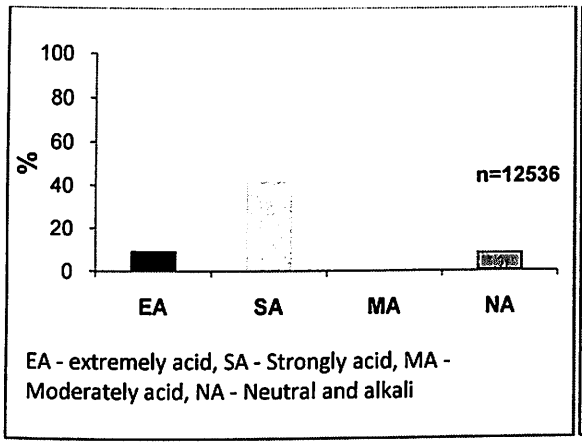
## 3. RESULTS AND DISCUSSION

Collected samples were analyzed for various soil fertility parameters such as soil reaction, soluble salts, macro and micro nutrients. The data with respect to the soil properties of each panchayath were updated in the website www.keralasoilfertility.net along with all the primary details such as name of farmer, survey No., crop,among others for preparing the soil health card. Considering the difficulty in tabulating the large number of data generated as part of this study, an attempt is made to highlight the general fertility status of the district by categorizing them into different fertility classes based on the soil fertility rating chart followed by the Kerala Agricultural University.

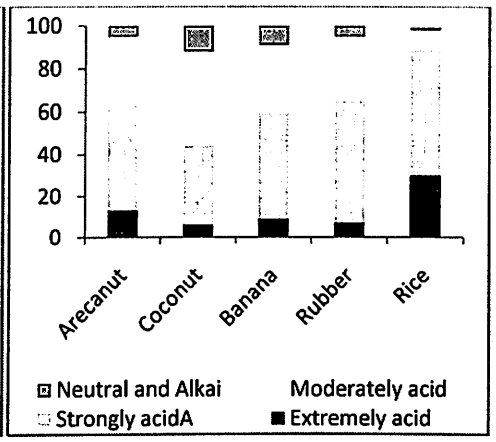
*1. Soil Reaction*

The soils of the district, in general, belonged to various classes of soil reaction (Figure 7) ranging from neutral and alkaline to extremely acid, with 91 % of the samples in the acid range. Of this, 51 %were with strong to very strong acidity (pH <5.5). The soils of Kerala in general are acid in reaction brought out by the intense rainfall and consequent leaching of bases. The acidity of the study area in particular is aggravated by several factors, such as, proximity to sea coupled with acid contributing geological materials, heavy input of acidic fertilizers, lack of inputs to neutralize acidity etc.

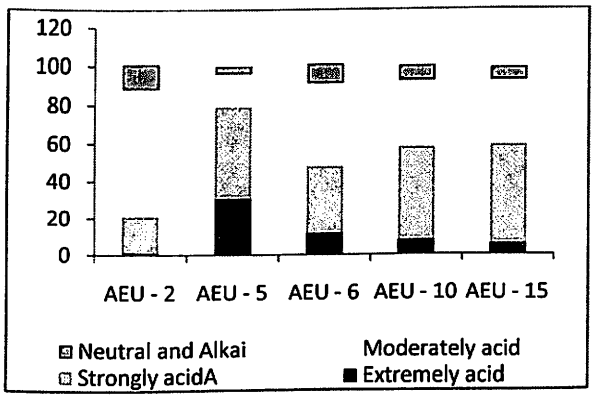
On assessing soil acidity in relation to major crops, it was found that 89 % of the samples accounted for strong to extreme acidity in rice production system, 73 % in vegetables, 65% in rubber, 63% in arecanut and 59% in banana. Strong soil reaction was relatively less rampant in coconut production system (44 %). Most of the rice growing areas in the district were confined to extremely to strong acid soils of pokkali and kole areas and this together with high input of acid fertilizers lead to higher soil acidity in rice production system. Neutral and alkaline soils under coconut production systems were comparatively higher in this district, might be due to external application of amendments having acid neutralizing potential.




a. General status




b. Between crops




c. Between AEUs

Figure7. Frequency of soil reaction classes in Thrissur district

Among the AEUs of the district, extremely acid soils were relatively high in pokkali lands (31 %) followed by kole lands (12 %). But it was negligible in northern coastal plain (2%). The soil with this extreme acid condition were relatively low in north central laterites (8%) and northern high hills (6 %) also.On the contrary, strongly acid soils were higher in northern high hills (53 %) and northern central laterites (50 %) followed by Pokkali (46 %), Kole (36 %) and northern coastal plain (20%). Moderately acid soils were high in northern coastal plain (67 %) followed by kole lands (43 %) and north central laterites and northern high hills (33-34 %) and very low in pokkali lands (17 %). Neutral and alkaline soils were also higher in northern coastal plain and kole lands (19-20 %) followed by north central laterites and northern high lands (7-8 %) and least in pokkali lands (4 %). Extremely acid soils of the district was concentrated mainly

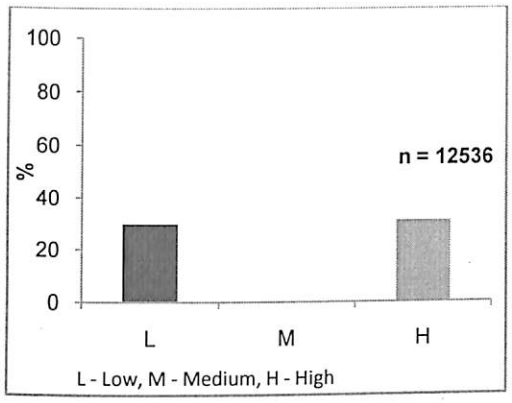
in the special AEUs of the district like pokkali and to some extent in kole lands also. Soils of pokkali lands in general were strongly to extremely acid in reaction while that of kole lands were moderately to strongly acid in reaction. Strongly acid soils were relatively low in northern coastal plain and most of the soils in this area are moderately acidic. Soils of north central laterites and northern high hills in general are strongly acid to moderately acid in reaction.

*2. Available nitrogen*

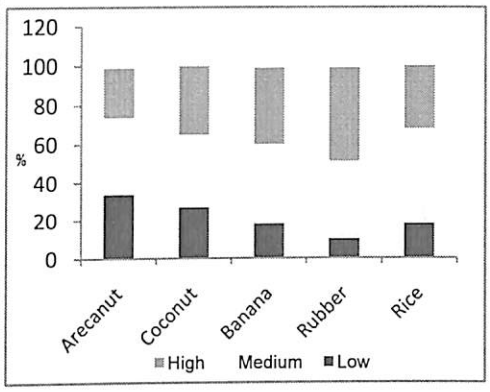
Plant available N, estimated based on the content of organic carbon in the soil (Figure 8), belonged almost equally to all N classes such as low (30 %), medium (39 %) and high (31 %) in the district. On considering each crop separately, vegetable growing areas were more deficient in N (45 %) followed by arecanut (34 %) and coconut (27 %). Continuous and intensive cultivation leading to high crop removal together with insufficient replenishment are supposed to be the reasons for more N deficient areas under vegetable cultivation. Soils with higher levels of N (48 %) were more in rubber and this might be due to the contribution from leguminous cover crops growing around this crop.

Among the various AEUs in the district, deficiency of N was more pronounced in northern coastal plains (52 %), kole lands (44 %) and pokkali lands (37 %). Deficiency was relatively very less in northern central laterites (17 %) and almost negligible (6 %) in northern high hills. Northern high hills are supposed to contain relatively high content of organic carbon and this on decomposition might be releasing more N into the soil. Heavy leaching of N through running water and insufficient stock of organic carbon to supply N might be the reasons for its deficient levels in other AEUs.

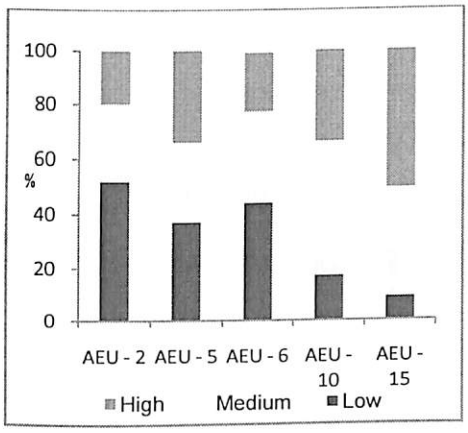
Soils of Thrissur district being rich in low activity clays, it is essential to maintain high levels of organic matter in the soils. High levels of organic matter not only provides part of the N requirement of crop plants, but also enhance nutrient and water retention capacity of soils and creates favourable physical, chemical and biological environment.




a. General status




b. Between crops




c. Between AEUs

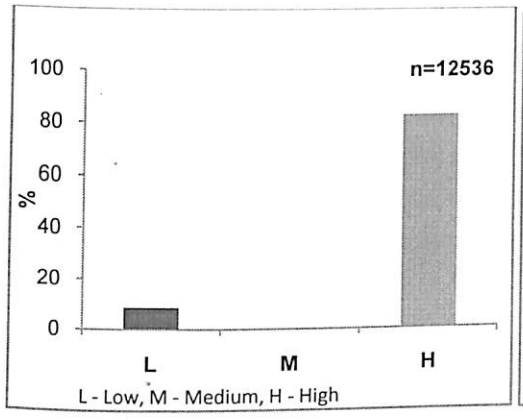
Fig.8. Frequency of available N classes in Thrissur District

*3. Available phosphorus*

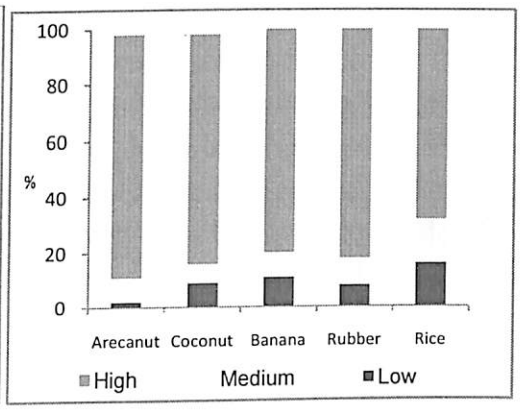
Plant available P (Figure 9) was deficient only in 8 % of the soils in the district. A very high proportion of samples (83%) were with excess levels of P, which is thought to be due to the high input of phosphatic fertilizers over a long period of time. This points out to either skipping or minimizing the use of costly phosphatic fertilizers in the region. Again, correction of soil acidity through liming can lead to release of P fixed by soil into the available pool.

There was no considerable variation between different cropping systems with respect to the availability of P. Excess levels of P were more pronounced in all the production systems (71-97 %) while low and moderate levels of P were relatively less. High levels of P in the soil not only

impair the availability and uptake of other essential nutrients by plants but also leads to the pollution of water bodies.




a. General status

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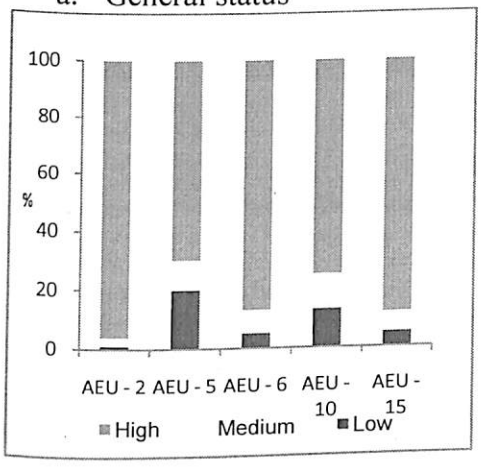



c. Between AEUs

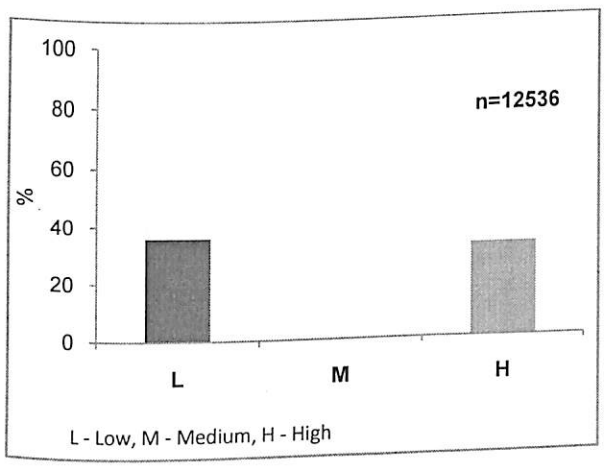
Figure9. Frequency available P classes in Thrissur District

Occurrence of excess levels of P in soils wasalso well pronounced in all the AEUs of the district, accounting 97% in northern coastal plains, 88 % in northern high hills, 87 % in kole lands, 76 % in northern central laterites and 71 % in pokkali lands. Deficient levels were more in pokkali lands (20 %) and northern central laterites(19 %), and the deficient samples were negligible in other AEUs (1-9 %).Moderate levels of P in all the AEUs was less ranging from 3-12 %.

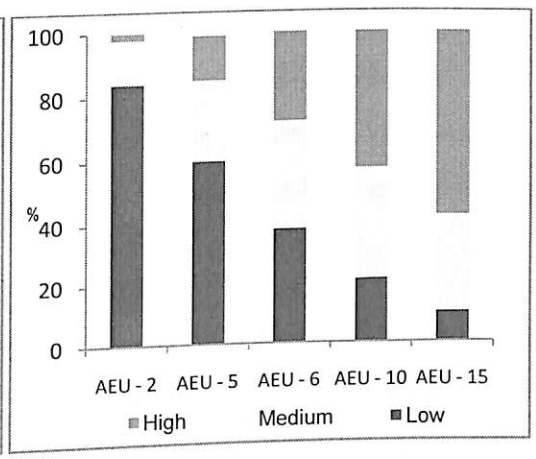
Results in general point out the need for a restricted use of phosphatic fertilizers based on site specific soil test results and skipping its application in cases of its excess levels.

*4. Available potassium*

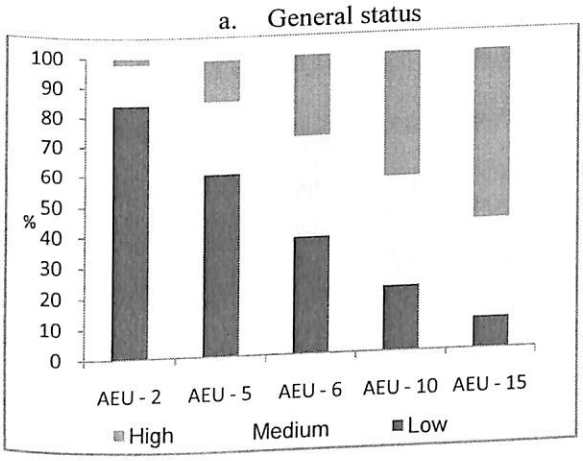
Almost same proportion of samples (one third) tested for K belonged to (Figure 10) deficient, optimum and high levels in the district. Same trend was also noticed for the samples drawn from coconut and arecanut systems. But in rubber and banana, only less than 20 % samples were in the deficient range, which might be due to the high use of potassium fertilizers in these crops. Deficiency of K was more pronounced in vegetables (64 %) and rice (53 %), the probable reason might be the intensive leaching condition brought in by irrigation coupled with very strong




a. General status




b. Between crops




c.Between AEUs

Figure 10.Frequency of available K classes in Thrissur District

acidity which does not permit retention of K on the soil exchange complex. Excess levels of K were relatively more in the soils growing banana (57 %), rubber (44 %) and coconut (34 %), might be the contribution from K containing fertilizers.

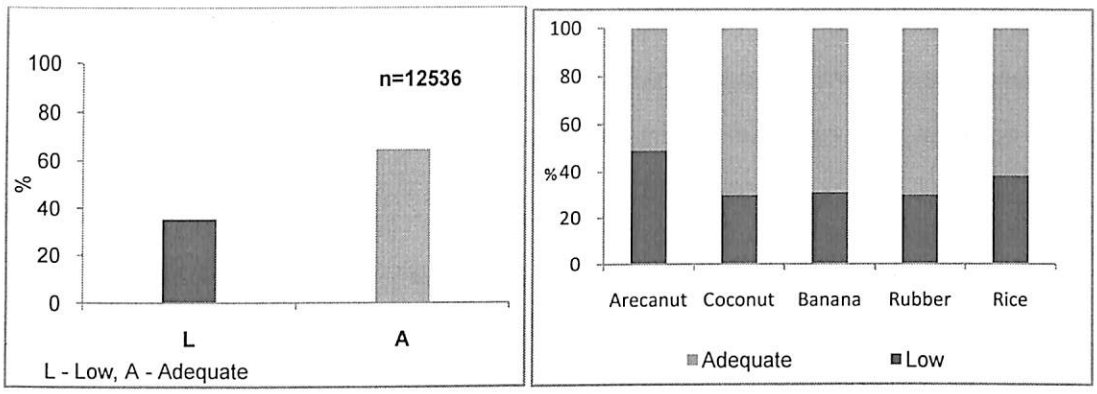
Among the various AEUs, deficiency of K was more pronounced in northern coastal plains (84%), pokkali (60%) and kole (38%) lands. But in north central laterites (21%) and northern high hills (10%), deficiency level was relatively low. On the contrary, high levels of K was more pronounced in northern high hills (58%) and north central laterites (49 %) and less in kole (23 %) and pokkali and least in northern coastal plains (2%). Moderate levels of K was more in northern central laterites (36 %) followed by kole lands (34 %), northern high hills (32 %), pokkali lands (14%) and least in northern coastal plains.

The results in general point out that K is found to be a deficient element in the district, especially in the coastal areas, vegetable and rice production systems. So appropriate measures need to be taken care of to elevate its level to satisfy the requirement of crops.

*5. Available calcium*

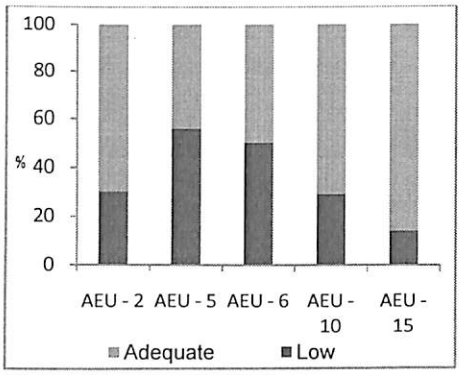
Though 51 % of the soils were strongly acid in reaction, absolute deficiency of available Ca (Figure 11) was seen only in 35 % of the samples in the district. No significant deviations from this trend were observed when each cropping systems were considered separately, except for samples from vegetable growing-areas, wherein almost all the samples recorded deficient levels of calcium. Continuous uptake by actively growing plants coupled with non replenishment of this nutrient back to soil can be the reason for the acute deficiency observed in vegetable growing areas.

Among the AEUs in the district, Ca deficiency was more pronounced in pokkali (56%) and kole (50%)lands. Soils of northern coastal plain (30%) and north central laterites (29%) were also deficient in Ca to some extent and it was least in northern high hills(14%).As expected, adequate levels of Ca was more dominant in northern high hills (86 %), north central laterites (71%) and northern coastal plain (70%). In pokkali and kole lands, deficiency and adequate levels go almost hand in hand to each other.




a. General status

b. Between crops




c. Between AEUs

Figure11. Frequency of available Ca classes in Thrissur District

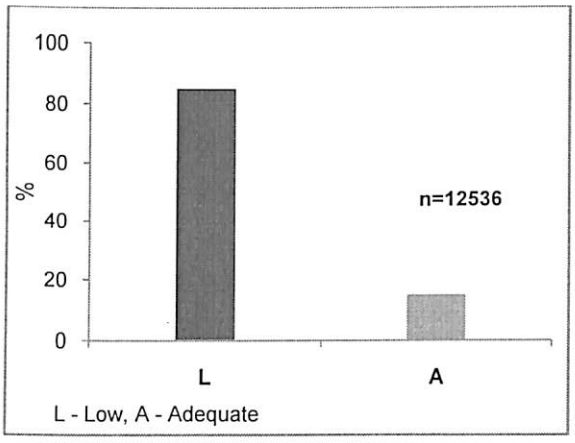
In addition to the extremely acidic condition, low input of liming materials also might have aggravated the deficiency of Ca in pokkali and kole lands.

*6. Available magnesium*

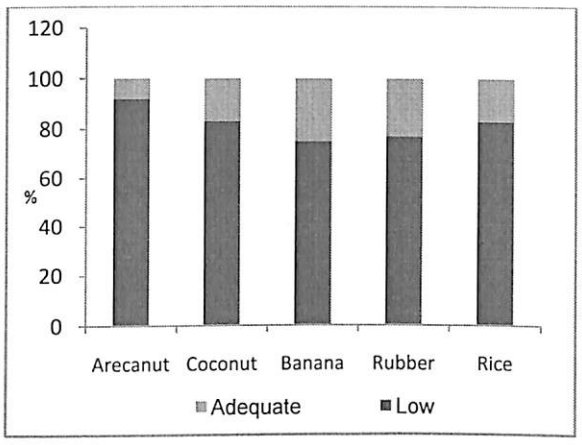
In general, almost 85% of the samples in the district (Figure 12) were with deficiency of Mg. Almost same percentage of samples were deficient in all the cropping systems, except in vegetable growing areas, wherein all the samples were deficient in this nutrient.

Deficiency of Mg was well pronounced in all the AEUs of the district and its severity was more in northern coastal plain (99%), pokkali (96 %) and kole (94%) lands followed by north central laterites (73%) and northern high hills (79 %). Application of high dose of NPK fertilizers, inherent high soil acidity, lack of application of Mg containing amendments, heavy leaching etc.

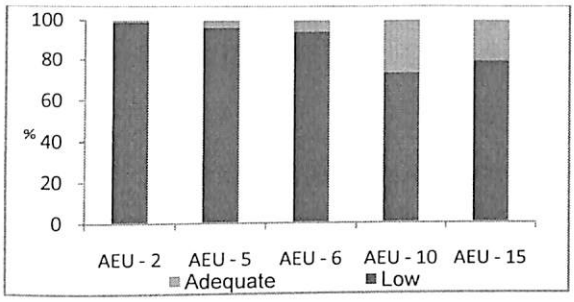
are the various reasons attributed to the severe deficiency of this nutrient in the district. Unlike Ca which is applied as calcite, Mg is often neglected in most cropping sequences leading to its deficiency. Application of Mg rich ammendmentsmay provide a viable strategy to ameliorate its deficiency in these soils.




a. General status




b. Between crops

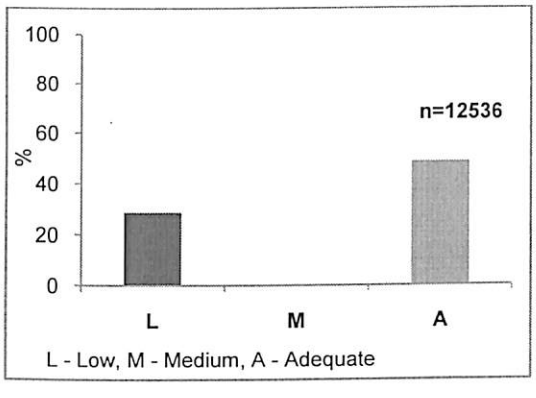



c.Between AEUs

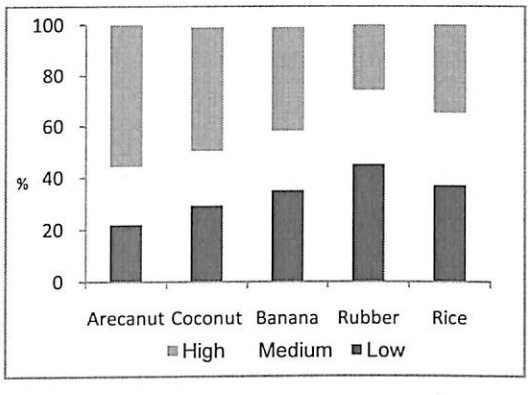
Figure 12.Frequency of available magnesium classes in Thrissur District

*7. Available sulphur*

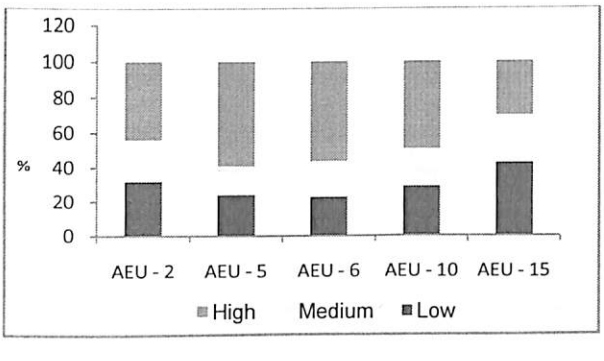
Sulphur deficiency (Figure 13)was observed only in 29 % of the soils in the district. Most of the phosphatic fertilizers contain sulphur as an additional constituent and this is responsible for fairly satisfactory levels in soil, despite the low retention capacity of the soil for sulphur.Among the various cropping systems, deficiency of S was well pronounced in rubber (45 %) and rice (37 %) while excess levels of this nutrient were dominant in arecanut (56 %), coconut (49 %) and banana (41 %).




a. General status




b. Between crops




c.Between AEUs

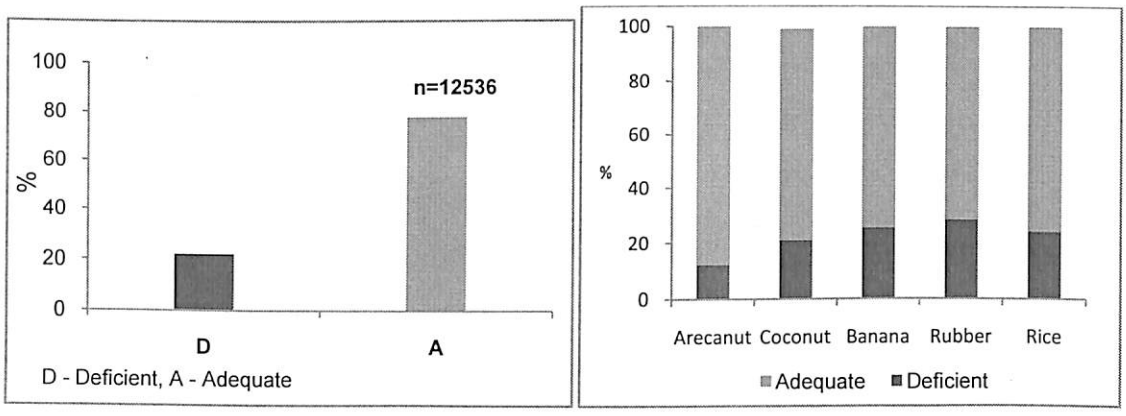
Figure 13. Frequency of available S classes in Thrissur District

Compared to Ca and Mg, deficiency of S was less pronounced in all the AEUs except in northern high hills where 43 % of the samples belonged to this class. In other AEUs, only 24- 32 % of the samples weredeficient.

*8. Available zinc*

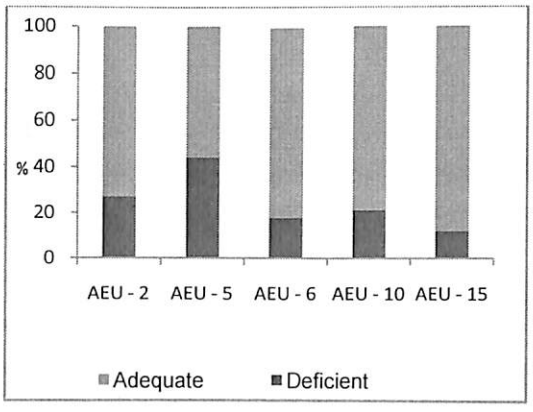
Deficiency of Zn is less pronounced in the district in general(Figure 14) as well as among various crops and AEUs. Deficiency of Zn was relatively very low in vegetables and arecanut. Among the AEUs, Pokkalilands (44 %) were with higher deficiency of Zn and northern high

hills with lower deficiency (12 %). Deficient samples varied from 18 -27 % in the rest of the AEUs. Higher deficiency in Pokkali lands might be due to its peculiar geographical situation, especially below the sea level. Usually, this element occurs as a contaminant in phosphatic fertilizers, including rock phosphate. So high input of phosphatic fertilizers might have ensured adequate level of Zn in these soils.




a. General status

b. Between crops

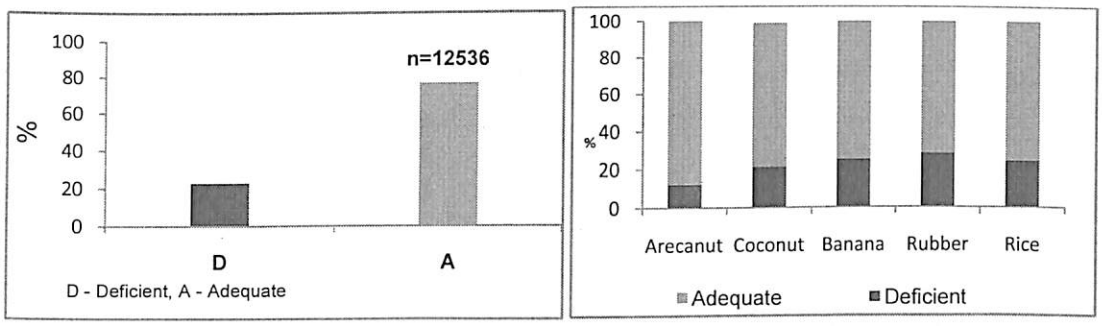



c.Between AEUs

Figure 14. Frequency of available Zn classes in Thrissur District

*9. Available copper*

With respect to Cu, 77 % of the soils contained adequate content of this nutrient in the district ( Figure 15) and its deficiency is about 23 %. Cu is an important ingredient of common fungicides used to combat many fungal born diseases of crop plants in humid areas. Cu input from fungicides and the retention of the element in soil organic matter may explain the reason for its adequate levels inthese soils




a. General status

b. between crops

c.Between AEUs

Figure 15. Frequency of available Cu classes in Thrissur District

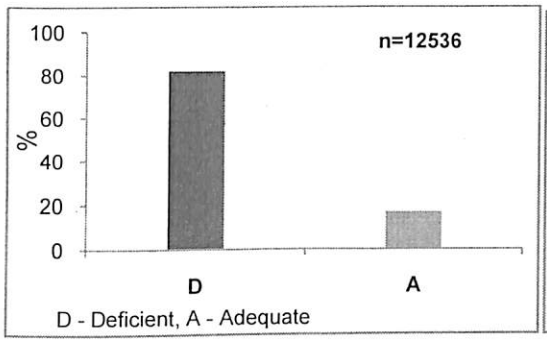
On assessing crop wise status of Cu in the soil, it was found that deficient level of this nutrient was less prominent in all the crops, vegetables and arecanut containing the least (10-12 %) and coconut, rice, banana and rubber with relatively elevated levels (21-28 %). Cu, being an

ingredient in common fungicides, their frequent application either to soil or crop might be boosting itscontent above the deficiency range.

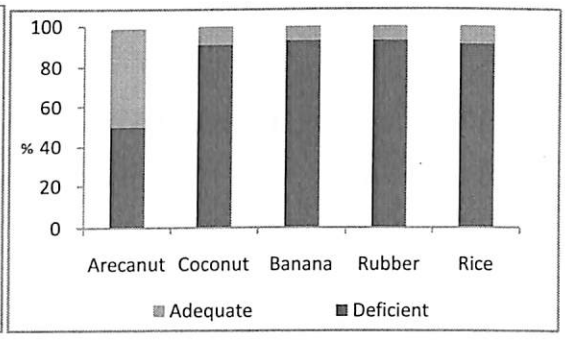
Among the AEUs, deficiency of Cu was pronounced in pokkali lands (48 %) and it was very less in northern high hills (10 %). The rest of the AEUs were with almost same deficient samples (23-27 %).

*10. Available boron*

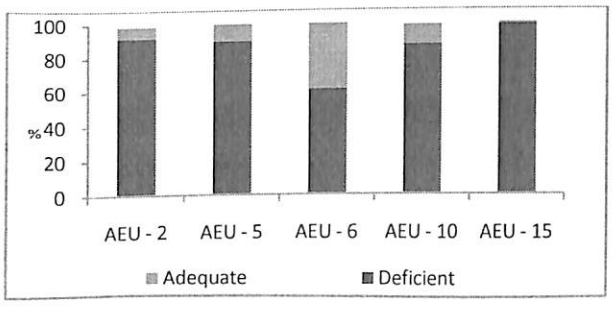
Among the micro nutrients, deficiency of B was found severe in the district (Figure 16), 82 % of the samples being in the deficient range. When each cropping system was considered separately, more than 90% per cent of the samples from rice, coconut, banana and rubber were deficient in this nutrient. But in arecanut, only half of the samples were with low levels of B.




a.General status




b. Between crops




c.Between AEUs

Figure 16. Frequency of available B classes in Thrissur District

Deficiency of B was well pronounced in all AEUs of the district. Almost all the samples from northern high hillsshowed boron deficiency. Samples from northern coastal plains (92 %), pokkali (90 %) and northern central laterites(87 %) were also with higher levels of B deficiency. But B deficiency was relatively less (60 %) in the kole lands.

B, being water soluble, escape quickly from the system through leaching and it is not replenished in to the system either directly or indirectly through fertilisers. This is supposed to be the major reason for the acute deficiency of B in the district, without any crop wise or AEZ wise deviation.

## 4. CONCLUSIONS AND RECOMMENDATIONS

1.The soils of the district, in general, were in the acid range and relatively more acidity was in rice production systemand vegetables . Extremely acid soils of the district is concentrated mainly in the special AEUs of the district like pokkali and to some extent in kole lands also. In order to tackle the problems with high acidity, liming of soils in accordance with soil test results is highly recommended.

2. Soils with low, medium and high range classes of N were almost equal in the district, but the deficiency was more pronounced in vegetables and AEUs like northern coastal plains, kole lands and pokkali lands

3. Deficiency of available P was negligible in the district while its excess levels were well pronounced in all the crops and AEUs. So either skipping or minimizing the use of costly phosphatic fertilizers based on soil test results is highly recommended.

4. As in the case of N, soils with low, medium and high range classes of K were almost equal in the district,but its deficiency was more pronounced in the vegetable and rice production systems and also in coastal areas. So appropriate measures need to be taken care of to elevate its level to satisfy the requirement of crops.

5 Even though, deficiency of available Ca was not well dominant in the district, soils from all the vegetable growing-areas were deficient in this nutrient. Among the AEUs in the district, Ca deficiency was more pronounced in pokkali and kole.

6. In general, deficiency of Mg was well pronounced in the district. Deficiency was severe in all the cropping systems and the severity was more in vegetable growing areas. Similarly all the AEUs of the district was with acute deficiency of this nutrient. Application of magnesium sulphate @80 kg/ha is recommended to ensure adequate levels of magnesium and sulphur to crops.

7. Deficiency of Zn is less pronounced in the district in general, as well as among various crops and AEUs. Deficiency of Zn was relatively very low in vegetables and arecanut growing soils and in pokkali lands.

8. Deficiency of B is well pronounced in the district in general as well as in all the crops and AEUs. Regular application of borax @10 kg/ha is recommended until the soils attain its adequate level.

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