THREE DECADES OF SOIL RESEARCH (1972-2006)

Compiled by

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FOREWORD

Soil research in Kerala has been in progress for nearly one hundred years in the past and much of the work conducted during 1920s was included in the Memoirs of the State Department of Agriculture. In 1926, the soil survey report of Vaikom Taluk is seen to have published as Bulletin No.19 of the Department of Agriculture. The first research paper published in a scientific journal appears to be the one entitled "Some peculiar low-lying soils of Central Travancore" by T.R. Narayana Pillai and V. Subramanyan in the Journal of the Indian Institute of Science, Bangalore (vol 13A, pp 1-10) in 1930. This was followed by various other investigations but most of them remain in official records and have not been published. Research on soil problems was strengthened when the College of Agriculture, Vellayani, Thiruvananthapuram was established in 1955 and post-graduate programme commenced in 1961. Later, the College of Horticulture, Thrissur was established in 1972 with M.Sc. programme in 1976 and Ph.D. programme in 1981. However, most of these investigations were in the form of research carried out by postgraduate students which was embodied in their theses and mostly remained unpublished. The Centre of Excellence for Tropical Soils established by the Kerala Agricultural University in 1985 made an assessment of the work already carried out and brought out a compilation entitled "Sixty Years of Soil Research in Kerala (1926-1986)" by M.M.Koshy and P.A.Korah in 1987 which served as a summary of abstracts of the investigations on soil carried out till that time. Afterwards, no such attempt has been made to list out the work done after 1986. I am extremely happy to note that the Department of Soil Science & Agricultural Chemistry of the College of Horticulture is bringing out a similar compilation of the work carried out at this Department from the very inception of the College of Horticulture.

I hope that this will be the fore-runner of several significant publications that this Department will produce in the near future.

Wishing all success,

Thrissur
December 10, 2006

Prof. A. I. Jose
Former Director of Extension
Kerala Agricultural University

PREFACE

Soil research plays a prominent role in the management of natural resources for sustainable agricultural production. Soil Science being one of the most important aspects of Physical Science coming under the Natural Resource Management area, the students and teachers need to be well aware of the latest developments in this field.

Keeping this in mind, an attempt is made to incorporate the research works carried out in the department of Soil Science and Agricultural Chemistry for the last three decades. This book of abstracts is divided into sections according to specific areas of work and in each section the salient results obtained are well presented. It contains lot of information on the various research programmes carried out in the department.

This publication is brought out on the eve of the winter school on "GIS based watershed planning in agriculture" held during December 2nd to 22nd 2006, at Kerala Agricultural University.

I congratulate the authors for bringing out this excellent compilation of research works. I hope that this book will serve as an up to date reference to post graduate students, teachers and scientists working in the field of natural resource management.

With best wishes

Dr. P. K. Rajeevan,
Associate Dean

THREE DECADES OF SOIL RESEARCH – A PRELUDE

Life could originate and flourish on earth only because the environment of earth provided the conducive conditions for it. The man – nature interaction occupies a special place in the life and thought of Indian people, since pre-historical times in the Indian sub-continent, the bush green vegetation of the tropical south always occupied a dominant position with its highly divergent life styles and cultural ethos. The development and progress of Kerala must be compatible with the goal of achieving ecological and nutritional security. Soil research plays a prominent role in the management of natural resources for sustainable agricultural production. The Kerala Agricultural University in general and the Department of soil Science & Agricultural Chemistry in particular is in the forefront for inter or multidisciplinary research related to soil use and management under ecological, social, economic and environmental aspects. So, lot of information is available from this small document which focuses on the various research programmes carried out in the department for the last 30 years.

In the real sense, this publication is a compilation of the contribution of the department of Soil Science & Agricultural Chemistry in the different spheres of its activity, particularly in the management of natural resources, the prime of which is soil, the placenta of earth.

We take this opportunity to profusely thank Dr. P. K. Rajeevan, Associate Dean, and College of Horticulture in motivating us to bring out this publication. We are ever grateful to Dr. A.I. Jose, Former Director of Extension, KAU, who readily agreed to write a forward for this document. With deep sense of gratitude, we remember that he served as our Department Head for two decades. In this occasion, we acknowledge the contributions made by the former Heads of Department and other Scientists who worked in the department which have proved the way for all the development of this department. The dynamic leadership given by Dr. K. C. Marykutty, Head of the Department, in this venture is to be well appreciated by all.

We extend our grateful appreciation to the Editorial committee members, other staff members and the post graduate students of this department without whose contribution, this publication would not have been materialized. We are thankful to Dr. Jiju P. Alex and Dr. Jacob John for the help given by them for designing the cover page.

This publication is brought out on the eve of the winter school on "GIS based watershed planning in agriculture" held during December 2nd to 22nd 2006, at Kerala Agricultural University, Thrissur and this opportunity is gratefully acknowledged.

We hope that this publication will be read widely by the scientific community and utilized in their future programmes for further improvement.

Authors

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FORMER HEADS OF DEPARTMENT

1. Dr. A. I. JOSE	01-01-1976	- 11-12-1995
2. Prof. K. Leela	12-12-1995	- 15-05-1998
3. Dr. N.P. Chinnamma	16-05-1998	- 15-03-2002

PRESENT STAFF POSITION

A) TEACHING

1. Dr. K.C. Marykutty, Professor & Head i/c
2. Dr. K.A. Mariam, Associate Professor
3. Dr. N. Saifudeen, Associate Professor (i/c of CLRRM)
4. Dr. M.A Hassan, Associate Professor (STCR Project)
5. Dr. P.K. Sushama, Associate Professor
6. Dr. Betty Bastin, Assistant Professor, Senior Scale (STCR Project)
7. Dr. P. Sureshkumar, Assistant Professor, Senior Scale, (Radiological Safety Officer, RTL)
8. Dr. P.R. Suresh, Assistant Professor, Senior Scale

B) SUPPORTING STAFF

1. Sri. P.R. Sathyan, Farm Supervisor (STCR Project)
2. Sri. Ananthakrishnan, Farm Assistant Gr.II (STCR Project)
3. Smt. V.M. Baby, Lab. Assistant Gr.II.
4. Sri. S. Biju, Lab. Assistant Gr.II
5. Sri. K.A. Vinod, Lab. Assistant Gr.II

LIST OF COURSES OFFERED

A. Courses offered for B. Sc. (Ag.) programme

Major courses

1. Chem. 1101	Fundamentals of Soil Science	2+1
2. Chem. 1202	Elementary Biochemistry	2+1
3. Chem. 2103	Soil Fertility and Nutrient Management	2+1
4. Chem. 3204	Conservation and management of soil and Water resources	2+1
5. Chem. 3205	Agro ecology and environmental pollution	2+1

Optional courses

6. Chem. 4106	Analytical Chemistry	0+1
7. Chem. 4107	Soil survey, soil taxonomy and remote sensing	1+1
8. Chem. 4108	Organic farming	1+1
9. Chem. 4109	Fertilizer technology	1+1
10. Chem. 4110	Agrl. Chemicals and environmental pollution	1+1

B. Courses offered for B.Sc. Forestry

1. Chem. 1101	Geology and Soil Science	2+1
2. Chem. 3103	Soil Survey and Land use planning	1+1
3. Agro. 2102	Fertility of soil and nutrient management	2+1

C. Courses offered for M. Sc. (Ag.) programme

1. Ag. Chem. 601	Physical Chemistry	2+0
2. Ag. Chem. 602	Organic Chemistry	1+1
3. Ag. Chem. 603	Agrl. Biochemistry	2+1
4. Ag. Chem. 604	Agrl. Chemicals and Environmental pollution	1+1
5. Ag. Chem. 605	Instrumental methods of Analysis I	1+1
6. Ag. Chem. 606	Instrumental methods of Analysis II	1+1
7. Ag. Chem. 607	Soil Chemistry	2+1
8. Ag. Chem. 608	Pedology	1+1
9. Ag. Chem. 609	Soil Bio-chemistry	1+1
10. Ag. Chem. 610	Soil plant relationships	1+1
11. Ag. Chem. 611	Soil colloids and Clay Mineralogy	2+0
12. Ag. Chem. 612	Soil Physics I	2+1
13. Ag. Chem. 613	Soil Physics II*	2+0
14. Ag. Chem. 614	Chemistry of Micronutrients	1+1
15. Ag. Chem. 615	Manures and Fertilizers	1+1
16. Ag. Chem. 616	Fertilizer Technology	1+1
17. Ag. Chem. 617	Fundamentals of Radiation and Radio-isotopes	1+1
18. Ag. Chem. 618	Application of Isotopes in soil plant research	1+1
19. Ag. Chem. 619	Seminar	0+1
20 Crop 504	Soil Fertility and soil plant relationships**	2+0

* Course offered for M. Sc. Forestry

** Course offered for Ag. Statistics students

D. Courses offered for Ph. D. programme

1. Ag. Chem. 701	Chemistry of submerged soils	1+1
2. Ag. Chem. 702	Laterite and Associate Soils	1+0
3. Ag. Chem. 703	Plantation crop soils	1+0
4. Ag. Chem. 704	Chemistry of problem soils	1+1
5. Ag. Chem. 705	Soil Survey and classification	1+1
6. Ag. Chem. 706	Soil Micromorphology	1+1
7. Ag. Chem. 707	Soil Fertility Evaluation	1+1
8. Ag. Chem. 708	Soil Organic matter	1+1
9. Ag. Chem. 751	Seminar	0+1
10. Ag. Chem. 752	Seminar	0+1

LIST OF Ph. D AND M. Sc. (Ag.) DEGREE RECIPIENTS

1. CHARACTERIZATION OF SOILS OF KERALA

1.1 Ph. D. theses

Sl. No.	Name of student/ Admission No.	Title of the theses-	Year	Name of the Advisor
1.1.1	Manorama Thampatti, K.C. 92-21-18	Morphological, physical and chemical characterisation of the soils of North Kuttanad	1997	Dr. A.I Jose
1.1.2	Sujatha, M.P 92-21-19	Characterisation of soils under reed in Western Ghats	1999	Dr. A.I Jose

1.2 M. Sc. (Ag.) theses

1.2.1	Betty Bastin 82-11-29	Physico-chemical characterization of red soils in different regions of Kerala	1985	Dr.V.K. Venugopal
1.2.2	Stella Jacob 84-11-32	Characterisation of laterite soils from different parent materials in Kerala	1987	Dr.V.K. Venugopal
1.2.3	Kamalam, P.V. 85-11-23	Characterization of Kerala soils into fertility classes with respect to available P and K extracted by a common extractant	1988	Dr. A.I Jose
1.2.4	Cicy P.Mathew 86-11-44	Sulphur status of the Kuttanad soils of Kerala	1989	Dr. A. I. Jose
1.2.5	Visveswaran, S. 91-11-29	Characterisation of soil and irrigation water of the sugarcane belt in Palghat in relation to yield, nutrient uptake and quality of cane	1995	Dr. P.A. Korah

2. SOIL INVENTORY AND TAXONOMY

2.1 Ph. D theses

2.1.1	Nageswara Rao, D.V.K 95-21-16	Productivity classification of soils under rubber in Kerala	2000	Dr. A.I. Jose
2.1.2	Anup Balakrishnan 2000 – 19- 21	A geographic information system for micro-level decision making in the agricultural sector of central mid lands of Kerala	2005	Dr. N. Saifudeen

2.2 M. Sc. (Ag.) theses

2.2.1	Elsy, P.A 85-11-24	Physico-chemical characteristics, genesis and classification of soils from forest ecosystems in Kerala	1989	Dr.V.K.Venugopal
2.2.2	Krisnakumar, P.G. 88-11- 47	Taxonomy and fertility assessment of the soils in command area of Edamalyar Project	1991	Dr.V.K.Venugopal

2.2.3	Ambili, C. 92-11-45	Taxonomy and fertility capability of soils in kole areas of Thrissur	1995	Dr. V.K.Venugopal
2.2.4	Deepa, K.P. 92-11-48	Fertility investigation and taxonomy of soils of of RARS, Pattambi	1995	Dr. N.P.Chinnamma
2.2.5	Sreerekha, L 92-11-50	Fertility investigation and taxonomy of soils of of BRS, Kannara	1995	Dr. K.C.Marykutty
2.2.6	Seena, E. 98-11-35	Soil resource inventory of Main Campus, KAU, Vellanikkara (East)	2000	Dr. P.Sureshkumar
2.2.7	Sajananath, K. 98-11-36	Soil resource inventory of Main Campus, KAU, Vellanikkara (West)	2000	Dr.N. Saifudeen

3. SOIL FERTILITY EVALUATION

3.2 M. Sc. (Ag.) theses

3.2.1	Johnson, P.T. 76-11-37	Foliar diagnosis, yield and quality of ginger (*Zingiber officinale*) in relation to nitrogen, phosphorus and potassium	1978	Dr. A.I. Jose
3.2.2	Saifudeen, N. 78-11-86	Foliar diagnosis, yield and quality of turmeric (*Curcuma longa* L) in relation to nitrogen, phosphorus and potassium	1981	Dr. A.I. Jose
3.2.3	Gopi, C.S. 78-11-57	Foliar diagnosis in coconut (*Cocos nucifera*,Linn.) relation to nitrogen, phosphorus and potassium	1981	Dr. A.I. Jose
3.2.4	Sushama, P.K. 79-11-30	Foliar diagnosis, yield and quality of pepper (*Piper nigrum* L) in relation to nitrogen, phosphorus and potassium	1982	Dr. A.I. Jose
3.2.5	Krishnakumar, N. 81-11-28	Yield prediction in coconut based on foliar nitrogen, phosphorus and potassium	1983	Dr. A.I. Jose
3.2.6	Rosily Mathew 88-11-24	Yield prediction in cashew based on foliar nutrient levels	1990	Dr. A.I. Jose
3.2.7	Ramesh, V. 91-11-27	Foliar diagnosis and yield prediction in sugarcane in relation to N, P and K	1994	Dr. Sumam Suasn Varghese
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3.2.9	Jayalakshmi.M 99-11-42	Soil test crop response studies in ginger in laterite soils of Kerala	2001	Dr. M.A. Hassan
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3.2.11	Siddha, P.S. 01-11-44	Soil Test Crop Response studies on groundnut in laterite soils of Kerala	2004	Dr. Betty Bastin

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4.1.1	Anilakumar, K. 83-21-03	Nitrogen losses from the rice soils of Kerala with special reference to ammonoia volatilization	1989	Dr. A.I. Jose
4.1.2	Sailajakumari , M.S. 99-21-11	Critical analysis of the soil plant atmosphere continuum for increasing the productivity of rice in laterite soils	2005	Dr. K.A. Mariam

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4.2.1	Manorama Thampati, K.C. 82-11-24	Potassium utilization in cassava (*Manhot utilissimum* Pohl) as influenced by neemake-urea blend	1985	Dr. P. Padmaja
4.2.2	Anilkumar,K. S. 84-11-34	Chemistry of coconut rhizosphere	1987	Dr. P.A. Wahid
4.2.3	Prema, D. 84-11-30	Effect of sodium chloride on soil characteristics, yield and quality of coconut grown in laterite soil	1987	Dr. A. I. Jose
4.2.4	Jayaraj. P. 86-11-47	Efficiency of potassium in mitigating the effect of shade in intercrops	1990	Dr. P.Padmaja
4.2.5	Muraleedhara Menon, P.G. 88-11-23	Efficiency of potassium under different levels of irrigation in summer vegetable ash gourd	1990	Dr. K.C. Marykutty
4.2.6	Jessymol, A.S. 89-11-48	Influence of soil texture on potassium availability, fixation and uptake by rice in laterite soils	1991	Dr. K.A. Mariam
4.2.7	Padmom, M.K. 89-11- 44	Effect of long term application of manures and fertilizers on soil properties, utilization efficiency of nutrients and quality of rice	1992	Dr.N.P.Chinnamma
4.2.8	Tessy Jocob K 89-11-47	Management of acidity by combined application of lime and gypsum in low activity clay soils of Kerala	1992	Dr.V.K.Venugopal
4.2.9	Mini, E.R. 89-11-49	Fractionation of organic and inorganic nitrogen in important soil types of Kerala.	1992	Dr. Suman Suasn Varghese
4.2.10	Sivakumar, C. 90-11-20	Growth and nutritution of black pepper as influenced by decaying litter materials in soil	1992	Dr. P.A.Wahid
4.2.11	Muraleedharan , P. 90-11-22	Response of rice to application of micronutrients	1992	Dr. A. I Jose
4.2.12	Joemon Joseph 89-11-52	Soil fertility of coconut rootzone as influenced by long term inorganic fertilizers	1993	Dr. P.A. Wahid

4.2.13	Muhammed Sakeer 93-11-61	Exchangeable aluminum as an index of the lime requirement of the laterite soils of Kerala	1997	Dr. K.C. Marykutty
4.2.14	Rosamma Abraham 95-11-34	Indole acetic acid oxidase activity in brinjal as influenced by fertilizer treatments	1998	Dr. Jacob John
4.2.15	Binu Thomas 95-11-35	Regulation of major nutrients and organic matter for improving the nutritive quality of banana grown in laterite soils	1999	Dr.M.A. Hassan
4.2.16	Nair Rajeev, R.K. 99-11-69	Effect of major nutrients on the yield and quality of nuts in graft raised cashew	2002	Dr. Sam T. Kurumthottical

5. AVAILABILITY INDICES OF NUTRIENTS IN SOIL

5.2 M. Sc. (Ag.) theses

5.2.1	Mathew Jacob, K. 77-11-33	Evaluation of available phosphate reserve of soil by chemical methods	1979	Dr. A.I. Jose
5.2.2	Durga Devi, K.M. 83-11-25	Evaluation of available phosphorus and potassium in soil using a common extractant	1986	Dr. A .I. Jose
5.2.3	Sapheena, K.S. 90-11-21	Evaluation of methods to improve the nitrogen use efficiency of urea in rice	1993	Dr. N.P.Chinnamma
5.2.4	V.P.Sudheesan 93-11-52	Standardisation of rooting media for selected tree crop seedlings with special reference to plant nutrients	1996	Dr. M.A. Hassan
5.2.5	Priya, P 01-11-30	Availability indices for stressed nutrients for coconut in an Ultisol	2003	Dr. P. Sureshkumar

6. NUTRIENT DYNAMICS IN SOIL

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6.1.1	Prema, D. 89-21-10	Status availability and transformation of magnesium in acid soils of Kerala	1992	Dr. A.I. Jose
6.1.2	Rani, B. 93-21-17	Dynamics of K, Mg and sulphur in plant and soil with special reference to the application of langbeinite	2000	Dr. A.I. Jose

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6.2.1	Mashar Velapurath 83-11-30	Relative efficiency of rice varieties for absorption and utilization of soil and fertiliser phosphorus	1986	Dr. P. Padmaja
6.2.2	Vijayan, A.P. 90-11-24	Behaviour of phosphorus in selected soil types of Kerala	1993	Dr. Sumam Suasn Varghese

6.2.3	Smitha, B. 92-11-53	Soil nutrient dynamics in Cocoa	1995	Dr. P.A. Wahid
6.2.4	Nisha, P.T. 92-11-55	Dynamics of nutrient release and transformations from slow release fertilizers in acid rice soils	1995	Dr. P.K.Sushama
6.2.5	Dineshkumar , K.K. 91-11-22	Seasonal variations in the nutrient transformations in the laterite alluvial rice soils of permanent manural trials	1996	Dr.N.P.Chinnamma
6.2.6	Jyothikumari , K.M 92-11-54	Dynamics of potassium in the soils of kole lands	1996	Dr. K.A. Mariam
6.2.7	Nicy Thomas 95-11-36	Form, availability and transformation of potassium in laterite soil as influenced by crop uptake	1998	Sri. Gopi, C.S.

7. SUITABILITY OF COMMERCIAL PRODUCTS AS A SOURCE OF NUTRIENT IN SOIL

7.2 M. Sc. (Ag.) theses

7.2.1	Regi P.Mathews 82—11-23	Suitability of rock phosphate for direct application in acid rice soils of Kerala	1985	Dr. A.I. Jose
7.2.2	Susan Varghese 89-11- 43	Suitability of magnesite as a source of magnesium in acid rice soils of Kerala	1992	Dr. A. I. Jose
7.2.3	Anila Mathew 93-11-52	Suitability of Sul-Po-Mag as a potassium cum magnesium fertilizer for banana in Kerala	1997	Dr.N.P.Chinnamma
7.2.4	Santhoshkumar, V.C. 93-11-56	Suitability of Tunisia rock phosphate for direct application in acid rice soils of Kerala	1997	Dr. K.A Mariam
7.2.5	Suja Thomas 94-11-49	Evaluation of maton rock phosphate in the acid rice soils of Kerala	1997	Dr. P.K.Sushama

8. SOIL ORGANIC MATTER AND BIOCHEMICAL STUDIES

8.2 M. Sc. (Ag.) theses

8.2.1	Usha, P.B. 79-11-31	Characterisation of soil organic matter in different soil types of Kerala	1982	Dr. A.I. Jose
8.2.2	Rekha Pillai 88-11-23	Quality of oil of clocimum as influenced by stages of harvest and shade	1990	Dr. N.P.Chinnamma
8.2.3	Mullakoya, C.P. 93-11-69	Increasing the geraniol of palmarosa oil by chemical methods	1997	Dr. Samuel Mathew

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9.2.1	Jayasree Sankar, S. 82-11-25	Studies on the root activity pattern of black pepper (*Piper nigrum* L) employing radiotracer technique	1985	Dr. P.A. Wahid
9.2.2	Padmini Amma, K.P. 85-11-25	Reductive transformation of iron and sulphate in anaerobic soils	1988	Dr. P.A. Wahid
9.2.3	Smitha, M.S. 03 – 11-24	Phosphorus dynamics in an Ultisol.	2005	Dr. P. Sureshkumr

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10.1.1	Betty Basin 91-21-08	Fate of Carbofuran applied to the soil basin of black pepper	1996	Dr. P.A. Wahid
10.1.2	Vijayan, A.P. 95-21-17	Carbofuran residue in banana	2000	Dr.N.P.Chinnamma
10.1.3	Durga Devi, K.M. 96-21-21	Assessment of 2-4-D residues in major rice soils of Kerala	2002	Dr.N.P.Chinnamma

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10.2.2	Muthukannan, K. 2000-11-29	Persistence of selective herbicides in rice-rice system	2003	Dr. K.M.Durga Devi

11. SOIL PHYSICS

11.2. M. Sc. (Ag.) thesis

11.2.1	Ushakumary, K. 81-11-29	Aggregate size distribution and its relationship to physical and chemical properties of some typical soils of Kerala	1983	Smt. K. Leela

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12.2.1	Jothimoni, S. 90-11-25	Decomposibility and mineralisation pattern of coir pith in latosols	1993	Dr. P.K.Sushama
12.2.2	Venugopal, R. 91-11-26	Effect of coir pith on physcio chemical and moisture retention properties of selected soil groups of Kerala	1995	Dr. P.K. Sushama
12.2.3	Preetha, D. 01-11-29	Biotic enrichment of organic waste from Ayurvedic preparations	2003	Dr. P.K.Sushama
12.2.4	Lakshmisree, C.S 01-11-31	Aerobic composting and enrichment of Ayurvedic waste	2003	Dr. Betty Bastin

12.2.5	Arun, G. 01-11-45	Soil properties and produce quality of cardamom under organic farming	2004	Dr. N. Saifudeen
12.2.6	Thankamoni, K. 02 – 11-23	Stndardisation of production and enrichment of vermi-wash	2005	Dr. P.K.Sushama

13. STUDIES ON HEAVY METALS

13.2 M. Sc. (Ag.) theses

13.2.1	Jidesh,C.V. 94-11-54	Assessment of some phosphatic sources for possible accumulation of heavy metals in chilli	1997	Dr. Sam T. Kurumthottical
13.2.2	Vanisree, K. 01-11-33	Assessment of selective retention site of cadmium and lead in tomato	2004	Dr. Sam T. Kurumthottical

POST GRADUATE STUDENTS IN ROLL

1.	Santhosh, C. 04-11-29	Availability indices of potassium in an Ultisol under coleus cultivation	Dr. K.A.Mariam
2.	Deepa K. kuriakose 05-11-125	Amelioration of subsoil acidity by calcium sources in laterite soils of black pepper gardens	Dr. P.R. Suresh
3.	Anjali Nambiar 05-11-126	Leaching behaviour of pretilachlor in the kole lands of Kerala	Dr. K.M. Durga Devi

JUNIOR POST GRADUATE STUDENTS

A. Ph.D. Students

1.	K. Sajnanath 2006-21-111	Dr. M. A. Hassan
2.	C.J. Bindhu 2006-21-112	Dr. P.K. Sushama

B. M. Sc. (Ag.) student

1.	Geetha, P 2006-11-129	Dr. P. Sureshkumar

ABSTRACTS OF THESES

1. CHARACTERIZATION OF SOILS OF KERALA

1.1 Ph. D theses

1.1.1 Manorama Thampatti, K.C. 1997. Morphological, physical and chemical characterization of the soils of North Kuttanad.

An investigation was carried out to evaluate the morphological, physical and chemical characteristics of the soils of North Kuttanad and to assess the extent of toxic factors that pertained to the soil due to restricted movement of water under the influence of Thanneermukkom regulator. The study was carried out in three parts, viz., a) Morphology and physicochemical characteristics b) Fertility characteristics c) Toxicity characteristics. Fifteen-soil profiles were drawn from North Kuttanad to study the morphology and physical characteristics of the area. The fertility characteristics were studied by collecting 97 surface soil samples from 27 padasekharams of the area during rainy and summer seasons (before and after the closure of Thanneermukkom regulator). Toxicity characteristics of the area were studied by collecting bulk soil samples, surface water and ground water from the above sites during the same period. Soils were dark brown to black in colour, sticky and plastic, subangular blocky in structure and sandy to clayey in texture with random deposits of lime shells and humus. Soils of the area were highly acidic and mildly saline and acidity and salinity increased with depth. Organic carbon, CEC and ECEC of the area were higher compared to the other parts Kerala, but the base saturation was comparatively lower. The area was rich in almost all the essential nutrients except P. Fe, Al and S were present in toxic concentrations. On evaluating the fertility characteristics of the area it was observed that the area experienced an increase in soil acidity and availability of N, P, Fe and Zn and a decrease in salinity, CEC, ECEC and available K, Ca, Mg, Mn and Cu. Potential acidity and hydrolytic acidity recorded higher values during rainy season while exchangeable acidity was greater during summer.

Among the various elements present in the water, Na and Cl^- were the dominant ions expressing greater concentrations during summer in both surface and ground water. The chlorinated hydrocarbon pesticides identified in the area were α - HCH, γ -HCH and DDT. They showed higher concentration during summer. Among the chlorinated hydrocarbons, DDT was present in larger quantities, though it was banned for agricultural uses. The accumulation of fertilizer residues in the area was not so negligible. The highest concentration was observed for NH_4-N during additional crop season, at the time of basal dressing, both in soil and water. The study indicated that the area is subjected to severe pollution due to the accumulation of native toxic factors as well as residues of pesticides and fertilizers. The closure of Thanneermukkom regulator aggravates the situation by restricting the movement.

1.1.2 Sujatha, M. P., 1999. Characterization of soils under reed (*Ochlandra travancoria* Bench.) in the Western Ghats.

A study was carried out to characterize the reed growing soils of Western Ghats. The study comprised of four parts viz., pedological / taxonomical characterization of reed growing soils, evaluation of fertility status of reed growing soils, assessment of growth performance of reed in relation to soil fertility and study on litter decomposition and nutrient release from reed leaf litter. The pedological / taxonomical characterization was carried out by digging representative soil profiles at two different types of topography (flat-undulating and sloping) in two different elevations (200-300 m and 600—800 m) at four locations viz., Vazhachal, Pooyamkutty, Adimalai and Pamba. Reed growing soils were found to carry litter on soil surface, which was under varying stages of decomposition. Fine fibrous roots were found to mat the soil surface giving granular and crumb structure. These soils were strongly to moderately acid in reaction and in pure reed areas surface soils were more acid than subsurface soils. In general, the change in location, elevation and topography was not found to exert any definite impact on depth wise distribution of soil properties in these soils.

These soils are classified under Ustic Kandihumult, Ustic Palehumult, Ustic Haplohumult, Ustic Kanhaplohumult, Typic Kanhaplostult, Ustic Humitropept, Ustoxic Humitropept, Ustic Dystropept, Ustoxic Dystropept, Oxic Ustropept and Lithic Dystropept at sub group level. Results in general revealed that reed bamboo play a significant role in conserving soil and its fertility. Number of matured culms ha^{-1} was found to be a better parameter in judging the growth performance of reed and Class I reed was found to have higher number of matured culms ha^{-1} than Class II and Class III. The model fitted through stepwise regression relating number of culms to different soil properties viz., soil pH, organic carbon, available N, P and K was $Y= 501.0420-179.881920x_1 + 1.9450x_1x_2$ where Y= number of culms ha^{-1}, x_1= soil pH and x_2= organic carbon. The models fitted through stepwise regression relating dry weight of culms and leaves with the uptake of N, P and K were $Y_1 = - 1294.29 + 37.265$ N + 321.410 P + 226.442 K, $Y_2= 2.1+38.403 + 187.2$ K where Y_1 is the dry weight of culms ha^{-1} and Y_2 is the dry weight of leaves ha^{-1}. The time required for 50 per cent and 95 per cent decomposition was 3 and 13 months respectively. Based on the concentration and absolute content, the nutrient mobility from decomposing reed leaf litter was in the order K > N > Mg > Ca > P.

1.2 M. Sc. (Ag) theses

1.2.1 Betty Bastin, 1985. Physico-chemical characterization of red soils in different regions of Kerala

An attempt had been made to evaluate the morphological, physical and chemical characteristics of red soils occurring in different regions of Kerala.

Six series representing red soils identified by the Soil Survey Unit of the Department of Agriculture, Kerala were selected for investigation. The series identified were Vellayani, Cherniyoor, Bharanikkavu, Beypore, Chirakkal and Kunhimangalam located in Thiruvanathapuram, Kollam, Kozhikode and Kannur Districts. Soil samples from different horizons of the profiles were collected to study the interrelationship between the various properties and to relate these to the genesis of the soils. Surface samples also collected from each series to find out the available nutrients. The morphological features of the soil profiles revealed prominent red hues with increase in redness with depth. Soils were all sandy in nature with fine sand fraction predominating and acidic with low electrical conductivity. Silica recorded very high values. In respect of total micronutrients, iron and manganese recorded high values while zinc and copper were low. The available nutrients of the surface samples showed high levels of phosphorus in all the soils. The SiO_2/Al_2O_3, SiO_2/Fe_2O_3 and SiO_2/R_2O_3 ratios recorded for all soils were higher than the values reported for typical laterite soils.

1.2.2 Stella Jacob, 1987. Characterization of laterite soils from different parent materials in Kerala.

An attempt has been made to evaluate the morphological, physical, chemical and mineralogical characteristics of laterite soils occurring in different regions of Kerala in relation to parent rock. Six soil series representing laterite soils identified by the Soil Survey Unit of Department of Agriculture, Kerala State were selected for the investigation. The soil series identified were Thonnaackal, Kootala, Anjur, Kanjikulam, Mannur and Nenmadnda located in Thiruvanthapuram, Thrissur, Palakkad, and Kozhikode Districts. Soil samples representing the different horizons were collected. The physicochemical characteristics of the soils, behaviour of iron and phosphorus fractions of the samples were investigated with a view to study the interrelationship between various properties and to relate these characteristics to the genesis of the soils. Mineralogy of the fine sand fraction was also carried out. Placement of these soils under soil taxonomy was also attempted based on the available data. All soils were acidic in nature in reaction with low values of electrical conductivity. The dithionite extractable iron formed the predominant iron fraction. Based on the 'degree of freeness of iron' in soils, Kanjikulam series was the oldest in respect of the age followed by Anjur, Kootala, Mannur, Nenmanda and Thonnackal. Silica formed the predominant fraction of the clay. Judged from the SiO_2/Al_2O_3 ratio of clay fraction, Thonnackal and Nenmanda were designated as ferralitic or true laterite. Based on the available data Thonnackal series classified under fine loamy kaolinitic isohyperthermic family of Typic Haplorthox while others belong to the clayey, kaolinitic isohyperthermic family of Typic Haplorthox.

1.2.3 Kamalam, P.V. 1988. Characterization of Kerala soils into fertility classes with respect to available P and K extracted by a common extractant.

An investigation was carried out in order to verify the suitability of Mathew's triacid extractant (0.06N H_2SO_4 + 0.06N HCl + 0.05N oxalic acid with a soil solution ratio of 1:10 and an equilibration period of 30 min) for the combined extraction of available P and K in the soils of Kerala and to establish precise relationships between the amounts of P and K extracted by triacid and that extracted by the individual extractants now employed in the soil testing laboratories of the state (namely Bray I for available P and neutral 1N NH_4OAc for available K). A large number of surface soils (0-15 cm) were collected from all over the state, which comprised samples from all the districts and various soil groups of the state. The physiochemical properties of the soil were determined. Available P was extracted by Bray I extractant as well as the triacid. Available K was extracted by neutral 1N NH_4OAc and the triacid. Relationship between P extracted by Bray I and the triacid was established by working out the co-efficient of linear correlation between them. Regression equation in order to predict Bray P values from triacid P values or the vice versa was worked out. The values of class intervals corresponding to the ten soil fertility classes in terms of triacid P were defined making use of this regression equation. Similarly the coefficient of correlation, linear regression equations were worked out for the values obtained from 1N NH_4OAc and triacid K

1.2.4 Cicy P. Mathew, 1989. Sulphur status of the Kuttanad soils of Kerala

A study was carried out to find out the forms and availability of S in the acid saline soils of Kuttanad and to understand whether the application of S containing fertilizers is necessary in this region, which is the major rice-growing tract of the state. One hundred and fifty one surface soil samples were collected from kari, karapadom and kayal soils. The available S in these soils was determined by employing four extractants viz., water, $CaCl_2$ solution, KH_2PO_4 solution and Morgan's reagent. The fractionation of S was carried out in 39 soil samples and the fractions estimated were total S, organic S, sulphate S and nonsulphate S. All the soils were acidic in nature, the pH ranging from 2.7 to 5.6. The organic carbon varied from 1.23 to 6.72 per cent. In general, soils of Kuttanad contained large amount of water soluble, $CaCl_2$ solution, KH_2PO_4 solution and Morgan's reagent soluble S and the highest values recorded by kari soils. Kuttanad soils contained large amount of total and organic S. The carbon: organic S ratio of the soil recorded to a mean value of 19.38. Sulphate S accounted 17.4 per cent of the total S where as nonsulphate S registered 20.5 percent of the total S. The study revealed that the contents of total and available S in acid saline soils of Kuttanad are so high that these soils are not likely to run deficient in S in the near future.

1.2.5 Visveswaran, S. 1995. Characterization of soil and irrigation water of the sugar cane belt in Palghat in relation to yield, nutrient uptake and quality of cane.

The investigation undertaken, envisaged the characterization of the soil and irrigation water of three sugarcane growing regions namely Vannamada, Meenashipuram and Attapadi in Palghat district and their relation to nutrient uptake, yield and quality of sugarcane. One hundred and ninety seven surface samples from three regions were characterized for the major physico-chemical properties. Twenty four farmer's field were identified as observation plots to assess the yield, dry matter production and quality parameters of sugarcane juice and the inter relations between these parameters. Samples of irrigation water from four commonly used sources namely bore well, canal, open well and river water used for irrigating sugarcane plots were collected in pre monsoon and monsoon periods for the determination of quality parameters. Soils of the three regions were mildly alkaline in reaction. The major texture of the soils was sandy clay loam followed by sandy loam. The water holding capacity and volume expansion of the soils were significantly higher in Vannamada and lowest in Attapadi regions. None of the physical properties had any adverse effect on the growth of sugarcane. Organic carbon and total N, P, and K recorded low values in the soils of the three regions. The rating of available N was medium in all the three regions. For available P and K, the rating of Vannamada and Meeenashipuram regions was medium while for Attapadi it was high. The micronutrients viz., Fe, Zn, Cu and Mn were above the sufficiency limits. The quality parameters of the irrigation water such as pH, EC, chloride, sulphate RSC and SAR were within the safe limits for the irrigation of the sugarcane. Juice quality parameters were significantly and positively correlated with N, P, K and Na.

2. SOIL INVENTORY AND TAXONOMY

2.1 Ph. D theses

2.1.1 Nageswara Rao, D.V.K, 2000. Productivity classification of soils under rubber (*Hevea brasiliensis* Muell. Arg) in Kerala

The Productivity classification of soils under rubber (*Hevea brasiliensis* Muell. Arg) in Kerala was taken up with the objectives to study the soil taxonomy of selected prominent soils under rubber in Kerala, to classify the soils according to the norms of fertility capability classification, to attempt an introduction of local modifiers into the FCC based on specific crop requirements of rubber plant to group the soils by numerical classification technique using important soil properties to test the direct and indirect effects of relevant soil factors on the growth of rubber and to identify the spectral signature of rubber using multibrand satellite imagery. Six prominent physicographic units, present in Wayanad, Malappuram, Thrissur, Kottayam and Pathanamthitta were selected to characterize the soils and classified according to the norms of Soil Taxonomy. The soils of all the reaches in the

selected physiographic units belonged to Ustic Kandihumults, Ustic Kanhaplohumults, Typic Kandiustults, Ustoxic Dystropepts, Typic Kandiustults, Uatoxic Dystropepts and Typic Kanhaplustults. There were differences among the reaches of slope and physicographic units with reference to fertility capability classification. Inclusion of a condition modifier 'm' could be identified three FC classes with deficiency in available Mg. In numerical classification of soils it was seen that all soils belonging to Ustic Kanhaplohumults were grouped with some members, however, forming individual clusters because of the intragroup distance. Different soil taxa vix., Typic Kanhaplustults, Typic Kandihumults and Ustoxic Dystropepts formed individual clusters.

The factor analysis of the data on soil variables measured at different times of observation identified two important factors i.e., 'Soil Reaction Control Factor' and ' P Limitation Factor' which explained much of the variability in the data on soil properties. The regression analysis identified that the growth was associated with P Limitation Factor. Soil temperature and moisture were the most important parameters regulating the availability of P and K. It was clear from the study of spectral signatures that rubber could be easily separated from other vegetation types owing to its specific spectral behaviour particularly in band 4 (0.77 –0.86 μm)

2.1.2 Anup Balakrishnan, 2005. A geographic information system for micro-level decision making in the agricultural sector of central Midland of Kerala.

A study was carried out with the broad objective of integrating available data on the land and agricultural resources of Madakkathra Panchayat into a Geographic Information System (GIS) and to demonstrate the capability of GIS as a decision support system to design projects for integrated resource management. Cadastral maps (1:3960 scale) of the Panchayat and the land use and assets maps of the Panchayat were used as base maps of the study. These maps were processed, traced, scanned, joined and digitized. The digitized maps were then projected and converted to shape files using PCARC/INFO resulting in the spatial data. Primary and secondary information on watershed and panchayat were collected and tabulated using MS Access and MS excel to form the attribute data of the respective theme. Then spatial and attribute data were integrated to prepare the GIS of Madakkathra Panchayat. The thematic maps generated were water availability, drainage pattern of the pnachayat, soil type, land use type, distribution of wells and contours of the panchayat. These maps on soil type of the panchayat revealed the presence of five types of soil and their characteristics. The important soil types were lateritic soil, variable shallow soils, colluvial soils, rivirine alluvium and forest loam soils. The thematic map of the land use pattern revealed that the major cropping pattern of the panchayat as coconut based. Important seasonal crops were rice, banana and tapioca.

The physiography of the panchayat was undulating with hills, hillocks and valleys. The contours of the panchayat ranged from 20 m to 320 m above

mean sea level. The digital terrain model (DTM) of the Panchayat was created using the GIS and was used to delineate the Kachithode-Kothara watershed. The watershed consisted of a perennial dam and streams contributing water to dam. Water drained through several first and second order streams. The main stream of the watershed is non-perennial and drains the overflow water of the dam during monsoon to Kallayi thodu. The soil of the watershed was fine, mixed, isohyperthermic family of typic Kandiustalfs. The upper reaches of water being hilly faces the threat of soil erosion due to the mixed cropping of erosion permitting crops. Appropriate conversion measures should be adopted based on the slope and elevation of the area. These area require attention in rain water harvesting methods. Based on the salient findings it may concluded that micro level data integration is needed for arriving at various decisions for integrated resource utilization and the study reported has resulted in a functional GIS that can be effectively used by all those interested in agriculture and overall development of Madakkathra Panchayat and Kachithode-Konthara watershed.

2.2 M. Sc. (Ag.) theses

2.2.1 Elsy, P.A. 1989. Physico- chemical characteristics, genesis and classification of soils from forest ecosystems in Kerala.

A study was conducted to evaluate the morphological, physcio-chemical characteristics and genesis of the soils representing different forest ecosystems in Kerala. Soil profiles representing six vegetation types viz., tropical evergreen, semi evergreen, moist deciduous, grasslands, hill top evergreen (Shola forest) and dry deciduous were selected for the study. Soil profiles were excavated to carry out the morphological studies. Soil samples representing the different horizons were collected. The physico- chemical characteristics of the soils and distribution of iron and phosphorus fractions were investigated with a view to study the inter-relationships between various soil properties and to relate them to the genesis of soils. Attempts have also been made to classify the soils according to the soil taxonomy. The surface soils from all the profiles had darker colours ranging from greyish brown to brown, evidently due to higher organic matter. All the soils were acidic in reaction and silica constituted the predominant portion followed by Al_2O_3. Judged from the ratio of (Fe-P + Al-P) /Ca-P which is an indicator of the degree of weathering, the grasslands were the most mature along the soil development scale and the dry deciduous forests were the least mature. From the SiO_2/Al_2O_3 ratio of the clay fraction, most of the soils under investigation belonged to ferrallitic group. Based on the available data, the soils have been classified under soil taxonomy. Tropical evergreen, moist deciduous, grasslands and dry deciduous have been classified as Typic Haplohumults, semi evergreen as Typic Humitropics and hill top evergreen as Oxic Humitropics. Based on the degree of freeness of iron, which is an indicator of the age of soils, grasslands were the most weathered.

2.2.2 Krishnakumar, P.G. 1991. Taxonomy and fertility capability assessment of the soils in command area of Edamalyar project.

An attempt has been made to evaluate the morphological, physical and chemical characteristics of eight soil series occupying in command area of Edamalyar irrigation project. Three series located in uplands consisting of well drained soils represented by Thodupuzha, Punnamattom and Velappaya series. The remaining five soils characterized by imperfectly drained paddy lands occupy the valley between the undulating laterite hills namely, Mulamthuruthy, Kothamangalam, Ikkanadu, Ayyanthole and Konchira. Profiles pits were dug and examined for their morphological features. Soil samples representing the different horizons were collected. The physico-chemical characteristics of the soil profiles were investigated with a view to study the interrelationship between the various properties and to relate these characteristics to the genesis of the soils.

Surface samples collected from different locations under each series were analysed for available nutrients and other fertility parameters to arrive at fertility capability classifications. Based on the 'degree of freeness of iron' all the soils indicated the more or less same rating in the maturity scale. Thodupuzha and Konchira are classified under Ultisols, Velappaya and Mulamthuruthy under Entisols, and Punnamattom, Kothamangalam, Ikkanadu, Ayyanthole under Inceptisols. From the classification it is observed that the dry land soils namely Thodupuzha and Velappaya have gravely loam top soil over gravely loamy sub soils susceptible to severe erosion. In the Punnamattom series though they are gravel free, risk to soil erosion is high. Soil erosion controls needs priority in these areas. With regards to soils with aquic moisture regimes, high P fixing capacity was a common feature. Low K reserves were noted in Ayyanthole and Konchira, here again quantity of fertilizer to be added, sources and method of application are to be decided based on site-specific characteristics.

2.2.3 Ambili, C. 1995. Taxonomy and fertility capability of soils of the Kole areas of Thrissur.

An attempt has been made to evaluate the morphological, physical and chemical characteristics of seven soil series identified in the areas of Thrisssur, viz., Manalur, Ayyanthole, Anthikkad, Kizhpallikkara, Kattoor, Konchira and Perumpuzha. All the soils were flexible rice lands situated in lower topographic positions. Profile pits were dug at these locations and examined the morphological features. Physico- chemical characteristics of the soil were analysed to classify the soils under Taxonomy, and to relate the characteristics to the genesis of these soils. Surface soil samples were analysed for available and micronutrients and other fertility parameters to arrive at fertility capability classification. The soils generally had brown surface soils and grey coloured subsoils. The soils were highly weathered as indicated by the silt/clay ratios. The total N, P, K, Ca, Mg and Na contents were low. When classified up to sub group level, Ayyanthole and Kattoor were under Alfisols and all the other

soils under Inceptisols. From the fertility capability classification, it was observed that all the soils have high P fixing capacity, demanding proper management of phosphorus. Manlur and Ayyanthole soils have low inherent fertility and chances of aluminium toxicity in well aerated soils. Konchira soils are potential and sulphate soils. Koncira and Perumpuzha soils have clayey topsoils with shrink–swell properties. The quantity of fertilizer to be added, source and methods of application are to decide based on site-specific characteristics and soil test data.

2.2.4 Deepa, K.P. 1995. Fertility investigations and taxonomy of the soils of Regional Agricultural Research Station, Pattambi.

The present study was formulated to find out the morphological and physico-chemical characteristics of soil profiles of selected blocks, to analyse the surface soil samples from all the blocks for fertility parameter, to classify the soils under taxonomy and to prepare the soil fertility map of the station. The soils had predominantly red hues. In general, the soils were acidic in nature. With regards to available nutrient content of soils, nitrogen status of the soil worked out based on the organic carbon content showed that it was high in one block, low in 2 blocks and medium in 19 blocks. Nutrient index worked out for available P content showed that it was medium in 12 blocks and high in 10 blocks. For available K, the nutrient index values indicated that it was low in 10 blocks and medium in 12 blocks. Based on the indices, the fertility map of the station was prepared. Based on the profile sample analysis, classification of the soils under Soil Taxonomy was attempted up to sub group level. Out of 9 profiles, only 3 fell under Inceptisols and the remaining 6 were under Entisols.

2.2.5 Sreerekha, L. 1995. Fertility investigations and taxonomy of the soils of Banana Research Station, Kannara.

The present study was undertaken to find out the fertility investigation and taxonomical classification of the Banana Research Station, Kannara. Surface soil samples were collected from each block of the station, namely, A, B, C, D, E and F for investigating the fertility status of the soil. Profiles taken for the study were P1 and P2 from A block, P3, P4, and P5 from B block, P6 and P7 from C block, P8 from D block, P9 from E block and P10 from F block. Based on the soil test values, fertilizers were recommended for various blocks. Nitrogenous fertilizers can be reduced by 10 per cent. Application of the phosphatic fertilizers can be reduced by 75 per cent in most of the blocks. Potassium fertilizers also can be reduced considerably. Nutrient indices were calculated and soil fertility map was drawn. Classification of pedons of various blocks according to soil taxonomy has been attempted and found that P1 of A block belongs to the order Entisol. P2 (A block), P3, P4, and P5 (B block), P6 and P7 (C block), P9 (E block) and P10 (F block) belong to the order Alfisol. P8 of D belongs to the order Inceptisol.

2.2.6 Seena, E. 2000. Soil resource inventory of the main campus, Kerala agricultural University, Vellanikkara: Part I - (East).

Kerala Agricultural University is situated in Madakkathra Panchayat in Thrissur district. It is having an area of 384.56 ha in its main campus in Vellanikkara. In this inventory, the eastern part of the main campus comprising an area of 214 ha which is divided into 25 blocks. For identification of samples sites, a 1:2000 scale map of the campus was used. A grid size of 80 m x 80 m was used to locate the sites. The samples were taken from both surface (0-20 cm) and subsurface (20-40 cm) layer. Soil samples were analysed to record the physico-chemical characteristics, available nutrients and other fertility parameters. The soil samples were predominantly gravelly coming under clay loam and acidic in nature. The organic carbon content was medium in 90 per cent soil samples. Available phosphorus content recorded low values in almost all soils and K content was medium. The results revealed that 63 to 65 per cent of soils were coming under medium fertility with respect to available potassium. Among the micronutrients, Mn, Fe, and Cu, about 98 per cent of the samples showed the values far above the critical ranges where as available Zn content was below the critical range. The P fixing capacity was high in all soils. The exchangeable ions were in order Ca > Na > Mn > K > Mg > Al > Fe. Sodium saturation was observed very high in case of both surface and subsurface soils. The Eastern part of the campus poses several limitations for the crop production in terms of high graveliness, low CEC, high aluminium saturation, acidity, high P fixing capacity, low K reserves potential influence of Na in the exchange complex, ustic

2.2.7 Sajnanath, K. 2000. Soil resource inventory of the main campus, Kerala agricultural University, Vellanikkara: Part II - (West)

Kerala Agricultural University is situated in Madakkathra Panchayat in Thrissur district. It is having an area of 384.56 ha in its main campus in Vellanikkara. The main campus includes three colleges and the area of three Research Stations. In this inventory, the western part of the main campus, which includes the areas of research stations and Farms occupied by mostly perennial crops. For identification of samples sites, a 1:2000 scale map of the campus was used. A grid size of 80 m x 80 m was used to locate the sites. The study area constituted 12 blocks out of 37 in the campus. The samples were taken from both surface (0-20 cm) and subsurface (20-40 cm) layer. Altogether 518 soil samples, collected from the 23 phases of the study area, were analysed to record the physico-chemical characteristics, available nutrients and other fertility parameters. Most of the soil samples were sandy clay loam and acidic in nature. The organic carbon contents were medium, available P was generally low and the K content was rated as low in 56 per cent of the surface samples. Among the secondary nutrients, both calcium and magnesium were recorded in a wide range in the soil. In micronutrients, Mn was the highest followed by iron. The P capacity of all soils was found to be high. The regression analysis of the data revealed that the relative factor for

exchangeable K and Na with respect to other multivalent ions could be better expressed as $K/(CA + Mn)^{1/2} + (Al)^{1/3}$ ions. The generated data were used for the study of nutrient interactions in the study area.

Using the potential of Geographic Information System (GIS), the soil fertility map of the study area for the major parameters such as soil texture, organic carbon, available P and K were prepared. The properties of soils, in phase wise manner were used foe Fertility Capability Classification (FCC) with its limitations. From the FCC notation, the problems and limitations of the soils can be estimated. The soil maps with FCC units super imposed will help in the delineating areas with similar limitations and management requirements. The information regarding the properties of the soils of western part of the main campus can be manipulated for the planning and motivating the cultivating practices and to attain the maximum output with available resources.

3. SOIL FERTILITY EVALUATION

3.2 M. Sc. (Ag) theses

3.2.1 Johnson, P.T. 1978. Foliar diagnosis, yield and quality of ginger (*Zingiber officinale*) in relation to nitrogen, phosphorus and potassium.

A field experiment was carried out at the Instructional Farm, to study the effect of graded doses of nitrogen, phosphorus and potassium on growth, yield and quality of ginger and also to develop suitable foliar diagnosis techniques in relation to these nutrient elements. The treatments comprised of three levels of nitrogen (40, 80 and 120 kg N ha^{-1}), phosphorous (30, 60 and 90 kg P_2O_5 ha^{-1}) and potassium (40, 80 and 120 kg K_2O ha^{-1}). The experiment was laid out in a 3^3 factorial experiment in RBD confounding the effect of interaction NP^2K^2 totally. Of the fertilizer treatments, only nitrogen at 80 kg ha^{-1} significantly affected the height of tiller, total dry weight of the plants, rhizome yield and the uptake of N and P by plants. The total period of the growth was divided in to three phases with respect to the development of aerial tissues namely, a phase of active vegetative growth (90th to 120th day after planting), a phase of slow vegetative growth (120th to 180th day) and a phase approaching senescence (180th day to harvest). There was marked uptake of N, P and K nutrients by the plants during the period of active plant growth (90th to 120th day after planting). The content of N, P and K was highest in the top most leaves and continuously decreased with increasing number of the leaf position, when leaves were numbered from the top to bottom of the tiller. In consideration of the stability of the nutrient level with leaf positions and sensitivity or correlation with varying doses and uptake, the group of 5th to 12th leaves appeared to be the best suited for foliar diagnosis of N, P and K status of the crop.

3.2.2 Saifudeen, N. 1981. Foliar diagnosis, yield and quality of turmeric (*Curcuma longa* L.) in relation to nitrogen, phosphorus and potassium.

A field experiment was carried out at the Instructional Farm, to study the effect of graded doses of nitrogen, phosphorus and potassium on growth, yield, uptake of nutrients and quality of turmeric and also to develop suitable foliar diagnosis techniques in relation to these nutrient elements. The treatments comprised of three levels of nitrogen (0, 20 and 40 kg N ha^{-1}), phosphorous (0, 20 and 400 kg P_2O_5 ha^{-1}) and potassium (0, 40 and 80 kg K_2O ha^{-1}). The experiment was laid out in a 3^3 factorial experiment in RBD confounding the effect of interaction NP^2K^2 totally. Results revealed that among the morphological characters, number of tillers per clump responded to the increasing levels of nitrogen. Maximum production of dry matter took place at 40 kg K ha^{-1} level. A period of pronounced active vegetative growth was observed during the period between 120^{th} and 150^{th} day. The contents of N, P and K were highest in the top most leaf and continuously decreased with increasing number of the leaf position when the leaves are numbered from top to bottom of the tiller. In consideration of the stability of the nutrient level with leaf position and correlation with uptake of nutrients, the third leaf appeared to be the best suited for foliar diagnosis of N, P and K of the crop. The period between 90^{th} to 120^{th} days after planting was recommended as optimum period for the detection and amendment of the nutrient status of the crop.

3.2.3 Gopi, C.S. 1981. Foliar diagnosis in coconut (*Cocos nucifera* Linn.) in relation to nitrogen, phosphorus and potassium.

A study was undertaken to standardize the foliar diagnosis techniques in coconut palm in relation to N, P and K, making use of the experimental palms of permanent NPK trial maintained at Coconut Research Station, Balaramapuram, Thiruvanthapuram districts. The palms received applications of N, P and K viz., 0, 340 and 680 g N, 0, 225 and 450 g P_2O_5 and 0, 450 and 900 g K_2O $palm^{-1}$ $year^{-1}$ respectively. For standardization of tissue for foliar diagnosis, samples of leaf lamina and mid-rib were drawn separately from all the leaves of the experimental palms. Attempts were also made to establish critical levels of N, P and K in the leaf and also to work out regression models to predict yield based on the tissue content of these nutrients. Observations revealed that the number of leaves retained by the palm was mainly a function of potassium applied and it was significantly correlated with the yield. The potassium content of lamina of the 2^{nd} leaf can be predicted from the number of leaves retained, making use of the regression equation, $Y = 5.32 + 8.95\ X$ where X is the potassium per cent of leaf lamina and Y is the number of leaves retained and was also found to be significantly correlated with yield. Taking the percentage of N and K in the lamina of the 2^{nd} leaf and leaf number (L) as independent variables, yield can be predicted with an accuracy of 84 per cent by the regression model, $Y = -14.956 + 39.215\ N - 16.097N^2 + 83.873\ K -$

37.388 K^2- 11.046 L –0.202 L^2- 44.186 (N x K) + 5.529 (N x L) + 6.276 (K x L). The critical values for N and K in the leaf lamina of the 2nd leaf were found to be 3.31 and 2.17 per cent respectively. The multiple correlation coefficient between yield and percentage of N, P and K was highest for the lamina of the 2nd leaf, among all the position and types of tissue examined and hence, this tissue is recommended as the best tissue for the foliar diagnosis of N, P and K.

3.2.4 Sushama, P.K. 1982. Foliar diagnosis, yield and quality of pepper (*Piper nigrum* L) in relation to nitrogen, phosphorus and potassium.

Pepper vines of the variety, Panniyoor-I, of the NPK fertilizer trial maintained at the Pepper Research Station, Panniyoor, Kannur district were selected for the collection of tissue samples. The experiment was laid out in a 3^3 factorial design in RBD, confounding the effect of NP^2K^2 totally. In order to standardize the best leaf position for foliar diagnosis, the mature leaves of the fruit bearing laterals were numbered from the youngest to the oldest, taking the youngest fully matured leaf as the first. The most suitable season for the collection of leaf intended for foliar diagnosis was also standardized by drawing samples the first mature leaf at different stages of the growth of the vine. The suitability of the different types of the stem of the plant such as runner shoot, top shoot, fruit bearing lateral and hanging shoot for tissue analysis was also examined. The first mature leaf is recommended as an index for the foliar diagnosis in pepper in relation to N, P and K status of the vine. The period just prior to flushing is the most suitable season for the collection of the leaf samples indented for foliar diagnosis. The runner shoot appeared to be a better tissue as phosphorus content established a high degree of correlation with yield. The period of maturity significantly influenced the P, K and oleoresin contents of the berry Their contents increased from four to six months after flowering and then decreased.

3.2.5 Krishna Kumar N, 1983. Yield prediction in coconut based on foliar N, P and K values.

A study was undertaken to standardize the foliar diagnostic technique in coconut palm and to work out regression models for predicting the yield based on foliar nutrient contents. Palms were selected from three different zones of Kerala state, namely the Coconut Research Station, Balaramapuram, the Agricultural research Station, Mannuthy and the regional Agricultural Research Station, Pilicode. Leaf samples were drawn from the leaf positions 2, 10 and 14 separatively from each palm were analysed for nitrogen, phosphorus, potassium, calcium, magnesium and sodium. Ttempts were made to standardize the leaf position, the nutrient status of which will best reflect the yield and to establish the critical levels of the nutrients in index leaf. Regression modela were worked out to predict the yield based on tissue nutrient contents and the number of leaves retained by the palm.

The number of leaves retained was significantly correlated with yield. The optimum number of leaves to be retained for maximum production was worked out to be 46.62. Yield prediction models worked out using the percentage of nitrogen, phosphorus, potassium, calcium, magnesium and sodium, and the leaf number indicated that the model worked out for the 10^{th} leaf had the maximum accuracy of prediction. Models worked out eliminating calcium, magnesium and sodium also confirmed the supremacy of the 10^{th} leaf for the prediction of yield. Thus the leaf lamina of leaf position 10 has been recommended as the best tissue for foliar diagnosis in coconut.

3.2.6 Rosily Mathew, 1990. Yield prediction in cashew on foliar nutrient levels.

A study was undertaken with cashew plants of variety BLA-39-4 of the NPK trial at Cashew Research Station, Madakkathra to standardize foliar diagnostic technique for cashew in relation to nitrogen, phosphorus and potassium content of the lesf and to predict the yield based on leaf nutrient levels. The treatments consisted of three levels of each nitrogen (250, 500 and 1000 g N $plant^{-1}$ $year^{-1}$) Phosphorus (125, 250 and 500 P_2O_5 g $plant^{-1}year^{-1}$) and potassium (250, 500 and 1000 g K_2O $plant^{-1}$ $year^{-1}$). For standardization of leaf position and period of sampling purpose, the leaves were serially numbered selecting the last fully matured leaf, which was not having an inflorescence in the leaf axil as leaf No.1. Before flushing and flowering of the shoots the leaves were grouped into three viz., top, middle and basal leaves. After flushing and flowering, the leaves at different leaf positions grouped into four groups each consisting of two leaves; they were group I, 2, 3 and 4. For the purpose of standardizing the season best suited for the collection of leaf intended for foliar diagnosis, samples were collected at different stage of plant growth. The results indicated that coefficient of partial correlation was positive and significant in the first group of leaves collected during preflushing stage. So this group of leaves can be serving, as a sampling material for diagnostic purpose in relation to N and the optimum content of N at this stage was 2.00 per cent. Phosphorus content of the leaves failed to establish a significant positive correlation with yield irrespective of leave position and stages of sampling. Potassium percent of the first and second group of leaves collected during the fourth stage of sampling established significant and positive correlation with yield when both simple and partial correlations were considered. Optimum content of the first group of leaves at this stage was 1.307 per cent. Multiple regression models fitted with yield and percentage of nutrients in the leaves gave a maximum prediction of 55 per cent when the nutrient content of the first group of leaves collected during the first and fourth stages of sampling were considered.

3.2.7 Ramesh, V. 1994. Foliar diagnosis and yield prediction in sugarcane in relation to N, P and K.

A field trial to study the relationship of sugarcane yield and nutrient status through foliar diagnosis was carried out at Sugarcane Research Station, Thriruvalla with the hybrid variety C0T1 88322 (Madurai). The treatments consisted of 3 levels of nitrogen (0, 165 and 330 kg N ha^{-1}), phosphorus (0, 82.5 and 165 kg P_2O_5 ha^{-1}) and potassium (0, 82.5 and 165.0 kg K_2O ha^{-1}). In order to standardize the leaf position, the leaf that just began to unroll (spindle like) was taken as the first leaf and other leaves were counted from the first leaf below. For standardizing the best season suited for collection of leaf and to predict the yield, samples were collected at six different stages. Attempts were made to find out the direct and indirect contribution of N, P and K in different leaves with and without sheath on yield and to predict yield based on step wise regression analysis. Observations revealed that among the stages of sampling tillering stage is recommended for N, P and K. Regarding the leaf position, the third, fourth, and fifth leaves without sheath is ideal for diagnostic purpose in relation to K. For, P, the fifth leaf with sheath is found to the best. Step wise regression model fitted with yield and percentage of nutrients in different leaf positions at various stages of sampling gave a maximum prediction of 73 per cent when nutrient content of the third, fourth and fifth leaves collected at the second stage of sampling was considered.

3.2.8 Nimba Franco, E.F. 1998. Standardization of soil sampling and fertilizer recommendation techniques for coconut gardens.

An investigation was carried out to standardize soil sampling technique for coconut and to work out fertilizer recommendation system considering physical/textural nature of soil as well as nutrient levels. Two standing populations of WCT palms grown under good and average management practices (Situation A and B) located at Mulamkunnathukave (Thrissur district) were utilized for the study. The soil of the site was laterite (Oxisol). Composite samples were collected from three depths from the surface and from the radial positions and from the bole of he of the palm. Samples were collected in May, October and January. Leaf samples were collected the 10^{th} frond and observations on yield and yield attributes were also recorded. Physico-chemical properties of the soil, root activity pattern, leaf nutrient content and yield and yield attributes of the both situations were compared. Based on the observations the most suitable sampling technique for coconut is composite sampling containing both inside and outside basin soils from a depth of 0-30 cm from the surface. Varying interaction of organic carbon with different fractions of soil on one side simultaneously with its direct bearing on productivity would point out to the necessity of evolving texture linked indices to get reliable information about nutrient availability status of the soil. Therefore, some correction factor should be added to soil test values to account the anomalies caused by the coarser soil fraction, which is not having a direct role in production and productivity

3.2.9 Jayalakshmi, M. 2001. Soil test crop response studies on ginger in laterite soils of Kerala.

To establish soil test based on balanced fertilizer prescription for ginger variety Maran in laterite soils of Kerala, a study was undertaken. The field study consisted of fertility gradient experiment and STCR experiment. The desired gradient in soil fertility was created in the one and same field by applying N, P and K fertilizers and raising fodder maize var. Co.I. The STCR experiment was conducted in the same field using the test crop, ginger variety Maran. The treatments consisted of fractional factorial combinations of four levels of N (0, 50,100 and 200 kg ha $^{-1}$), three levels of P (0, 37.5 and 75 kg ha $^{-1}$) and five levels of K (0, 37.5, 75, 150 and 300 kg ha^{-1}) along with three levels of farm yard manure (0, 15 and 30 t ha^{-1}) fitted in a response surface design. Using multiple regression model, the fertilizer adjustment equation for N at varying soil test values for available N for maximum rhizome yield (t ha^{-1}) of ginger in laterite soil was derived as FN = 153 – 0.28SN where FN is the fertilizer N (kg ha^{-1}) and SN is soil available N (kg ha^{-1}). At varying test values for organic carbon (OC) percent and phosphorus kg ha^{-1} the above equation become FN = 312.94 – 518.4 OC and FP = 79.8 – 0.94SP for maximum rhizome yield. The nutrient requirement of ginger variety Maran was estimated to be 2.1, 0.3 and 5.6 kg N, P_2O_5 and K_2O respectively to produce one kg of rhizome. In laterite soil, the efficiencies of contribution of nutrients from the soil for ginger were calculated as 10.1, 6.9 and 44 percent N, P_2O_5 and K_2O respectively and the fertilizer efficiency were worked out as 27.3, 10.9 and 53.2 per cent N, P_2O_5 and K_2O. The efficiencies of contribution of nutrients from farmyard manure were calculated as 30, 7 and 60 per cent N, P_2O_5 and K_2O respectively.

3.2.10 Nagarajan, M. 2003. Soil test crop response studies on coleus (Solenostemon *rotundifolius* Poir J.K. Morton) in the laterite soils of Kerala.

To establish soil test based on balanced fertilizer prescription for coleus variety Nidhi in laterite soils of Kerala, a study was undertaken. The field study consisted of fertility gradient experiment and STCR experiment. The desired gradient in soil fertility was created in the one and same field by applying N, P and K fertilizers and raising fodder maize var. Co.I. The STCR experiment was conducted in the same field using the test crop, ginger variety Nidhi. The treatments consisted of factorial combinations of four levels of N (0, 20, 40 and 80 kg ha^{-1}), three levels of P (0, 45 and 90 kg ha^{-1}) and five levels of K (0, 25, 50, 100 and 200 kg ha^{-1}) along with three levels of farm yard manure (0, 7.5 and 15 t ha^{-1}) fitted in a response surface design. The nutrient requirement of coleus, variety Nidhi were estimated to be 9.15, 1.38 and 16.38 kg ha^{-1} N, P_2O_5 and K_2O respectively to produce one tonne of tuber. The soil efficiencies worked out as 21, 46.85 and 40.85 per cent for N, P_2O_5 and K_2O for coleus in laterite soil. The contribution of nutrients from fertilizer for coleus was calculated as 61.6, 9.57 and 56.60 per cent for N, P_2O_5 and

K_2O. Fertilizer prescription equation for specific yield targets of coleus variety Nidhi in laterite soil were derived as with out FYM, FN = 14.85T-0.34SN, FP_2O_5 = 14.42T-11.21SP and FK_2O = 28.98T-0.87SK and with FYM, FN = 14.85T-0.34SN-0.34ON, FP2O5 = 14.42T-11.21SP-3.25OP and FK2O = 28.93T-0.87SK-1.22OK where T is the target yield of tuber ha^{-1} SN, SP and SK are the available N,P and K in kg ha^{-1}, ON,OP and OK are the quantities of N,P and K supplied through organic manure in kg ha^{-1}.

3.2.11 Sidha, P.S. 2005. Soil test crop response studies on groundnut (Arachis hypogaea L) in laterite soils of Kerala.

To establish soil test based on balanced fertilizer prescription for groundnut variety TAG-24 in laterite soils of Kerala, a study was undertaken. The field study consisted of fertility gradient experiment and STCR experiment. The desired gradient in soil fertility was created in the one and same field by applying N, P and K fertilizers and raising fodder maize var. Co.I. The STCR experiment was conducted in the same field using the test crop, groundnut variety TAG-24. The treatments consisted of factorial combinations of four levels of N (0, 5, 10 and 200 kg ha^{-1}), three levels of P (0, 40 and 80 kg ha^{-1}) and five levels of K (0, 37.5, 75,150 and 300 kg ha^{-1}) along with three levels of farm yard manure (0, 2.0 and 4.0 t ha^{-1}) fitted in a response surface design. The nutrient requirements of groundnut variety TAG-24 were estimated as 49.46, 4.25 and 19.52 kg ha^{-1} N, P_2O_5 and K_2O respectively to produce one tonne of pod. The soil efficiencies worked out as 28.11,7.70 and 6.88 per cent for N, P_2O_5 and K_2O for groundnut in laterite soil. The contribution of nutrients from fertilizer for groundnut was calculated as 45.61, 11.18 and 27.33 per cent for N, P and K and the contribution from organic manure were 49.46, 4.25 and 19.52 per cent N, P and K respectively to produce one tonne of pod. Fertilizer prescription equation for specific yield targets of groundnut variety Tag-24 in laterite soil were derived as with out FYM, FN = 108.44T-0.616SN, FP_2O_5 = 38.01T-1.577SP and FK_2O = 71.43T-0.305SK and with FYM, FN = 108.44T-0.616SN-1.59ON, FP2O5 = 38.01T-1.577SP-1.87OP and FK2O = 71.43T-0.305SK-1.85OK where T is the target yield of tuber ha^{-1} SN, SP and SK are the available N, P and K in kg ha^{-1}, ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha^{-1}.

4. SOIL FERTILITY MANAGEMENT AND NUTRIENT INTERACTIONS

4.1 Ph. D. theses

4.1.1 Anila Kumar, K. 1989. Nitrogen losses from the rice soils of Kerala with special reference to ammonia volatilization

In order to get a deeper insight into the N dynamics of selected submerged rice soils, an investigation was carried out at the Regional Agricultural Research Station, Pattambi with the objectives to estimate the

magnitude of ammonia volatilization losses from submerged rice soils representing major rice growing tracts of Kerala, to study the factors responsible for accelerating the rate of ammonia volatilization under flooded condition, to evaluate the effect of submergence, organic matter application, complimentary effect of P and K on ammonia volatilization from the rice soil ecosystem, to identify suitable N carriers capable of reducing the loss of N due to ammonia volatilization from submerged paddy fields, to find out the effect of continuous application of organic and inorganic manures in lateritic submerged paddy soils on the quantum of N loss through ammonia volatilization and to find out the transformation and extent of mineralization of applied urea. In the incubation study for estimating the magnitude of N loss through ammonia volatilization, eight rice soils of Kerala viz., sandy, karapadom, kayal, kari, pokkali, kole, poonthalpadom and laterite soils were incubated with no N and 27 g N m^{-2} as urea and the result showed that sandy soil recorded the maximum N loss through ammonia volatilization where as the kole soil registered the least value. N loss through ammonia volatilization had a positive relationship with increased rates of urea application. The combined application of urea and muriate of potash was found to be significantly better in reducing the volatilization loss of ammonia. Soil samples maintained at saturation point recorded double the values for ammonia volatilization compared to the samples kept under submergence of 20 cm depth.

To identify suitable N carriers capable of reducing the loss of N due to ammonia volatilization from submerged paddy fields, it was found that urea mudball placements in the anaerobic layer of soil were found to be reduce the N loss through ammonia volatilization to negligible level. A study to trace the pathway of transformation and extent of mineralization of urea under flooded soil condition revealed that the rate of mineralisation stopped at the stage of NH_4^+ formation and chances of N loss through denitrification is meager, unless the soil is aerobic.

4.1.2 Sailaja Kumari, M.S. 2005. Critical analysis of the soil plant atmosphere continuum for increasing the production of rice in laterite soils.

The project entitled critical analysis of the soil plant atmosphere continuum for increasing the productivity of rice in laterite soils was conducted at two locations of Palakkad district (Koyalmannam and Ottappalam) in two seasons. Objective of the study was to identify the role of P, K and lime in influencing the nutrient content of soil and plant and hence rice yield in Fe toxic lateritic soils. The study included the evaluation of influence of P, K and lime on macro and micronutrient content at critical stages in addition to uptake studies, correlation pattern of nutrient ratios with soil and plant was also studied. Field evaluation of the crop performance at two locations revealed that at Koyalmannam and Ottapplam P, K and lime significantly influenced the yield and yield contributing characters.

Phosphorous, potassium and lime at 35, 70 and 600 kg ha^{-1} respectively increased the grain yield. However for the second crop at Ottappalam significant yield reduction was not observed even with the 17.5 kg ha^{-1} of P. Pooled analysis of yield data showed significant influence of higher level of P at 35 kg ha^{-1}. Potassium at higher level of 70 kg ha^{-1} significantly increased the yield. But higher level of lime application at 600 kg ha-1 significantly increased only the straw yield. However higher level of P, K and lime at 35, 70 and 600 kg ha^{-1} respectively increased the major nutrient content of the plant and decreased the Fe and Mn contents.

There was significant increase in the uptake of N, P and K while Fe uptake was reduced by the higher levels of K application. Potassium and phosphorus applied together in general decreased the Fe uptake while it enhanced the uptake of P and K. Soil available major nutrients also showed significant positive response to higher level of K and lime application. There was an increase in the N, P and K contents of the soil at higher levels of P application at 35 kg ha^{-1}. Available Fe and Mn contents of the soil showed significant decrease at higher doss of K and lime. Correlation studies showed significant positive correlation of N/Fe, P/Fe, K/Fe and K/Ca+Mg ratios of soil and plant with yield which indicated that an increase in P and K followed a decrease in the Fe content of the soil which subsequently increased the yield.

4.2 M.Sc. (Ag) theses

4.2.1 Manorama Thampatti, K.C. 1985. Potassium utilization in Cassava (*Manihot utilissima* Pohl) as influenced by neem cake – urea blend.

A study was carried out to understand the dynamics of NH_4^+ -N and K^+ ions when applied as urea or urea-neem cake blend either alone or along with muriate of potash in a soil column study. The columns were filled with soil collected from the field surface up to 60 cm depth. Each 15 cm was taken as a separate layer maintaining the same bulk density as observed in the field. Fertilizer treatments comprising no fertilizer, urea or urea-neem cake blend to supply 100 ppm N and muriate of potash to supply 100 ppm K either alone or in combination were applied to the surface 15 cm soil or mixed thoroughly. The study indicated that under natural conditions NH_4^+ -N was concentrated more in the lower layers of the soil beyond the root zone of cassava where as potassium was concentrated more in the surface layers of 0-30 cm depth. Application of muriate of potash either alone or in combination with urea-neem cake blend increased potassium in the surface layer within eight hours after fertilizer application. From the result of the field experiment, urea-neem cake blend at 5:3 ratio increased nitrogen availability, nitrogen uptake and yield. Maximum benefit per rupee invested was obtained when the rate of potassium was raised from 50 to 75 kg K_2O ha^{-1} along with 50 kg N as urea – neem cake blend. Changing the time of application of potassic fertilizers to one month and three months after planting also increased the benefit obtained.

4.2.2 Anilkumar, K.S. 1987. Chemistry of coconut rhizosphere.

A study on the chemistry of soil basins of coconut palm (Cocos *nucifera* Linn.) was undertaken to evaluate the lateral and vertical spread of active roots of the palm, to examine the role of active roots in the alteration of the chemical characteristics of the soil basins, to investigate the changes in the chemical characteristics of the soil basins in relation to long term application of inorganic NPK fertilizers, to find out the nutritional aspects of the palm as influenced by continuous fertilization and to evaluate the relationship of common soil test values with nutrition and yield of the palm. The coconut var. West Coast Tall was invariably used for the study. The studies on the root activity pattern of coconut revealed that major portion of the active roots reside in an area of 2 m radius around the palm. The vertical distribution of active roots was mainly confined to a depth of 60 cm depth. The surface 0-20 cm soil is practically devoid of root activity. Long term application of ammonical fertilizers induces acidification of soil and helps to develop sub-soil acidity. It is suggested that application of phosphatic fertilizers could be skipped for a few years in regularly P fertilized gardens as considerable build up of available of P occurs due to this and P application was not found to increase coconut yields.

4.2.3 Prema, D. 1987. Effect of sodium chloride on soil characteristics, yield and quality of coconut grown in laterite soil.

The coconut palm of two field experiments receiving different levels of K_2O and Na_2O, laid out at Regional Research Agricultural Research Station, Pilicode, were made use of this study. The soil of the experiment site is laterite (Oxisol) and the area receives an annual rainfall of about 3200 mm. The treatments were the substitution of K_2O (applied as KCl) by Na_2O (applied as NaCl) to the extent of 100, 75, 50, 25, and 0 per cent. In the first experiment, the fertilizer treatments were superimposed on 24-year-old palms, which were receiving N, P and K as per the recommended dose. The second experiment was in the newly planted seedlings and therefore the treatments were given from the very start of the experiment. The crop was rainfed. The soil and leaf samples were collected and analysed to find out the effect of sodium chloride on the uptake of nutrients and soil characteristics. The analysis of copra and quality evaluation of the oil were done only in the case of the first experiment since the palm of the second experiment have not yet reached the steady bearing stage. From the observations, it is concluded substitution of K_2O applied to the coconut palms as KCl, by Na_2O applied as NaCl to the extent of 50 per cent is possible without a reduction in the yield, quality of oil and adverse effects of the soil characteristics, under the climatic and soil conditions comparable to that tried.

4.2.4 Jayaraj, P. 1990. Efficiency of potassium in mitigating the effect of shade in intercrops.

A pot culture experiment was conducted to find out the efficiency of potassium in reducing the effect of shade in turmeric as well as in cowpea. Responses of both the crops under shade intensities (0, 25, 50 and 75 per cent shade) with different levels of K (100, 125, 150 and 200 per cent of the package of practices recommendations) representing 10, 12.5, 15 and 20 kg K_2O ha^{-1} for cowpea and 60, 75, 90 and 120 kg K_2O ha^{-1} for turmeric and time of application of K (complete as basal and split application) were studied. Turmeric performed well in 25 per cent shade. Maximum yield of 121.25 g $plant^{-1}$ was obtained with 90 kg K_2O ha^{-1} at 25 per cent shade, when entire K was applied in a single dose. This was 75 per cent more than the yield obtained in the open with recommended dose of K and 109 per cent more than the yield obtained at the same shade level with recommended dose. The curcumin content was found maximum at 25 per cent shade with 90 kg K_2O ha^{-1}. The above results indicated that cowpea is not suitable foe shaded condition, but turmeric can be effectively grown under shade with increased dose of potassium.

4.2.5 Muraleedhara Menon, G. 1990. Efficiency of potassium under different levels of irrigation in summer vegetable ashgourd.

A field experiment was designed for assessing the efficiency of potassium under different levels of irrigation in summer vegetable, ashgourd. The experiment consisted of twelve treatments from all possible combinations of four levels of potassium viz., 0, 75, 150 and 225 per cent of Package of Practice recommendations and three irrigation levels representing IW/CPE ratio of , 0.75, 0.50 and 0.25. The plant and fruit samples were analysed for various growth and yield contributing components. Soil samples collected from pits after destructive sampling were also analysed to assess the available nutrient status. The analysis of the data concluded that the levels of irrigation or potassium tried did not have any direct influence on yield. But the data on field water use efficiency revealed a significant effect of least frequent irrigation. Hence it could be concluded that a potassium level of 20 kg K_2O can be the best dose when the irrigation is scheduled with IW/CPE ratio as 0.25.

4.2.6 Jessymol, A.S. 1991. Influence of soil texture on potassium availability, fixation and uptake by rice in laterite soils.

An investigation was carried out in order to assess the influence of various proportions of clay on the potassium dynamics of soil on application of potassium fertilizer and its effect on the uptake of nutrients by rice. Sixty surface soil samples were collected from the major rice growing areas of Thrissur district. Based on the particle size analysis and organic carbon content, twenty samples were selected for studying the various physico-

chemical characteristics related to the potassium availability. In order to find out the transformations of applied potassium, a laboratory incubation experiment was carried out in five selected soils for a period of three months. Mineralogy of the fine sand was also carried out in these soils. A pot culture experiment was carried out in four selected soils to determine the uptake of nutrients. Soils are generally acidic in reaction with low values of electrical conductivity. Organic carbon content was showing wide variations and had a positive correlation with clay. Mineralogy of the fine sand fraction of the soils selected for incubation study revealed a predominance of quarz followed by feldspar. In heavy mineral suite, weatherable minerals like hornblende, pyroxenes and biotite were present. In presence of perthite and weatherable minerals accounts for the subsequent formation of 2: 1 type minerals in these soils.

On application of potassium fertilizer, different fractions viz., water-soluble, ammonium acetate extractable and nitric aid soluble K get increased at the end of the three month period. Even though the positive effect of potassium application on the yield of paddy is very conspicuous, the response varied with the textural composition. In more clayey soils, more of potassium fertilizers have to be recommended to get maximum response

4.2.7 Padmam, M.K. 1992. Effect of long term application of manures and fertilizers in soil properties, utilization of efficiency of nutrients and quality of rice.

A study was conducted during the first crop season to assess the effect of long term application of manures and fertilizers on soil properties, utilization efficiency of nutrients and quality of rice making use of the soil and plant samples taken from the existing permanent manurial trial (dwarf indica) at Regional research Station, Pattambi. The treatments consisted of application of entire quantity of N (90 kg ha^{-1}, as organic alone (cattle manure alone, green manure alone and cattle manure + green manure), inorganic alone (ammonium sulphate alone and NPK fertilizers) and combination of organics with inorganics (cattle manure + NPK fertilizers, green manure + NPK fertilizers and cattle manure + green manure + NPK fertilizers). At different stages of crop growth significant variation was noticed only in the case of organic carbon content and availability of P in soil due to treatments. Maximum grain and straw yield were recorded by the treatment receiving application of cattle manure alone and the results clearly indicated that application of cattle manure along with inorganic fertilizers is essential to maintain high yields. Significant correlation existed between organic carbon content and available P content of soil with grain yield. The results obtained clearly indicated that application of cattle manure along with inorganic fertilizers or green leaves is essential for maximum utilization efficiency of N applied to the soil.

4.2.8 Tessy Jacob, K. 1992. Management of acidity by combined application of lime and gypsum in a low activity clay soil of Kerala.

An investigation was carried out with a view to identify the most appropriate and economic lime recommendation method and the most suitable combination of lime and gypsum for profitable management of upland laterite soils. The first study was to characterize the low activity clay soils of Kerala in respect of acidity contribution factors. Another laboratory experiment was also conducted with PVC columns to study the mobility of Ca and Mg using different liming materials in combination with gypsum. A pot culture experiment was also carried out using soybean to study the effect of liming in combination with gypsum on growth, yield and uptake of various nutrients, The characterization study revealed that the soils in the Vellamikkara series come under the textural class ranging from silty loam to silty clay loam. The soils in general were acidic in reaction with fairly high content of exchangeable Al and low CaO and MgO contents. The combination treatment with $MgCO_3$ + 75 per cent $CaSO_4.2H_2O$ can be suggested as an ameliorant for acid surface as well as subsoils as it resulted in uniform distribution of exchangeable Ca and Mg throughout the length of the column and neutralized exchangeable Al in the whole length of the profile. Liming resulted in significant increase in plant height, nodule number, dry weight of pod, grain yield, haulm yield, total dry weight and N, P and K uptake. Liming at the rate of 1.5 times exchangeable Al content of the soil was found to be the most appropriate and economic lime recommendation method for the highly weathered and leached acid soils of Kerala

4.2.9 Mini, E.R. 1992. Fractionation of organic and inorganic nitrogen in important soil types of Kerala.

In order to study the distribution of various organic and inorganic fractions of soil nitrogen in different soil types of Kerala, 100 surface soil samples belonging to five types viz, laterite, forest, brown hydromorphic, coastal alluvium and kuttanad alluvium were collected from the various places of the state. Observations on the general characteristics of the soil revealed that total nitrogen and organic carbon was highest in the forest soil and was least in the case of coastal alluvium. All the soils were acidic in reaction. Fractionation of nitrogen for exchangeable ammoniacal nitrogen (NH_4-N), nitrate nitrogen (NO_3-N), total hydrolysable nitrogen (THyN), hydrolysable ammoniacal nitrogen (HyAN), Hexosamine and hydrolysable ammoniacal nitrogen, Hexosamine nitrogen (HaN), amino acid nitrogen (AaN), Unidentified hydrolysable form of nitrogen (UHyN), Non- hydrolysable form of unidentified nitrogen (NHyN) and fixed ammonical nitrogen (FAN) were carried out. Fractionation of nitrogen showed that the most dominant fraction in the case of laterite and brown hydromorphic are amino acid nitrogen (AaN) and that forest, coastal alluvium and kuttanad alluvium are non- hydrolysable form of unidentified nitrogen (NHyN). In all the five types, there are significant positive correlation between CEC and fixed ammonical nitrogen

(FAN). On studying the relationship of various nitrogen fractions to organic carbon on the selected soil types revealed that 75 per cent variation of organic carbon in laterite soil, 87 per cent in forest soil and 70 per cent in brown hydromorphic soil can be explained by the nitrogen fractionation of the soil. The significant relationship obtained by amino acid nitrogen (AaN) and alkaline $KMnO_4$ –N, considers alkaline $KMnO_4$

4.2.10 Siva Kumar, C. 1992. Growth and nutrition of black pepper as influenced by decaying litter materials in soil.

An investigation was carried out to assess the effect of soil application of various leaf materials on the growth and nutrition of black pepper (Panniyur-1), to determine the rates of decomposition of different leaf materials and to evaluate the effect on nutrient availability. The leaves of *Coffee arabica, Erythrina indica, Garuga, Pinnata, Grevilea robusta (Silver oak) and piper nigrum)* were used as organic sources. A laboratory incubation study and a field evaluation were carried out on the decomposition rates of various organic sources. Significant increases in major and micronutrient availability in soil were noticed following the incorporation of leaf materials. The rate of organic carbon loss was slowest in soil with coffee or silver oak leaves as the organic sources and was fasted when the garuga was the organic source. The half life values for organic carbon loss varied from 91-193 days. The half life values obtained for coffee, erythrina and black pepper leaves in field decomposition study were 40, 44 and 53 days respectively.

4.2.11 Murlidharan, P. 1992. Response of rice to application of micronutrients.

A field experiment was conducted to study the response of rice to application of secondary and micronutrients in the first and second crop seasons. The experiment was conducted at Agricultural Research Station, Mannuthy using the variety Jyothi and the soil was sandy clay loam in texture. The treatments consisted of the different micronutrients (Zn, Cu, Mn, B and Mo), magnesium, sulphur, a combination of the above said nutrients and Stanes Microfood, a micronutrient formulation, in addition to the control with no micronutrients. Soil and plant samples were collected at the maximum tillering, flowering and harvesting stages of the crop for the determination of uptake and availability of nutrients, pH and specific conductance. The continued effect of the application of micronutrients was studied by repeating the experiment in the second crop season with the same set of treatments applied to the same plots. The soil was a typical laterite soil of Kerala, sandy clay in texture, acidic and non-saline. The organic carbon content was medium and available P and K were high. Application of Stanes Microfood resulted in the highest grain yield of 2606 kg ha^{-1} during the first crop season while the combination of nutrients produced this effect in the second crop (3185 kg ha^{-1}). The content and availability of macro and micronutrients in the soil were related to the rate of uptake of the nutrients by the crop along with the

advancement of the crop growth. While the positive interactions such as P-Cu, P-Mg, K-Cu and Zn-Cu increased the availability of each other in the soil and thus increased uptake by the crop, adverse effects were caused by P-Zn, K-Mg, Mg-Zn and Fe-Mn interactions.

4.2.12 Jomon Joseph, 1993. Soil fertility of coconut root zone as influenced by long term inorganic fertilization.

The major objectives of the investigation were to get information on the enrichment /depletion of the nutrient reserved in coconut root zone as a result of regular annual application of NPK fertilizers viz., ammonium sulphate, super phosphate and muriate of potash, examining the extent of acidification of the root zone profile following regular application of inorganic fertilizers, evaluation the degrees of accumulation of P, its forms and leaching in the root zone and studying the changes that had taken place in the native reserves and its various fractions. Soil samples from coconut basins of NPK factorial experiment at the Coconut Research Station, Balaramapuram, which have been receiving inorganic fertilizers for the last 22 years were collected for the study. Both exchange acidity and exchangeable aluminium were increased following the application of ammonium sulphate, but there is a decrease in these characteristics as a result of the application of super phosphate. Muriate of potash decreased the exchangeable Al content in the absence of ammonium sulphate but was ineffective when applied along with ammonium sulphate. Among the inorganic fertilizers, only ammonium sulphate had shown a direct influence on the micronutrient reserves of the soil. Total K, S and Fe increased with depth, while total P, Ca and Mn decreased with depth. Significant changes in the P fractions were observed as a result of the application of superphosphate and muriate of potash but not ammonium sulphate. Highly significant correlation were obtained between Al-P, Fe-P, Ca-P, Saloid-bound P and available P. Step wise regression indicated that only two variables viz. Al-P saloid –bound P were more important in explaining the variations in the available P. The comparison of the chemical characteristics of the uncropped and unfertilized area with cropped but unfertilized area revealed that the soil reserves of all the nutrients remained more or less same throughout the root zone up to a depth of 100 cm irrespective of whether the land is cropped to coconut or not

4.2.13 Muhammed Sakeer, N.M. 1997. Exchangeable aluminium as an index of the lime requirement of the laterite soils of Kerala.

An investigation was carried to assess the lime requirement in terms of exchangeable aluminium, to correlate pH and lime requirement values with exchangeable aluminium content of the soil and to study the effect of liming on crop performance with special reference of aluminium content of the soil. A laboratory study with 50 surface soil samples from the rice growing tracts representing the laterite zone of Kerala viz., Malappura, Palakkad and Thrissur districts revealed that considerable amount of reserve acidity because of the

positive difference between pH(H_2O) and pH (KCl). The exchange aluminium obtained a higher r-value of 0.897 with exchangeable acidity. Lime requirement based on exchangeable aluminium recorded the lowest quantity of $CaCO_3$ when compared to LR's based on Shoemaker *et al* and total acidity. The results of the pot culture experiment to study the effect of graded levels of lime application using the rice variety Thriveni in three soils indicated that pH, exchangeable calcium, magnesium and sodium, available P, CEC, ECEC and base saturation of soils were increased while exchangeable aluminium, hydrogen and potassium content were decreased. Maximum yield was obtained with calcium at the rate of 0.5 times of exchangeable aluminium equivalent in having low exchangeable aluminium and 1.0 times for medium and high aluminium contents. The high contribution should be taken in account in liming and nutrient management of soils. If we adopt this method for lime requirement determination it will be more efficient and economical. The result of the study pointed out the advantages in adopting the exchangeable aluminium as an index of the lime requirement of the laterite soils of Kerala.

4.2.14 Rosamma Abraham, 1998. Indole acetic acid oxidase activity in brinjal as influenced by fertilizer treatments.

The study was aimed to find out the effect of organic manuring and chemical fertilizers on the levels of IAA and its influence on growth and yield of brinjal by monitoring the activity of IAA oxidase in plant leaves at different stages of plant growth. The experiment consisted of 13 treatments, which included combinations of different levels of organic manure and fertilizer, that is, zero, normal recommended dose and double recommended dose with and without foliar application of 150 ppm IAA and absolute control. IAA oxidase activity was found to increase with the age of the plant up to the flowering stage and thereafter it was found to decrease. Application of the treatment was found to influence the IAA oxidase activity only at the fruiting stage. Fruit yield was increased when IAA was applied along with FYM or fertilizer alone or in combination. Application of FYM, fertilizer and their combination with and without supplementary addition of IAA permitted significant difference in the uptake of N, P and K compared to control. Maximum uptake of N and P was recorded by the treatment, which received IAA application along with the double dose of fertilizer and FYM.

4.2.15 Binu Thomas, 1999. Regulation of major plant nutrients and organic matter for improving the nutritive quality of banana grown in laterite soils.

An investigation was taken to study the regulation of major nutrients and organic matter for improving the nutritive qualities of banana at Banana Research Station, Kannara. The result of the study revealed that application of fertilizer and organic matter is essential for getting better yield and quality of banana. Regarding the bunch yield, the fertilizer dose of 12.5 kg FYM, 200:

125: 300g N, P_2O_5 and K_2O per plant obtained maximum yield. Correlation studies revealed that the content of major nutrients in soil at 2, 4 and 6 months after planting has got much influence on the quality parameters studied. Hence fertilizer should be applied in split doses commencing from 2 months after planting. Path coefficient analysis revealed that direct effect of the three major nutrients on quality parameters was maximum at 6 months after planting. The direct effects at 2 months after planting and 4 months after planting were also significant. This indicated that the requirement of these nutrients is essential through out the growth of plant.

4.2.16 Nair Rajiv R. K. 2002. Effect of major nutrients on the yield and quality of nuts in graft-raised cashew (*Anacardium occidentale* Linn.).

An experiment was conducted to study the effect of major nutrients on the yield and quality of nuts in graft raised cashew at Cashew Research Station, Madakkathra. The treatments consisted of three levels of N, P and K on the eight year old cashew trees. The study revealed that the increasing levels of nitrogen significantly increased the height, spread of cashew trees, number of flushes, number of leaves per flush, panicles, nuts of panicle, yield of nuts and apples, and carbohydrate, reducing and non reducing sugar content of the kernels. Application of potassium at highest level increased the apple yield per tree, weight and volume of apples, nut length and kernel weight. The average nutrient off-take through nuts and apples was computed to be 273.43, 41.58 and 186.40 g of N, P and K respectively. The average nutrient off-take per tree through nuts from an average yield of 2.89 kg $tree^{-1}$ was found to be 93.56, 2.89 and 48.85 g of N, P and K respectively. In general, among the major nutrients applied at different levels, only nitrogen had shown exceedingly high effects in sustaining the growth, yield and quality parameters. The yield and quality parameters were also seen to be affected to a certain extent by the application of potassium but the response of the crop to phosphorus was seen to be exceedingly limited.

5. AVAILABILITY INDICES OF NUTRIENTS IN SOIL

5.2 M. Sc. (Ag.) theses

5.2.1 Mathew Jacob, K. 1979. Evaluation of available phosphate reserve of soil by chemical methods.

A laboratory study including a pot culture experiment was carried out using 18 laterite soil to evolve a suitable laboratory chemical method as an index for the estimation of available phosphate reserve (Ra-value) of the soil. The total plant removable phosphorus of the soils was determined by growing the rice (variety IR- 8) continuously in soils taken in pots, till the content of phosphorus in plants became below the critical level. To evolve a suitable extractant for the estimation of -"Ra-value", H_2SO_4 and HCl at different

concentrations were tried. Out of 29 extractants tried, 17 were selected based on their consistence in the pattern of phosphorus release and the amount of phosphorus extracted. From a pilot study, in which different organic acids at different combinations were screened, oxalic acid at a strength of 0.05N was selected as the best chelating agent to be employed with the 17 mineral acid combinations. The extractant 0.06 N H_2SO_4 and 0.06 HCl in 0.05N oxalic acid with an equilibration period of 30 minutes and soil solution ratio 1: 10 were found to be the best method for estimating the "Ra-value".

5.2.2 Durga Devi, K. M. 1986. Evaluation of available phosphorus and potassium in soil using a common extractant.

A laboratory evaluation and an uptake study using Neubauer seedling technique was carried out for evolving a single extractant suitable for extracting both available P and available K, so as to simplify the process of extracting these available plant nutrients in soil testing works. Eighty seven soil samples from different parts of the State were used to evaluate the performance of the selected number of extractants based on a 3 step evaluation viz., a) an initial study consisting one soil, 18 extractants at a single soil solution ratio (1: 10) and two equilibration periods (30 and 60 min) b) a preliminary screening consisting of 9 soils, 15 extractants a single soil solution ratio (1:10) and 5 equilibration periods (5,10,15, 30 and 60 min). c) a final selection of the common extractant consisting of 10 extractants with suitable equilibration periods at 1:10 soil solution ratio and 87 soils. Mathew's triacid extractant viz., 0.06N H_2SO_4 + 0.06N HCl + 0.05N oxalic acid with a soil solution ratio of 1:10 and an equilibration period of 30 min is recommended as a common extractant for available P and available K since it saves considerable time and materials in soil testing.

5.2.3 Sapheena, K.S. 1993. Evaluation of methods to improve nitrogen use efficiency of urea in rice.

An investigation was carried out to evaluate the various methods recommended by different agencies to increase the N use efficiency of urea in rice. The study consisted of incubation and a field experiment for two seasons using the rice variety Jyothi. There were 5 treatments for incubation study which were control and recommended dose of N as prilled urea, neemcake coated urea, neemcake-mixed urea and nimin-coated urea. The 13 treatments for field experiments consisted of control, recommended dose of N in two types of splits (50:50 and 75:25) as prilled urea, neemcake-coated urea, neemcake-mixed urea and nimin coated urea and 75 per cent of recommended dose of N in 50:50 split doses. The ammoniacal nitrogen content of the soil in incubation study increased up to a period of 20 days in all treatments. In the field experiment significant difference was noticed in the ammoiacal nitrogen content of the soil throughout the period of the first crop season. In the second crop season, variation due to treatments was not significant

5.2.4 Sudheesan, V.P. 1996. Standardization of rooting media for selected tree crop seedling with special reference to plant nutrients

An experiment involving twelve important tree crop seedlings (*Ailanthus triphysa, Albizia falcataria, Albizia lebbeck, Causarina equisetifolia, Ceiba pentandra, Dalbergia latifolia, Gmelina alborea, Hopea parviflora, Santalum album, Swietenea macrophylla, Tectona grandis and Vateria indica)* was conducted in the Instructional Farm, Vellanikkara, with an objective of standardizing the most suitable rooting media for the best growth of the above tree seedlings in the nursery for agroforestry planting. In this study altogether twelve different media were tried, considering their relative cheapness, easy availability and more or less satisfying the desired qualities of an ideal rooting medium. The results showed that the rooting medium containing soil, sand and FYM in the ratio of 1:1:1 was ideal for all the species except for Dalbergia and Vateria. For Dalbelgia, the best medium found was soil ½, sand 1/3 and neemcake 1/6 and for vateria it was soil 1/3, sand 1/3 and saw dust 1/3.

5.2.5 Priya, P. 2003 Availability indices for stressed nutrients for coconut (Cocos nucifera L.) in an Ultisol.

A study was conducted with an objective to analyse the soil-plant system, the level and interactions of nutrient ions in soil, soil solution and plant thereby finding out the contributing factors to yield. To study the ionic interactions and to unravel the role of Net Ionic Equilibrium based on Ratio Law on soil plant system, a sample of fifty phenotypically identical palms varying in yield from 14.4 to 84.4 nuts palm^{-1} year $^{-1}$ were selected. Index leaves were collected during pre and post monsoon seasons from 25 palms each from high yielding and law yielding groups. Soil samples were also collected from the basins at 30 cm (surface) and 60 cm (subsurface) depth at the same seasons. Leaves, soil and solution samples were analysed for different nutrient ions, and NIE ratios in these three phases were worked out with respect to K and Na. The soil samples were acidic in nature. In the case of available nutrients, micronutrients showed significant direct relation with yield both for high and low yielding populations. Exchangeable K had got a significant dominance in deciding the NIE ratio in soil, solution and in index leaves.

Exchangeable K controlled the soil solution concentration of K, which in turn controlled the NIE ratio in solution and the ratios in plant. Exchangeable K directly controlled the plant K content and plant K positively and significantly correlated with NIE ratios in plant and these ratios were positively and significantly correlated with yield. Among the ionic concentrations in soil solution, Fe was positively and significantly correlated with yield in both seasons. Potassium content and NIE ratio in the index leaves were found to have a significant direct relation with yield. The NIE ratios between the exchangeable ions, the ions in soil solution and the ions in the index leaf were mutually, positively and significantly correlated among

themselves. This lead to the conclusion that there exists constancy in the relative proportion of nutrient ions in the entire soil-plant system, which followed the Ratio Law.

6. NUTRIENT DYNAMICS IN SOIL

6.1 Ph. D. theses

6.1.1 Prema, D. 1992. Status, availability and transformation of magnesium in acid soils of Kerala.

An investigation was taken up to assess the Mg status of soils, to evolve a suitable extractant for estimation of available Mg in Kerala soils, to study the pattern of Mg in relation to the transformation of applied Mg in the form of $MgSO_4$ $7H_2O$, magnesite and dolomite in two important soil types of Kerala viz., laterite and kuttanad alluvium (Karapadom) and to know the requirement of Mg for banana in relation to different sources of Mg and the pattern of uptake of nutrients by the crop. One hundred and fifty surface soil samples were collected from all over the state to study the status of Mg as well as properties in relation to the behaviour of Mg in these soils. The acid soils of Kerala are deficient in total Mg reserves. About 24 per cent of the total Mg was considered as available Mg. In terms of the magnitude of available Mg in soil, the acid soils of the state were deficient where as all the black soils were rated as sufficient. This trend was also seen in the distribution of exchangeable Mg in soil. The amount of Mg extracted by various extractants failed to correlate significantly with the Mg uptake of test crop (rice). While comparing the efficiency of different Mg fertilizers to supply available Mg after six months of incubation, magnesite was found superior in laterite and karapadom soils. Magnesite was found as a good as magnesium sulphate in the supply of Mg in the soils.

6.1.2 Rani, B. 2000. Dynamics of potassium, magnesium and sulphur in plant and soil with special reference to the application of langbeinite

An investigation was undertaken to examine the dynamics of K, Mg and S in soil as influenced by langbeinite (Sul-Po-Mag), a K-cum Mg fertilizer in the acid laterite soils of Kerala using tapioca and bhindi as test crops. The first part of the study was to assess the suitability of Sul-Po- Mag as a K-cum-Mg fertilizer for tapioca in Kerala. It was seen that Sul- Po- Mag application produced dry matter and yield on par with the muriate of potash treatments and hence Sul-Po-Mag can be substituted for muriate of potash for tapioca in acid – laterite soils of Kerala. An incubation study was programmed with the intention of delineating the pattern of release of K, The exchangeable Mg and S during the course of incubation under submerged conditions, after the addition of Sul-Po- Mag, muriate of potash, $MgSO_4$ at three different levels of these fertilizers to two soils namely alluvial and laterite. Application either Sul-Po-Mag or muriate of potash resulted in a significant increase in the

available K both soils. The alluvial soil gave very low amount of K in leachate when compared to laterite soil. The leachate K was less in the Sul –Po- Mag. The exchangeable Mg for Sul-Po- Mag treatments showed higher values when compared to $MgSO_4$ indicating the gradual release of Mg from Sul –Po-Mag in alluvial soil. The same trend was found to be in laterite soil also, but it gave slight higher values at the end of the incubation. Application of Sul- Po-Mag or $MgSO_4$ resulted in an increase in the available S throughout the incubation period in both soils. The third of the study consisted of a pot culture experiment undertaken to examine the interaction of K and Mg in soil –plant system using bhindi as the test crop with different levels of muriate of potash, MgSO4 and Sul-Po-Mag. In alluvial soil, application of Sul-Po- Mag gave relatively high dry matter production where as in laterite soil it did not significantly increased. Fruit yield of bhindi was significantly higher for Sul Po- Mag in the alluvial soil but in laterite soil it was on par with the NPK treatment.

6.2 M. Sc. (Ag.) theses

6.2.1 Mashar Velapurath, 1986. Relative efficiency of rice varieties for absorption and utilization of soil and fertilizer phosphorous.

An investigation was carried out to study the efficiency of popular modern rice varieties of Kerala for absorption and utilization of soil and fertilizer P as well as for their capacity to P deficiency tolerance. A series of pot culture experiments was conducted using five short duration (Rohini, Jyothi, Annapurna, Triveni and IR-36 and eleven medium duration (Jaya, IR-8, Sabari, Bharathi, Mashuri, IR-20, Mo-4, Mo-7, H-4 and IR-42) rice varieties in a karappadom soil of Kuttanad region of Kerala. The first experiment involves evaluation of the varieties for their capacity to utilize soil and applied P using ^{32}P labeled superphosphate. The relative performance of all the varieties as well as their root distribution pattern were compared from another pot culture trial under identical fertility conditions. An experiment was also made to study the P requirement of each variety for the expression of maximum grain and straw yield from a solution culture trial. The various levels of P used were 0, 1, 2, 4, 5 and 10 ppm. The results indicated that variety IR-36 was having a very low P requirement for the expression of maximum yield potential among short duration varieties and that it responded well to applied fertilizer P, indicating its responsive nature as well as tolerance to P deficiency. Among the medium duration varieties Mashuri has the lowest requirement and majority of its requirement was met from fertilizer revealing that its P deficiency tolerance nature, and responsiveness to applied fertilizer P.

6.2.2 Vijayan, A.P. 1993. Behaviour of phosphorus in selected soil types of Kerala.

In order to study the distribution of inorganic P-fractions, finding suitable chemical extractant for phosphorus, to study Q/I relationship as a method of estimating available P and for studying adsorption-desorption characteristics of the soil type of Kerala, 100 soil samples were collected from five soil types viz., laterite, coastal alluvium, brown hydromorphic, kuttanad alluvium and black soil. Dominant inorganic fraction in laterite and black soil was Ca-P while in coastal alluvium, brown hydromorphic and kuttanad alluvium dominant fraction of Fe-P. Coastal alluvium recorded maximum content of saloid P, Al-P and Fe-P was maximum in kuttanad alluvium. Maximum content of Ca-P was recorded in black soil. The different extractants tried in different soils showed that extractants should be selected according to soil types. Mathew's triacid proved as a better extractant for available P in laterite soil and coastal alluvium where as in kuttanad alluvium soil Bray No.I is better. The desorption adsorption studies showed that adsorption studies was not correlated to P uptake, while the desorbed P correlated significantly and positively to P uptake in laterite soil alone.

6.2.3 Smitha, B. 1995. Soil nutrient dynamics in cocoa (*Theobroma cacao*).

An investigation on dynamics of soil nutrients in the root zone of cocoa was studied by taking soil and leaf samples of cocoa trees under Cadbury-KAU Co operative Cocoa Research Project using the variety Forastero. The soil of the site was laterite (Oxisol). The treatments consisted of factorial combination of N, P, and K fertilizers each at two levels (with and without), two levels of irrigation (with and without) and shade and seven age groups namely 1, 3, 4, 5, 6, 9 and 12 years. Soil samples were collected from an uncropped and unfertilized area nearby. The impact of long- term inorganic fertilization, irrigation and shade and age of the tree on soil chemical characteristics as well as foliar nutrition of cocoa influenced by long- term inorganic fertilization, irrigation and shade were assessed. Regular irrigation over a period of five years resulted in reducing the availability of P, Ca, Mn and Cu and increased the available K, Zn and S. Provision of shade for a period of 13 years resulted in the build up of soil organic carbon, available P, Fe and soil reserves of P, Ca, S, Fe, Zn and Mn. Nutrient dynamics in rootzone of cocoa over a period of 12 years of crop growth and fertilization could be described by linear or quadratic model. The linear model was found to be a better fit for available and total K, available and total Mg, available Cu and total Zn. In case of available and total P, available and total Ca, available Zn, total S and total Cu the changes in concentrations with time could be described by quadratic model.

6.2.4 Nisha, P.T. 1995. Dynamics of nutrient release and transformations from slow release fertilizers in acid rice soils.

A study was conducted to assess the pattern of release and transformation of major plant nutrients from slow release nitrogen fertilizers (SLNF) and to evaluate the efficiency of SLNF. Urea formaldehyde (UF), NP tablets (NP tab), NPK tablets (NPK tab), gypsum coated urea (GCU), blended urea ammonium sulphate (UAS), magnesium ammonium sulphate (MAP) were compared with no fertilizer (NF) and recommended dose of fertilizers (C). Evaluations were conducted with four acid soils viz., laterite, kari, kuttanad alluvium and coastal sandy kept under incubation for six months and a pot culture study using laterite soil and rice variety Jyothi during puncha season. The release of ammoniacal nitrogen was found to be maximum in kari soil followed by kuttanad alluvium where as the release of nitrate nitrogen was maximum in the earlier periods in the case of sandy and laterite soils. Irrespective of the soil types, the maximum content of ammoiacal nitrogen was recorded by NPK tab followed by MAP. The available P content of the soil recorded significant variation throughout the period of incubation. Irrespectives of the soil types, there was uniformity in the release of available K through out the period of incubation. Significant influence on morphological observations was also recorded with MAP maintaining superiority over the other treatments. Maximum leaching loss of N and P were seen with the control and minimum with MAP whereas it was with UF and NPK tab for K. The total ^{15}N recovery percentage was recorded in the decreasing order: MAP > C > UF > GCU > UAS > NP tab > NPK tab.

6.2.5 Dineskumar, K.K, 1996. Seasonal variations in the nutrient transformation in the lateritic alluvial rice soils of Permanent Manurial Trials.

A study was conducted during the first and second seasons to find out the seasonal variations in nutrient transformations in the existing two permanent manurial trials (one with tall *indica* varieties and other with dwarf *indica* varieties), which were started in 1961 and 1973 respectively at RARS, Pattambi. The experiments were laid out in RBD with four replications and eight treatments. The treatments consisted of application of entire quantity of N (90 kg ha^{-1}, as organic alone (cattle manure alone, green manure alone and cattle manure + green manure), inorganic alone (ammonium sulphate alone and NPK fertilizers) and combination of organics with inorganic (cattle manure + NPK fertilizers, green manure + NPK fertilizers and cattle manure + green manure + NPK fertilizers). For tall *indica* the dose of NPK applied is 40:20:20 kg ha^{-1} where as in the dwarf *indica* varieties the dose applied is 90:45:45 ka ha^{-1}. Soil samples were collected at 11 stages from harvesting of the second crop 1991 to the harvest of the second crop of 1992. Plant samples were collected at different stages. Results of analysis of soil samples showed that significantly higher values of organic carbon, available N, P, K and Ca were recorded in the initial stages of crop growth namely transplanting,

tillering and 50 per cent flowering in the first crop season but the trend reversed in both the experiments. In the grain significantly higher content of N, K and Mg were recorded in the second season. There was not much difference in the P content between the seasons. Similar trend was noticed in the nutrient content of both tall and dwarf *indica* varieties except for Ca.

6.2.6 Jyothikumari, K.M. 1996. Dynamics of potassium in the soil of kole lands.

An attempt has been made to evaluate the chemical nature, distribution, fixation and availability of potassium in the soils of kole lands. Soils were collected from 15 locations in Chathan kole - puppilakkad kole area, seven from Chittilapilly village and four from Adat and Chalakkal villages. A retention study and a laboratory incubation experiment of three month duration was carried out in order to find out the level of retention and transformation of applied potassium. In order to find out the most suitable extractant for assessing the available potassium, different chemical extractants were tried and its correlation with K uptake by rice in Neubauer experiment was carried out. Soils were generally acidic in nature. Total potassium showed significant positive correlation with clay content, organic carbon and CEC. Water soluble, exchangeable and HNO_3 soluble forms of potassium were low in these soils and showed significant positive correlation with each other and also with total K except for water soluble fraction. From the retention study it was found that in soils with high saturation capacity the retention capacity is low and hence longer duration of time is essential for maximum retention. 1N NH_4OAc extracted higher amount of potassium compared to Mathew's extractant and 0.01M $CaCl_2$.

6.2.7 Nicy Thomas, 1998. Forms, availability and transformation of potassium in laterite soil as influenced by crop uptake.

An investigation was taken up to study the fate of applied and native potassium in a laterite soil as influence by other major nutrients and organic matter and uptake by an annual crop, banana. The experiment was laid out at Banana Research Station, Kannara. The result of the study revealed that the necessity of fertilization of the field/soil for better yield. The maximum content and uptake of nutrients N, P and K occurred during the early and late vegetative stages of banana. Hence fertilizers should be applied for the crop from 2 months after planting onwards and continued up to 6 months after planting. Correlation studies revealed that the significant relationship of total K in the soil with yield at different stages. Also positive correlation between the exchangeable K content in the soil and yield was established. Path coefficient analysis revealed that the direct effect of total K content in the soil on yields was highest at six months after planting. The indirect effect was maximum at six months after planting through four months after planting. The exchangeable K was found to have positive direct effect on yield. The indirect

effects were not significant. Water soluble K at different stages showed a direct effect of comparable magnitude on yield.

7. SUITABILITY OF COMMERCIAL PRODUCTS AS A SOURCE OF NUTRIENT IN SOIL

7.2 M. Sc. (Ag.) theses

7.2.1 Regi P. Mathew, 1985. Suitability of rock phosphate for direct application in acid rice soils of Kerala.

An incubation study and a pot culture experiment were conducted to assess the suitability of Rajasthan rock phosphate (RRP) supplied from Rajasthan State Mineral Development Corporation, in comparison with that of Mussorie rock phosphate (MRP) supplied from Pyrites Phosphates and Chemicals Ltd. (U.P) and super phosphate (SP) in two acid rice soils of Kerala namely laterite (Kodakara, Thrissur district) and Karumadi, Alleppy district). Transformations of P fertilizers applied at the rate of 45 and 90 kg ha^{-1} in these soils under continuous submergence was studied. Soil samples were drawn at 15 days interval for the determination of various inorganic P fractions and available P. The direct and residual effects of the two rockphosphates in comparison with the water soluble SP were studied in a pot culture experiment using the rice variety Jaya as the test crop. Application of phosphatic fertilizers irrespective of their water solubility increased the various inorganic fractions and available P content of the soil. Fe-P was the dominant inorganic fraction of the total inorganic P followed by Al-P. The contents of Al-P, Fe-P reductant soluble – P and occluded –P were more in laterite soil compared to kari soil, while saloid-P and Ca-P were high in kari soil. The peak values of saloid -P was observed during the seventh fortnight. The extent of contribution of various inorganic fractions to available P was same in all the three sources of P added to the soil. In the pot culture experiment, application of P fertilizers had resulted in a better utilization of major nutrients by the rice plant and this result was more pronounced in kari soil during the first crop season. Application of SP at the rate of 90 kg ha^{-1} applied twice in equal doses separately for the first crop and second crop seasons increased the uptake of nutrient, yield of grain and straw and available P content of the soil compared to the application of the same total quantity of P initially for the first crop only as SP and rock phosphate.

7.2.2 Susan Varghese, 1992. Suitability of magnesite as a source of magnesium in acid rice soils of Kerala

An incubation study and a pot culture experiment were conducted to assess the suitability of magnesite in comparison with that of magnesium sulphate and dolomite in karappadom and laterite soils of Kerala. In the incubation study, these three Mg sources were tried at the rate of 25 and 50 kg ha^{-1} and their transformations under submergence were studied for 180 days. In pot culture experiment using rice (Annapurna) as the test crop, the direct

and residual effects of magnsite, dolomite and magnesium sulphate were studied. The residual effect of Mg fertilizers was assessed by continuing the experiment for the second season without the addition of Mg fertilizers. Among the various Mg fractions, mineral Mg was the dominant one in both the soils accounting to 42.23 and 41.63 per cent of total Mg in karappadom and laterie soils. The content of organic complexed Mg was very low and that of water soluble Mg was practically nil. The transformation of Mg in soil under submerged condition was highly dynamic, release and fixation existed side by side, the equilibrium being decided by the dominance of the nature of the reaction involved. Magnesite was 78.66 and 63.25 per cent as efficient as magnesium sulphate with regard to the release of water soluble Mg in karappadom and laterite soils respectively. There was no significant difference between the different Mg sources on grain yield during the first crop season, though magnesite was found to perform better in karappadom soil and magnesium sulphate in laterite soil. In the second season, the best source was magnesite followed by dolomite and magnesium sulphate.

7.2.3 Anila Mathew, 1997. Suitability of Sul-Po- Mag as potassium cum magnesium fertilizer for banana in Kerala.

The study was aimed to bring to light the suitability of Sul-Po-Mag as potassium cum magnesium fertilizer for banana in Kerala. The treatment included Sul-Po-Mag substitutes of potassium to the extend of 25, 50 and 100 per cent in the normal recommended dose of NPK as urea, diammonium phosphate and mutiate of potash at the rate of 190 g N, 115 g P_2O_5 and 300 g K_2O per plant per year. Treatments of muriate of potash supplemented with magnesium and sulphur separately and with magnesium and sulphur together were included and they were compared with the recommended practice. During the early stages of the growth; the treatment failed to influence the morphological characters such as height, girth and number of leaves, but at the later stages, the girth and number of leaves differed significantly by the application of Sul-Po-Mag. The maximum yield was given by the treatment where potassium was supplied by Sul-Po-Mag and muriate of potash in half doses. This indicated that Sul-Po-Mag is as good as MOP for its capacity to meet the potassium requirement of the crop. Significant difference were observed with TSS, ascorbic acid, acidity with Sul-Po-Mag. High pulp peel ratio of Sul-Po-Mag treatments showed increased storage quality. Treatments with Sul-Po-mag and magnesium showed high content of potassium in the leaves. The maximum values of uptake of magnesium found in treatment, which was applied with Mg equivalent to that present in half of Sul-Po-Mag.

7.2.4 Santhoshkumar, V.S. 1997. Suitability of Tunisia (Gafsa) rock phosphate for direct application in acid rice soils of Kerala.

A study was conducted to assess the suitability of Tunisia rockphosphate (TRP) for direct application in acid rice soils of Kerala as a source of P compared with single super phosphate (SSP), diammonium

phosphate (DAP) mad Mussoorie rockphosohate (MRP). In addition to the above sources, a control treatment (with our P fertilizer) and another treatment with SSP of the rate 45 kg P_2O_5 ha^{-1} given twice (conventional practice) were included. The P release from all the sources was monitored with an incubation experiment. In order to evaluate the residual effect of fertilizers two continuous pot culture experiments were undertaken using Thriveni variety of rice. The acid soils of Kerala namely kuttanad alluvium and laterites were used for the study. The available phosphorus content gradually increased with period of incubation and reached a peak at 60 to 90 days for water soluble phosphates and 90th and 120th day for rockphosphates. Comparing the two extracts, Mathew's triacid extracted more available P than that of Bray solution in both soils. Kuttanad alluvium recorded higher content of available nutrient as compared to laterite. The extent of fixation of P was higher in Kuttanad soil with Fe-P as dominant fraction while in laterite soil it was Al-P which is dominated. For evaluating the pot culture experiment, it was found that TRP registered a comparable uptake of P and gave a comparable yield and straw with other sources. The residual effectiveness was found to be higher than that of water soluble sources and TRP gave the highest. Kutttanad soil showed a higher residual effectiveness and resulted in higher yield for 2nd crop.

7.2.5 Suja Thomas, 1997. Evaluation of Maton rock phosphate in the acid rice soils of Kerala.

A study was conducted to assess the suitability Maton rockphosphate (MTRP) of for direct application in acid rice soils of Kerala as a source of P compared with single super phosphate (SSP), diammonium phosphate (DAP) mad Mussoorie rockphosohate (MRP). In addition to the above sources, a control treatment (with out P fertilizer) and another treatment with SSP of the rate 45 kg P_2O_5 ha^{-1} given twice (conventional practice) were included. The P release from all the sources was monitored with an incubation experiment. In order to evaluate the residual effect of fertilizers two continuous pot culture experiments were undertaken using Jaya variety of rice. The acid soils of Kerala namely kuttanad alluvium and laterites were used for the study. The content of available P gradually increased with period of incubation, reached a peak at 120 days for water soluble phosphates (SSP and DAP) and 180 days for rockphosphates irrespective of the soil types. Mathew's triacid extracted more available P than that of Bray solution. In general, kuttanad alluvium recorded higher content of available nutrients as compared to laterite. In both the soil types the most dominant P fraction was Fe- P followed by Al-P and Ca- P. While evaluating the pot cultural experiment it was found that even after the harvest of the second crop, the residual effect of MTRP was reached to be high. In kuttanad alluvium, DAP and MTRP yielded better in the first and second crop of the rice, while in laterite SSP was found to be better in the grain yield.

8. SOIL ORGANIC MATTER AND BIOCHEMICAL STUDIES

8.2 M. Sc. (Ag.) theses

8.2.1 Usha, P.B. 1982. Characterization of soil organic matter in different soil types of Kerala.

Large number of surface soils representing the different districts of the state were analysed in order to work out precise relationships between organic carbon, total nitrogen and available nitrogen in these soils. The soils were categorized into different groups based on soil texture and content of organic matter. Relationships between different soil properties applicable to the different categories of soil were then examined. Fractionation of soil organic matter was carried out in a limited number of soils. Also the distribution of elemental components of soil organic matter was studied in soils selected for fractionation of organic matter. Observations on the general characteristics of soil revealed that the content of organic carbon, total nitrogen and available nitrogen showed an increasing trend with increase in acidity of soil. More organic carbon was found in fine textured soils. Total and available N content increased with increase in content of organic matter. Since the C/N ratio increased with increase in content of organic carbon, it was necessary to predict the total and available nitrogen content of soil based on precise regression equations rather than depending upon a conversion factor. The C/N ratio was positively and significantly correlated with organic carbon and total nitrogen while it was negatively correlated with the available N. On an average, the percentage of humic acid, fulvic acid and humin in soil organic matter were 28.28, 36.51 and 35.21 respectively. Of the humic acid, 9.60 per cent was represented by hymatomelanic acid and the remaining by insoluble fraction of humic acid. Humic acid was found to be significantly and positively correlated with total organic carbon, total nitrogen, clay and fulvic acid. Of the total fulvic acid, 12.35 per cent was represented by beta humus and the remaining by the soluble fraction of fulvic acid. Humic and fulvic acid maintained a constant proportion irrespective of the variation in content of total

8.2.2 Rekha R. Pillai. 1990. Quality of oil of Ocimum (*Ocimum gratissimum* Linn.) as influenced by stages of harvest and shade.

Two field experiments were laid out separately one to obtain information on the optimum time of harvest for getting maximum yield of quality oil and the other to study the effect of shade on the production and quality of oil at Aromatic and Medicinal Plants Research Station, Odakkali. The treatment in one experiment consisted of five intervals of harvest (60, 75, 90, 105 and 120 days) and four levels of shade (0, 25, 50 and 75 per cent) were tried in the second experiment. The investigation revealed that herbage yield, oil yield and oil content were maximum at 60 days harvest interval and it was on par with 75 days harvest interval. Sixty days interval also recorded

the maximum eugenol content. The result also revealed that maximum yield and quality could be obtained only if there is ample light infiltration. The uptake of all nutrients was maximum under full illumination, which decreased with increasing the shade intensity

8.2.3 Mullakoya, C. P. 1997. Increasing the geraniol content of palmarosa oil by chemical methods.

A laboratory investigation was carried out at the Aromatic and Medicinal Plants Research Station, Odakkali to develop a method for upgrading the quality of palmasora oil by conversion of geranyl acetate in the oil to geraniol. Four treatments were tried for the hydrolysis of geranyl acetate, with essential oil of palmasora type ODP-3 as the best test material viz., methanolic sodium hydroxide, methanolic sodium carbonate, ammonia and aqueous sodium hydroxide. Mixing of essential oil with 5 per cent methanolic NaOH reagent in the ratio of 1:4 and keeping undisturbed at ambient conditions of 30 min were the optimum conditions for the complete hydrolysis of geranyl acetate in the oil. The product of reaction analysed 90.5 per cent geraniol and the process yielded geraniol to the extent of 78.74 per cent of the oil taken for the processing. In the case of sodium hydroxide method of hydrolysis, refluxing the essential oil with an equal volume of 20 per cent aqueous NaOH solution to 30 min. was optimum for the complete hydrolysis of geranyl acetate in the oil. The product contained 89.35 per cent geraniol and the quantiy yielded by the process was estimated at 86.67 per cent of the oil taken for processing. Oils of ODP-3 and Jamrosa were upgraded to meet the specifications for palmarosa oil. Verification of the sodium hydroxide hydrolysis method on pilot scale showed that it can be employed on large scale for the quality improvement of palmarosa oils which contain appreciable amount of geranyl acetate.

9. TRACER STUDIES IN SOIL

9.2 M. Sc. (Ag.) theses

9.2.1 Jayasree Sankar, S. 1985. Studies on the root activity pattern of black pepper (Piper nigram L.) employing radiotracer technique.

An investigation on the root activity pattern of black pepper vine (variety Panniyur I) and allied aspects was conducted to determine the soil zone of maximum nutrient absorption by the vines trailed on erythrina and teak poles, to assess the root density of erythrina in the rhizosphere of black pepper, to evaluate the root competition between the vine and the live standard for applied P, to compare the nutrient removal by the vine and erythrina and also to examine whether the climbing roots of the vine are capable of nutrient absorption. A method of soil injection of desired volume of ^{32}P solution especially suitable for root activity studies with perennial crop plants was developed. The method makes use of a "Lumac Dispensette" connected to a

reservoir bottle containing ^{32}P solution, which in turn is embedded in paraffin wax in a suitable plastic bucket. The method is rapid and the radiation hazard to the operating personnel is minimal at the level of radioactivity generally required in root activity experiments. The results indicated that fertilizer application in black pepper gardens should be restricted to a semicircle of radius 30 cm facing the vine irrespective of the type of standard for the maximum utilization of the added inputs. Growing the vine in association with erythrina as support was found to reduce the uptake of ^{32}P by at least 20 per cent as compared to that grown on teak pole.

9.2.2 Padmini Amma K.P. 1988. Reductive transformation of iron and sulphate in anaerobic soils.

An investigation on the physico-chemical characteristics, reductive transformation of iron and sulphate in flooded kari and karappadom soils of Kuttanad and pokkali soils of Eranakulam districts was conducted. The main objectives of the experiments were to evaluate the changes in soil properties and their influence on the transformation of Fe in anaerobic soils, to examine whether there was preferential reduction of amorphous Fe oxides or crystalline Fe oxides, to determine the relative extent of chemical vs. microbiological reduction of Fe and also to develop a methodology for studying sulphates reduction in anaerobic soils using ^{35}S. Forty three soils (15 karappadom soils from Moncompu area, 15 kari soils from Karumady area in Alleppey Districts and 13 pokkali soils from Kumblalangy, Elamakkra and Panangad areas of Eranakulam District) were used in these studies. Transformation of Fe (III) in submerged soils was studied by monitoring NaOAc- extractable Fe^{2+} concentration.

High concentration was observed in pokkali and kari soils compared to karappadom soils. Studies on the preferential reduction of amorphous and crystalline forms of Fe in flooded soils revealed that with time there was more or less a linear increase in the concentration of Fe^{2+} where as a reverse trend was noticed in the total free Fe, amorphous Fe and crystalline Fe forms with decrease in Eh and increase in pH. A method was developed to study the reduction of sulphate in flooded soils to its and products, H_2S, using ^{35}S. The evolution of $H_2{}^{35}S$ was detected from 91.5 h onwards following incubation of flooded soil in N_2 atmosphere. Evolution of H2 ^{35}S steadily increased upto 211.5 h of incubation, beyond which there was a slight decrease. The total quantity of $H_2{}^{35}S$ evolution during 312.5 h of the experiment was equivalent to the reduction of 6.5 µg of soil SO_4^{2-}. The reduction of $^{35}SO_4^{2-}$ to $H_2{}^{35}S$ commenced when Eh of the flooded soil dropped to –5mV where as the transformation of Fe^{3+} to Fe^{2+} started at a still higher Eh much earlier to the reduction of $^{35}SO_4^{2-}$

9.2.3 Smitha, M.S. 2005. Phosphorus dynamics in an Ultisol.

A pot culture experiment was carried out using laterite soil (Ultisol) from the main campus of Kerala Agricultural University with the objectives to

trace the fate of fertilizer P and to study the dynamics of P by the addition of amendments. The experiment included 13 treatments of three levels of P and four amendments and an absolute control. Amendments were added to the respective treatments and kept for wetting and drying cycles for two weeks. ^{32}P labeled KH_2PO_4 (^{32}P @ 0.4mCig^{-1} P) was added as per the treatments. Seeds of cowpea @ 3 seeds pot^{-1} were sown. Application of phosphorus at different levels significantly contributed to available P status, different P fractions i.e. non occluded Al-P and Fe-P, P sorbed by carbonate, occluded P and Ca-P in a linear fashion at all stage of the crop growth i.e. just before sowing, flowering and harvesting. The amendments also contributed to the pool. Among the amendments, Pongamia leaves was found to have better influence in contributing to the above pools except for Ca-P, where lime was found to have a better influence. This was supported by the data on plant P content at 15 DAS, flowering and at harvest. Ca-P fraction was dominantly contributing to the available P suggesting that applied P might get transformed to non occluded Al-P and Fe-P, occluded P as well as P sorbed by carbonate, which might be slowly transformed to Ca-P fraction probably Ca $(H_2PO_4)_2$, the soluble form which is contributing to plant P as time proceeded due to solubilisation of this fraction.

Application of P at increasing level and amendment significantly increased the dry weight of pods and haulm. Radioactive ^{32}P labeled with applied phosphorus could be traced out in the available pools and fractions of P only at just before sowing and flowering. Percentage of P derived from applied P was the highest for higher level of P and amendment sodium silicate.

10. POLLUTOION STUDIES IN SOIL

10.1 Ph. D. theses

10.1.1 Betty Bastin, 1996. Fate of carbofuran applied to the soil basin of black pepper.

A study on the fate of carbofuran applied to the soil basin of black pepper was conducted with the objectives to study the adsorption kinetics of carbofuran in laterite soil, to study the persistence of the pesticide in the soil and to study the influence of organic matter on the bioavailability of insecticide. The mobility of carbofuran under field conditions was also studied. An attempt was also made to assess the effect of cabofuran application to soil on the growth of black pepper vine (Variety – Panniyor I). The soil at the experiment site was laterite. The sorption of insecticide in soil was found to be explained by Freundlich adsorption equation. The rate of sorption of carbofuran was not influenced by the organic matter contents. An initial lag period was observed prior to carbofuran degradation in soil under laboratory conditions. Only one metabolite (3-hydroxycabofuran) was detected as the product of degradation. The total content of ^{14}C derived

radioactivity was high in plants grown in soils with lowest organic matter content and vice versa. Hence, bioavailability of the insecticide is less in soils with organic matter contents.

10.1.2 Vijayan, A. P. 2000. Carbofuran residues in banana.

An investigation was carried out to study the fate of cabofuran in banana. An analytical method using HPLC was standardized for the estimation of cabofuran and its metabolite residues in banana. Cabofuran and its metabolitie were estimated directly without any derivation and all the metaboilites are detected simultaneously in a single chromatographic run. Due to high sensitivity, up to sub- nanogram quantities were detected. Since only few steps were involved, recoveries of the test compounds were very high (81.4 to 98.1 %). Extraction and cleanup procedures were simple, fast and less expensive. Owing to the above advantages, this method can be used in research and in environmental monitoring programmes. A series of studies were conducted to investigate the absorption, translocation and metabolism of cabofuran applied to banana at different doses, at different periods of time and through different routes of administration, with special emphasis on the residues in the fruit. The treatments comprised of two levels and three modes of cabofuran application viz., soil application of 750 and 1500 mg ai plant^{-1}, leaf axil filling with 375 and 750 mg ai plant^{-1} and pseudostem implantation with 375 and 750 mg ai plant^{-1} at 7th month in addition to the normal recommended practice. Absorption of carbofuran from soil application and leaf axil application was similar. Absorption of insecticide increased up to 10 days, declined afterwards and ceased by about 21 days. When the granules were implanted by boring the pseudostem, the absorption was much higher which continued up to 33 days. When applied by foliar spray of a 100 ppm solution, one - third of the cabofuran was absorbed by third day and further absorption was limited. High rate of absorption recorded by pseudostem implantation. This new method of administration besides being more economic will help to reduce the pesticide load of the soils cropped to banana.

Degradation rate of cabofuran ($T_{½}$) in banana in soil, leaf axil and pseudostem implantation were 9.5d, 15.8d and 13.5d respectively. Residue dynamics in leaf was characterized by the fast depletion of carbofuran with a concomitant build up of 3–OH- carbofuran. At the end of the 63 day period of post application, the residue consisted of 1.5 per cent cabofuran, 98.5 per cent 3-OH- cabofuran in addition to small amounts of 3-OH-carbofuran conjugate. Carbofuran applied to the leaf was found to move only upwards. In the field experiment, cabofuran was applied at 8 times the recommended dose to banana after bunching (8 months). The residue distribution at the harvest showed that about 96.2 per cent of the total residues of carbofuran were concentrated in the leaf. Fruit contained meager amounts of the residue. Of the residue in the fruit, 91 per cent was located in the fruit peel and the rest in the fruit pulp. Mobilization of the residues to the fruit seldom occurs even at double the recommended dose and late application up to the 7th month.

10.1.3 Durga Devi, K.M. 2002. Assessment of 2,4-D residues in the major rice soils of Kerala.

An attempt was made to assess the behaviour of 2,4-D in three major rice soils of Kerala viz., Palakkad, Kuttanad and Kole lands. Three laboratory experiments were conducted in sixteen soil samples of the selected areas to understand the persistence, degradation, adsorption and leaching pattern of 2,4-D in these soil samples. A field experiment was also conducted in kole area of Thrissur district for estimating the dissipation pattern of 2,4-D from soil and plant under field conditions. In order to estimate 2,4-D residues of soil samples, a colorimetric procedure was standardized. The standardization process consisted of selection of estimation procedure, standardization of the extractants and the soil extractant ratios and clean up method. Among the different extractant tried, acetonitrile: distilled water: glacial acetic acid (80:20:205) in soil extractant ratio of 1: 4 was the best on in terms of recovery of applied 2,4-D from soil. NaOH 1N), concentrated HCl, diethyl ether, sodium hydrogen phosphate buffer, and carbon tetrachloride was efficient to remove the co-extractives. Persistence of 2,4-D in the soils was studied by fortifying the samples with 2,4-D at 0.50,1.00 and 2.00 $\mu g\ g^{-1}$ and incubating under submerged condition for varying periods. Residues of 2,4-D in soils were estimated at 0,1, 3, 6, 9, 15, 30 and 60 days after incubation. Half life of the 2,4-D in soils was worked out by fitting first order kinetic equation of the form $C= C_0e^{-kt}$. Lowest half-life was noticed by Karumudy sample. Adsorption of 2,4-D in the three soils of Kerala was studied at three different levels of equilibration (2,4 and 6 h) and three levels of 2,4-D(0.5, 1.0 and 2.0 $\mu g\ g^{-1}$ soil). The results indicated that degree of adsorption increased with concentration of 2,4-D in the soil solution ie., adsorption of 2,4-D in the rice soils of Kerala followed Freundlich isotherm of the form $x/m = KC^n$. A comparison of the strength of adsorption of 2,4-D in the soil samples was made by using the isotherm constant K.

Leaching and movement of 2,4-D in the soils was studied by applying 2'4-D to the top of soil columns in PVC tubes, directly from the field. The treatments consisted of 2,4-D @ 1.0, 2.0 and 4.0 kg ha^{-1}. 2,4-D residues retained in 0-10 cm, 10-20 cm and in leachate (>20cm) were estimated. The result showed that major part of the 2,4-D (more than 50 % of the applied 2,4-D) remained in the 0-10 cm depth. No 2,4-D residue was available in the leachate of any soil at the lowest level of application of herbicide ie., 1.0 kg ha-1. 2,4-D residues in drinking water at concentrations greater than 0.0001$\mu g\ l^{-1}$ is considered to be toxic to human beings and animals. The findings of the study emphasizing the need for restricting the 2,4-D application to 1.0 kg ha^{-1}, particularly in the sandy soils of Kerala. Studies on dissipation of 2,4-D from soil and rice plant under field condition consisted of five treatments viz., 2,4-D @ 0.0, 0.5, 1.0, 2.0 and 4.0 kg ha^{-1}. At the present recommended level of 1.0 kg ha^{-1}, 2,4-D residues persisted in paddy field for less than 30 days. Effect of 2,4-D on microbial population was studied by soil plate dilution technique. The results of the study revealed that the key role of fungi in the degradation

of 2,4-D in paddy field. 2,4-D residues in the grain and straw samples were very much lower than the maximum residue limits. The findings of the present investigation made it clear that the present recommendation of 2,4-D at the rate of 1.0 kg ha-1 for weed control in rice does not cause any adverse effect in the soil or crop produce.

10.2 M. Sc. (Ag.) thesis

10.2.1 Muthu Kannan, M. 2003. Persistence of selective herbicides in rice-rice system.

An investigation was carried out to study the persistence of selective herbicide in rice-rice system with the objectives of determining the persistence of butachlor, pretilchlor and 2,4-D. Six treatments consisted of hand weeding twice (25 and 40 days after sowing), application of herbicide with 100 per cent NPK as inorganic fertilizer in different combination in two seasons of two consecutive years and 75 per cent of NPK as inorganic fertilizer and 25 per cent through FYM. The pre emergence herbicides butachlor @ 1.25 kg a.i ha^{-1} and pretilachlor @ 0.75 kg a.i ha^{-1} were applied at 8 days after sowing for the control of grassy weeds. 2,4-D @ 1.00 kg a.i ha^{-1} was applied at 20 days after sowing for the control of broad leaved weeds. Persistence of the above three herbicides applied in the first and second crop was estimated at one and 30 days after spraying and at the time of harvest. On comparing the extent of dissipation of the three herbicides, it was found that 2,4-D had been dissipated to a higher magnitude than the other two. At the time of harvest, residues were not detected in soil, rice grain and straw. From the study it could be concluded that at the present recommended rate of application, residues of the three herbicides do not persist in paddy soil to detectable level beyond 30 days. Residues were not detected in the grain and straw also. Application of FYM enhanced the microbial degradation of herbicide and reduced the adverse effect of herbicides on soil microflora. 2,4-D was highly efficient in controlling broad leaved weeds in the rice- rice system. Both pretilachlor and butachlor grasses except *Echinochola spp.* Butachlor had shown its superiority over pretilachlor in the weed management of rice-rice cropping system.

11. SOIL PHYSICS

11.2 M. Sc. (Ag.) thesis

11.2.1 Ushakumary, K. 1983. Aggregate size distribution and its relationship to physical and chemical properties of some typical soils of Kerala.

A study was undertaken to evaluate the structural indices of some typical soil groups of Kerala, namely, laterite, black, red loam, riverine and coastal alluvium and to relate them to some physiochemical properties of the soil. Soil samples were selected from five extensively occurring series

namely, Velappya, Valiavallampathy, Vellayani, Ponnamattom, and Beypore series covering Thrissur, Palakkat, Thriruvanathapuram, Eranakulam and Kozhikode Districts respectively. Three profiles were chosen from each series and from each profile, samples were collected at four depths viz., 0-15, 15-30, 30-45 and 45-60 cm. The results clearly indicated that black soils were relatively well aggregated as compared to other soil groups. They were also superior to other soil groups in respect of CEC and available water status. Laterite, red loam and coastal alluvium soils were highly pervious whereas black and riverine alluvium soils relatively less pervious and the rate and stability of aggregation in these soils were more or less at similar type.

12. SOIL SUSTAINABILITY THROUGH ORGANICS

12.2 M. Sc. (Ag.) theses

12.2.1 Jothimoni, S. 1993. Decomposability and mineralisation pattern of coirpith in latosols.

The experimental soil site was laterite and the various treatments employed for mixing with the soil comprised of coirpith raw as well as enriched with *Pleurotus sajor caju,* urea and rock phosphate. The individual and different combinations of these factors were compared with the control (Glyricidia *maculata*) applied to the soil. The study involved an incubation and field trial. In order to measure the decomposition of coirpith compared to glyricidia in laterite soil under incubation, the measurement of CO_2 evolution was carried out for a period of six months. A field experiment was conducted to study the influence of additives such as microbe, rockphosphate and urea on decomposition of coirpith. The mineralisation of lignin rich coirpith was found to be accelerated due to the addition of both *Pleurotus sajor caju* and mineral N in the form of urea. With the treatments and treatment combinations the rate of CO_2 evolution was found to be highest at the second day of the incubation and appreciable changes were associated in general, up to 48^{th} day of incubation. Due to the incorporation of either the glyricidia or coirpith with and without the various adjustments, a steady state of acidic reaction was maintained in the soil. Both the microbe and urea enrichment to coirpith reduced the organic carbon content due to faster decomposition where as it was slightly improved by the addition of rock phosphate. There was progressive increase in the available nitrogen contents of the soil with the advancement of period of incubation due to the mineralisation of glyricidia and coirpith. The content of available P is increased when coirpith was incorporated with urea where as glyricidia incorporation showed a better performance for the release of available K from the soil.

12.2.2 Venugopal, R. 1995. Effect of coir pith on physico-chemical and moisture retention properties of selected soil groups of Kerala

The study was conducted on the effect of coir pith on physico-chemical and moisture retention properties of selected soil groups of Kerala viz., coastal sandy, laterite and red soils as influenced by the application of different levels of coir pith. An incubation study for a period of one year was conducted to evaluate the physico – chemical properties and an *in vitro* study for six months using cocoa seedlings as an indicator plant for the water retention property of coir pith. Samples were collected from the pots at quarterly intervals and analysis done for various physico-chemical properties like volume-mass relationships, moisture retention at tensions of 30, 500, 1000 and 1500 kPa and organic carbon. At the end of one year after incubation water stable aggregates and CEC were analysed. Application of the coir pith significantly improved the bulk density, maximum water holding capacity and percent pore space. There was a significant increase in the moisture retention at different tensions. The percent aggregate stability, the mean weight diameter, structural coefficient and stability index showed significant increase with increasing levels of coir pith. Soil moisture retention at different tensions was significantly influenced by the addition of coir pith. Significant correlation was obtained between various physical properties and organic carbon content of the soils.

12.2.3 Preetha, D. 2003. Biotic enrichment of organic wastes from ayurvedic preparations.

A study on the biotic enrichment of organic wastes from ayurvedic preparations was conducted using ayurvedic waste from Oushadhi, the Pharmaceutical Corporation (Indian Medicines), and a Government of Kerala Undertaking. The investigations were undertaken to standardize the substrate controlled micro-environment as well as to identify the promising bioagents for the composting of Oushadhi wastes and to determine the effect of the best selected enriched compost on soil and plant. The standardization of the best substrate and enrichment techniques was based on the principle of aerobic composting. The collected wastes were grouped into three different size categories such as unsieved, 4 mm sieved and 2 mm sieved. The enrichers used were cowdung, quil manure and their 1:1 mixtures, each at 5, 10 and 15 per cent levels respectively. As introduced by biotic agents, two types of earthworms (*Eudrilus eugeniae* and *Eisenia foetida*) and two fungal inoculi (*Schizophylus communae* and *Pleurotus platyus*) were tried. They were compared with native macrofauna and microflora so as to monitor their respective role in the composting process.

The temperature within the treatments of compost was recorded daily and the fluctuations of pH were noted at fortnightly intervals. Based on these parameters, three distinct stages of composting as measophilic (upto 10 days), hemophilic (10-30 days) and maturity (30-60 days) were identified. Dehydrogenase activity was maximum at thermophilic stage, followed by

maturity and mesophilic stages. After the thermophilic stage, the earthworms were introduced and the counts with respect to *Eudrilus eugeniae* was more than that of *Eisenia foetida* at two stages of sampling. Based on the C: N ratio (11.4) and the least time (48 days) for maturity the best treatment was selected which consisted of the unsieved substrate enriched with 5 per cent mixture of cowdung and quail manure (1:1 ratio) and later vermicomposted with *Eisenia foetida*. To evaluate the effect of the selected enriched compost, the much responsive crop amaranthus was field tested for a period of two months with two rates of compost (5 and 2.5 t ha^{-1}) with and without full and half levels of recommended package of NPK fertilizers, along with FYM and absolute control. The results indicated that with higher doses (5 t ha^{-1}) of the selected enriched compost along with 50:50:50 NPK gave the maximum yield followed by the treatment in which 2.5 t ha^{-1} of selected enriched compost along with 50:50:50 NPK was applied.

12.2.4 Lekshmisree, C. S. 2003. Aerobic composting and enrichment of ayurvedic waste.

A study was conducted to investigate the basic physico-chemical properties of Oushadhi waste material, to standardize formulations of enriched compost from the waste material and also to determine the effect of compost on plant and soil. The waste materials were collected from the Oushadhi Pharmaceuticals. A preliminary was taken to confirm the basic physico-chemical properties of the waste material for a period of 6 months by taking composite samples from the factory at an interval of 10 days. The waste material were categorized into three substrates namely unsieved (O_1) 4mm sieved (O_2) and 2mm sieved (O3) fractions. Each substrate was enriched with organic and inorganic enrichers at different levels. The organic enrichers used were cowdung, poultry manure and neemcake each at 5, 10 and 15 per cent of substrate and also their mixtures. The study involved aerobic composting of enriched treatment combinations in pots of size 30 x 32 cm^2. The selected enriched compost was superior in nutrient contents compared to ordinary composts. This enriched compost contained 3.25, 0.36 and 0.68 per cent n, P and K respectively. This compost was odourless and fine textured near neutral pH of 6.37. The compost matured within 50 days resulting in a favourable C: N ratio of 12 at maturity. With respect to organic and inorganic enrichers, even though the nutrient content was high in inorganic enrichment the time taken for attaining maturity was low in organic enricher treatment combinations due to the high temperature registered. In the field study, it was inferred that with higher doses of selected compost, there was corresponding increase in growth and yield in the test crop amaranthus. The selected compost at the highest level i.e 5 t ha^{-1} with full dose of recommended NPK emerged as the best treatment for economic yield return. This treatment also witnessed the increased build of available nutrient status of the soil.

12.2.5 Arun, G. 2004. Soil properties and produce quality of cardamom (*Elettaria cardamomum* Maton).

An investigation was conducted at the Upputhara panchayath of Peermede taluk, in Idukki dirict of Kerala with the objective to compare the soil properties, crop nutrient concentrations and quality of cardamom under organic and conventional farming. Nine certified organic farms that follow IMO and Skal International certification standards and eight adjacent conventional cardamom farms following recommendations of Spice Board were selected for investigation. Fifty samples of soil and cardamom samples were collected from each farm. A proforma was developed in accordance with the standards fixed by IFOAM for documenting farming practices of the study area. Biometric parameters and yield attributes of cardamom plants were observed directly and yield data for the organic and conventional cardamom farms were collected from records during the survey. Conventional and organic farming practices of the study area differed mainly on fertilization policy, plant protection strategy, weed control and land management. Soils of organic cardamom farms were found to have better aeration than conventional farms, evident from the significantly lower bulk density of soils of the organic farms. Another significant effect of organic agriculture in cardamom was the improvement of soil electrochemical properties. Microbes were proliferating in the organic farms resulting in better decomposition of organic matter with concomitant solubility of major nutrients in the soil. Panicle length, number of panicle per clump, number of racemes per panicle and number of capsules per raceme were significantly lower in organic farms contributing to lower yield, which of course are expected to improve as farming practices stabilize in due course. Size of fresh cardamom capsules, colour and liter weight were higher in the organically produced cardamom samples. Number of seeds per capsule was lower in organic cardamom. Both oleorsin and volatile oil contents were found significantly superior in the organic to that of conventional cardamom.

12.2.6 Thankamony, K. 2005. Standardization of technique for production and enrichment of vermiwash.

A study on the standardization of techniques for production and enrichment of vermiwash was conducted with the objective to standardize the substrate controlled environment for worm multiplication, to identify the enrichment techniques of vermiwash and to evaluate the efficiency of enriched vermiwash on crop and soil. The standardization of substrate controlled environment was based on the principle of aerobic composting. For, this, plastic drums of 50 litre capacity with appropriate fabrications and arrangements were taken. Agro wastes such as banana pseudostem, coconut leaf, green leaf and cow dung in different combinations were kept for pre-composting with the addition of fungal inoculums. The earthworms were inoculated @ 1000 numbers per unit. The population of phosphate solubilizers were maximum in the initial stage (pH range of 6.53 to 6.84) and nitrogen fixers, in the middle stage (pH range of 7.63 to 8.11). The earthworm

population was found to be controlled by a substrate controlled criterion. As the substrate combination, banana pseudostem: glyricidia leaves: coconut leaves: cow dung in the ratio 2:2:2:1 registered the least C: N ratio of 12.25 which attained maturity within 47 days, it was identified as the best substrate controlled environment for vermicompost production. This substrate registered a pH of 7.68 and the nutrient content of 1.19, 0.36 and 0.87 percent N, P and K respectively. It has a relatively good load of microflora as the banana pseudostem favours the flourishment of the microbial and worm population.

The selected substrate was taken for further enrichment techniques. An Organic Enriching Media (OEM) was prepared using neemcake, poultry manure and bonemeal. Vermiwash collected after the compost maturity. The plain vermiwash was enriched by mixing OEM @ 10 per cent of substrate. The resultant and best enriched vermiwash registered nutrient contents of N (1.425 %), P (0.096%) K((0.410%), Zn (169.0 ppm) with a pH of 8.01. With respect to the crop response studies, foliar application of one per cent urea recorded the highest yield of 95.70 g pot^{-1}. The soil application of vermiwash at 50 per cent field capacity proved better than foliar application of vermiwash. For fertigation, the vermiwash was found to be very effective on the test crop of amarantus.

13. STUDIES ON HEAVY METALS

13.2 M. Sc. (Ag.) theses

13.2.1 Jidesh, C.V. 1998. Assessment of some phosphatic sources for possible accumulation of heavy metals in chilli (*Capsicum annuum* L).

Rock phosphate sources collected from different locations were analysed for both phosphorus content and heavy metals namely cadmium and lead. Those sources, which are relatively high content of heavy metals, were included for conducting a pot culture experiment using chilli as test crop. To derive meaningful comparison, partially acidulated rock phosphates as well as direct water soluble sources of cadmium and lead were applied to assess their bioavailability to plants. The influence of organic matter when applied alone or in conjunction with heavy doses of heavy metals was also assessed to study. In the pot culture experiment, the entire fertilizer management was based on package of practice (N, P and K at 70, 40 and 25 kg ha^{-1}) recommendation. The five sources of P selected were Maton rock phosphate, Mussorie rock phosphate, Gafsa rock phosphate, Rajsthan rock phosphate and single superphosphate. The maximum content of cadmium (55 mg kg^{-1}) was recorded in Gafsa rock followed by 25 mg Cd kg^{-1} for the Maton rock and single super phosphate recorded the least concentration of cadmium (15mg kg^{-1}). Highest lead content of 230.5 mg Pb kg^{-1} was analysed in Maton rock while lowest (38 mg kg^{-1}) in Mussoorie rock. The shoot portion of test crop chilli recorded highest cadmium uptake while root portion noted the maximum lead uptake. The least uptake of heavy metals was noted in the chilli

fruit, which is the edible part of the plant.. However, the uptake of cadmium and lead from those sources remained higher in plant parts. Application of organic matter in conjunction with a heavy dose of heavy metals to soil resulted in a significantly higher uptake of cadmium and lead in all plant parts. Application of partially acidulated rock sources to soils, though could cause enhanced uptake of heavy metals, could not show higher residual effects of heavy metals in post-harvest soil samples.

13.2.2 Vanisri, K. 2004. Assessment of selective retention sites of cadmium and lead in tomoto (*Lycopersicon esculentum* Mill.)

A study was conducted to identify the selective retention sites of cadmium and lead in tomato plants, to quantify the selectivity retained heavy metals in tomato at different levels of their application and to observe if the applied doses of cadmium and lead affect the normal growth and production in tomato including the possible manifestation of toxicity symptoms. A pot culture experiment was conducted after providing pre-calculated quantities of metals in pot, 42 days old and uniformly grown tomato plants of variety Sakthi were transplanted. Biometric observations on the plants due to the impact of the metals were recorded. At the harvest, the plants were uprooted and each portion was kept for analysis. Post harvest soil samples were also collected for analysis. An increase in metal load permitted enhanced potassium availability in soil while the same status had an opposite effect with respect to the available P and N. Much before an apparent growth or yield reduction was noted in tomato with cadmium application, the tomato plants readily exhibited certain characteristic symptoms, which could be associated with the metal toxicity on that plant. Preliminary indications appeared on leaves with such leaves picking up yellowing and inter-venial chlorosis depending upon the metal load. At high concentrations of the metal, invariable splitting up of the stem at the collar region leading to complete death of such plants has been noted. As the concentration of the cadmium load increased beyond 1.5 mg kg^{-1} soil, the tomato plants failed to fruit. The successful survival and fruiting of the plants was noted at lower levels of cadmium (0.5 and 1.0 mg kg^{-1}).

Lower doses of addition of Cd had exhibited vegetative influence on growth and development in tomato with the manifestation of significant reduction in the number of branches, leaf length, leaf number, plant height, production of trusses and subsequent reduction in yield. At all the levels of cadmium application, there was sufficient retention of the metal in the plant whether it is root, shoot or fruits. Higher doses of lead rendered some fruits, if not all with certain malformations. This together with the total absence of any phyto-toxicity testifies that the tomato plants are able to tolerate high concentrations of lead inside them. Lead application in soil, irrespective of its levels, permitted maximum accumulation of the metal in fruits followed by shoots and roots. All accumulations noted in the plant were observed to be significant, projecting serious concern for the silent inclusion of lead in the economically important part of the plant.

CONCLUDED PROJECTS

1. Coconut Root (wilt) Disease Project (1981-85)

To study the coconut root (wilt), five experiments were conducted at the Regional Agricultural Research Station, Kumarakom and College of Horticulture, Vellanikkara. A field experiment was conducted to study the effect of micronutrients on the disease intensity of the root (wilt) affected palms. The micronutrients (Fe, Mn, Cu, Zn, B, Mo) were applied through soil and leaf. The yield intensity of the disease, uptake of nutrients by plants and soil characteristics were closely monitored. The application of the micronutrients for the five years could not reduce the intensity of the disease.

The effect of application of boron on the incidence and control of leaf rot disease on root (wilt) affected the palms was investigated. The application of boron in different forms had no influence either on the incidence or the control of leaf rot disease on root (wilt) affected palms.

Biochemical characterization of root (wilt) disease was attempted. The possibility of detecting the disease incidence by the spectrophotometric readings of the plant extract was ruled out.

A large number of chemical agents comprising hormones, reducing agents, chelates, oxidizing agents and phenols were screened to find out their effect on the control of the disease. None of the chemical agents screened was effective in reducing the intensity of the disease.

The X-ray fluorescence spectra of the leaf and root samples of the root(wilt) affected palms were studied in order to find out the possible role of different elements including heavy metals on the incidence of the root (wilt) disease. No regular pattern of accumulation of any element was observed in relation to the intensity of the disease.

2. Project on Promotion of Agri-Electronics (1987-1992)

Department of Electronics, Government of India and ICAR sponsored this project. The objectives of the project were to create awareness, appreciation and establishment of credibility among farmers through demonstration of Agri-electronic instruments and equipment in comparison with conventional methods, to convince the farmers about the utility of electronic devices and instruments in agricultural production, processing and storage, to make available to the farming community economical and field usable electronic gadgets and equipment and to organize prompt, efficient and well spread servicing and training support in agri- electronics. The project work had been put into operation in three Blocks namely Puzhakkal in Thrissur district, Alathur and Thrithala in Palakkad district. Some of the salient findings of this project were:

- The farmers were fully convinced the use of Agricultural Electronics Equipments (AEEs) in agricultural operations.

- AEEs are more convincing to farmers compared to the conventional methods because AEEs are operated in the presence of farmers and they get participatory feeling in the adaptation of new technology.
- It is seen that a vast majority of the farmers are quite new to the use of AEEs. They stated that they tested their farm soil for the first time. Project on the promotion of Agricultural Electronic Equipments (PPAE) in that way did marvelous job in conscientising the different farmer groups especially the marginal ones.
- One of the notable achievements of PPAE service is the enhanced use of lime in paddy fields. Farmers were conscientised and are in tune with PPAE recommendation.
- PPAE recommendations on chemical fertilizers helped the farmers to substitute cost effective ones and by that to save on expenditure on chemical fertilizers.
- The weaker sections in the farming community in general got the advantage of 'yield effect' and 'price effect' that is reflected in the increased returns to them after PPAE service.
- The farmers in Puzhakkal block saved on the expenditure made on fertilizers after PPAE service by about 1.09 per cent.
- One of the area in which PPAE service is widely appreciated is testing the quality of milk supplied to Dairy co-operatives. For instance, a dairy farmer could get an additional income of Rs.61/- during the month following PPAE service solely due to price fixation based on PAPE milk testing.
- Above all, the farmers especially the small cultivators felt that the use of AEEs in agricultural operations can be explained only if there exists other supportive measures to make agriculture a viable proposition.

3. Collaborative Research project on the evaluation of slow release fertilizers for important crops in Kerala (1995-1999).

This project was sponsored by DSIR, New Delhi – Executing Agency-FACT, Udyogamandal, Cochin. The main objectives were to evaluate the efficiency of slow release fertilizers developed by the FACT, to modify the release pattern of nutrients from slow release fertilizers depending on the crop and soil requirements and to evolve suitable agronomic or soil management practices for the efficient use of slow release fertilizers. In order to fulfill the objectives of the project, six crops of paddy and three crops of banana were raised under different location, together with three years of observation on coconut seedlings in the farmer's field at Alpara. The different formulations were applied as per the technical programme and the results were concluded.

RICE

Slow release fertilizer formulations could not ensure sustained yield in paddy under acidic and waterlogged conditions. The low content of clay, poor CEC, poor base saturation and acidic pH of the soil might have contributed much for the observed inconsistency in yield from different locations. The

application of the spike form of fertilizer formulation was difficult. Yellowing of paddy was noticed invariably in all fields immediately after placement of spike form of fertilizers. However, in the application of mixtures this problem of yellowing was not noticed. The yields obtained from the different slow release formulations were comparable with the package of practices of the University. There are considerable savings in the labour cost on account of straight fertilizers. This will offset the cost of cultivation to great extent. Treatments 4 and 5, which were mixtures, observed to be best comparable with other treatments, provided maximum yield. Handling and application of mixtures will be easier than that of straight fertilizers. These factors must tip in favour of mixtures while popularization of slow release fertilizers for rice.

BANANA

Three crops of banana were raised at three locations to test the different formulations. From all the experiments, it was clear that wherever urea formaldehyde component has been incorporated into the formulation, the yield were higher indicating the positive influence of this chemical in enhancing the yield. Package of practices of the University was observed to be on par with most of the treatments. However, the slow release fertilizer formulations for banana has innate advantages over the normal package of practice, where six-split applications of fertilizers were necessitated. This points out to an important fact that application of slow release fertilizer will definitely decrease the cost of cultivation of banana without compromising on the yield. Application of the tablets and mixtures had not posed any problems on growth of banana. The treatment 5 (mixture) had given the highest yield. As long as the efficiency of some slow release formulations remains on par, their market cost will decide the popularity among farmers.

COCONUT

Uniformly coconut seedlings were selected and planted at the farmer's field at Alpara in order to evaluate the efficiency of different fertilizer formulations. The influence of fertilizers was not apparently evident during the first year, as growth remained uniform in all plants. But towards the end of the second year, the specific influence of treatment 1 (Spike) and 5 (mixture) were pronounced on seedlings. Though these treatments had different composition of urea formaldehyde, its influence on the biometric observation was not significantly apparent. During the third year growth, the influence of treatment 1 over the rest, were much pronounced and this treatment was adjudged as the best one. The influence of Package of practice of the University was observed to be inferior to treatment 1 in the third year though the difference remained only marginal. The advantage of one time application of slow release fertilizers is likely to tip the farmers over the normal conventional straight fertilizers which necessitates split application to ensure fertilizer efficiency.

4. Collaborative Research Project on Adaptive Research for Evolving Recommendations for major Groups of Soils in Kerala (1993-1995)

The Soil Survey Wing of the Department Agriculture and the Kerala Agricultural University implemented this project as a collaborative programme. The objectives of the study were to test the validity of present soil testing methods and recommendation system under up land conditions, to study the effect of gravel conduct and CEC in crop productivity and to suggest a suitable method for its inclusion in soil testing programme, to study the effect of FYM in the presence and absence of chemical fertilizers, to develop a suitable location specific and crop specific fertilizer recommendation system considering physical and chemical parameters of the soil and to test the relevance of surface sampling (0-15 cm) for a crop whose effective root-zone depth goes to 60 cm or deeper. Six series were selected viz., Thiruvanathapuram Trivandrum district), Varkala (Kollam district), Adoor (Alappuzha district), Manathala (Thrissur district), Nenmanda (Kozhikode district) and Pilathara (Kannur district). In all the six series selected three sites having coconut palms of uniform age (15-20 years), variety and yield potential. There were eight treatments which included farmer's practice (FYM 25 kg, lime 1 kg and 0.5 kg $MgSO_4$ per palm per year as control), Fertilizer as per the package of practices, fertilizer as per soil test values of the surface soil (0-15), entire root zone (0-60), modified by gravel factor and CEC factor along with control treatment.

The result indicated that the gravel content of the field soil samples of the six soil series studied showed wide variation ranging from 0 to 73 per cent by weight. This indicated that there would be much variation in their physical properties. The CEC, which is the primary chemical property of any soil, also showed wide variation ranging from 0.4 to 5.9 cmol kg^{-1}. The chemical characteristics are more related to the finer fraction of the soil while physical characteristics are dependent largely on the coarser fractions of the soil. The present system of expressing the nutrient content in weight per weight basis, without considering the gravel content and also the coarser fractions within the 2 mm sieved soil, may not have much relevance in actual field conditions.

The effect of added nutrients is dependent upon the initial or reference organic content which is to be estimated in areas where soil is minimum disturbed such as outside root zone or inter- space. Out of the total 18 plots in six soil series, the yield had increased in 12 plots where treatments were applied based on soil test values of 0-60 cm depth, than 0-15 cm. This showed that for giving fertilizer recommendation for coconut soil samples are to collected up to a depth of 60 cm from surface.

5. Variability in iron and zinc availability in laterite and lateritic soils of central Kerala with reference to rice nutrition. (ICAR A-hoc Project, 1996-1999)

Soils were collected and characterised for iron and zinc availability. Most of the collected lateritic soils were found to have enormous quantities of

available iron to the tune of toxic levels to plants. Pot culture experiments were carried out to screen rice varieties for iron toxicity. It was found that tall indica varieties like PTB – 1 were tolerant while dwarf varieties like Annapoorna were susceptible. The susceptible varieties were found to produce roots excessively to replace the decay of roots due to iron deposition. Application of zinc was found to have no response in iron toxic environment even under zinc deficient soils. The studies using radioisotopes of zinc and iron showed that high levels of iron reduced zinc absorption by rice plants. On the other hand, zinc has antagonistic effect on iron absorption only at lower concentrations of iron.

Field experiments to manage iron toxicity by use of different amendments revealed that application of *Pongamia* leaves showed yield enhancement. Lime, *Pongamia,* heavy dose of potash and silicates have positive effects in reducing the iron and manganese content of rice plants and are found to increase the nutrient use efficiency. However, the optimum combinations of these treatments and their different levels and frequency of application and the chemistry behind their positive interactions are some of the concerns for future line of work.

6. Utilization of indigenous phosphate Rock modified with chemical and biological amendments (ICAR ad-hoc research project, 1998 – 2001)

The main objectives of the project were to evaluate the performance of the products obtained from mixing the rock phosphate under test with compost, partially acidulated rock phosphates and rock phosphates with iron pyrite and to screen the most promising fertilizer products through incubation studies, pot culture and field experiments. The fertilizer products were thoroughly screened to assess the release of P, uptake by the crop, and economic yield parameters. There was no substantial reduction in yield in residual crop of rice even without the application of P fertilizers. P response was also found to be higher for residual crop and thereby the suggesting the possibility of application of phosphate rocks modified with either chemical or biological amendments for the rice – rice cropping system. The residual effect of phosphate rocks is very much improved by the use of either biological or chemical amendments. With the incorporation of amended rock phosphates with slow and steady release of P, the level of fertilizer can be reduced to 5 per cent of the optimum. A study on apparent P recovery again emphasis the skipping of phosphatic fertilizers for one or two seasons in the waterlogged rice soils of lateritic origin.

The use of composting with coir pith can be widely popularized as an efficient technique to harness the natural resources for fertilizer use. This being the farmer contributed and researcher refined technique possess wide adaptability and technical suitability for the acid growing tracts of the state.

7. DST project on 'Biochemical investigations of enriched coir pith compost materials' (2003-2005)

A protocol was developed for the composting and enrichment of coir pith using organic amendments, including water hyacinth. The enriched coir pith compost was proved as promising organic manure from the various pot trials on tomato and amaranthus. Field trials on banana signaled the possibility of using the compost material along with the recommended inorganic fertilizers. Biochemical investigations on the raw as well as composted coir pith revealed the degradability of coir pith and conversion of the same into good quality organic manure through suitable enrichment. The results revealed through the experiments helped to modify the present practice of aerobic composting in to a more rapid and farmer friendly technique. Repeated application of the enriched coir pith compost improved the soil fertility. All these results were very well communicated among the local farmers. Established coir pith compost units where unemployed youth and women were engaged for entrepreneurship development.

8. NATP-CGP – "Decision Support System for Integrated Agricultural Resource Management at Micro-level: Pilot Study and Capacity Building"

The project aimed at developing an Integrated Agricultural Resources Information System (In-ARIS) at cadastral level, for *Madakkathara Gramma Panchayat* in Thrissur district of Kerala. The scope of the project is to enable the planners and decision-makers to better visualise existing natural, social and infrastructural situations in the Panchayat, while designing projects for resource management and development or for infrastructural development.

The project formally started on 15 January 2003. Necessary equipment and research materials were acquired. Primary resource materials like cadastral maps from concerned revenue village offices, reports, toposheets, etc of the Panchayat were collected from various sources. Thematic maps of the study area prepared by the State Land Use Board were also used. Base map for the Panchayat was traced from the cadastral maps. The same was scanned at the GIS section of IT department of the Govt. of Kerala. The base map was digitised, using R2V software acquired for the project from C-DAC, Pune. A Satellite imagery of the area (PAN + LISS3 merged data) was bought from the NRSA, Hyderabad. The imagery was interpreted for deriving predominant land use of the area.

Socio-economic and other attribute data for the Panchayat was collected, using a separate proforma. In addition, the Deputy Collector (Elections) contributed current voter's list in digitised form. Census 2001 data for the panchayat was also utilised. Participatory Rural Appraisal (PRA) of the Panchayat was organised at the Panchayat office, with the involvement of the Dept of Extension and students of College of Horticulture. About 100 villagers

(mostly farmers and farm workers) including 72 women participated in the effort.

The maps were geo-referenced in a GIS environment and presented before the Panchayat functionaries for necessary wetting. The prepared database was map-linked and integrated into a GIS for designing the Integrated Agricultural Resources Information System (In-ARIS) for the Panchayat. The information system thus developed is now ready for use at Panchayat level. But awareness on the use of such a system for decision-making has to be brought about through necessary campaigns and trainings, for effective utilisation of such tools.

ONGOING PROJECT

DBT project on "Vermitechnology for organic seed production and rural employment generation" (2004-2007)

Promising methodologies developed is commercially exploited for providing employment opportunities for rural women. Small scale Agro Industrial Units were set up at three places, via. Elanjikulam (Ollukkara panchayath) and Kattilapoovam (Madakkathara panchayath) apart from a mother unit at Agricultural University campus, Vellanikkara. The units are engaged in the production of quality products like Vermicompost and vermiwash. The mother unit also imparted practical orientation for trainees on various aspects of vermitechnology, which eventually lead to the production and sale of earthworms, vermicompost, and vermiwash units.

After the initial hiccups of one year, the units turned out to be a self-sustaining one. The units are also maintaining demonstration plots on organic farming in vegetables and Azolla. Facilities such as portable vermiwash units in plastic as well as earthern pots, biogas unit and mushroom culture are acting as complimentary rewarding components as well. At present there are 14 women beneficiaries in 3 vermicompost units with one anchor farmer for each unit. By the production and sale of compost, vermiwash and earthworms, they are earning about Rs. 3000/- per month individually. The skill imparting training was given to trainees to equip them to earn satisfactorily and to enthuse others for helping themselves. The second target population namely farming community of the locality is benefited from the decentralized system of quality vegetable seed production along with door step delivery of organic inputs at reasonable price including quality manure and compost effectively transferred on a sustained way in the target area.

TRAININGS/ SEMINARS/ENDOWMENT LECTURES / WINTER SCHOOL ORGANIZED

1. Special training course in soil testing to High School (Science) teachers (20-4-1981 to 30.41981)
2. Introductory training on soil testing to the Scientific Assistants of the Department of Agriculture, Kerala (19-11-1992 to 21-11-1992)
3. A short term training in Soil Science and Agricultural Chemistry to the Scientists of the Rubber research Institute of India, Kottayam (28-6-1993 to 15-10-1993)
4. Training on soil testing for the Agricultural Officers/Assistant Directors of the Department of Agriculture, Kerala (27-11-1995 to 1-12-1995)
5. Thrissur Chapter of Indian Society of Soil Science conducted Dr. B.V.Mehta Memorial Lecture on "New approaches in waste land development and watershed management" by Dr. K.M. Ramanthan on 25th March 2000
6. DAE-BRNS Workshop on ' The Impact of Applications of Radiation on Food and Agriculture ', organised by BARC Mumbai and Kerala Agricultural University during 27-28, December, 2001
7. One day seminar on Consultation on Natural Resources of Kerala (6th September, 2004)
8. Training on vermicompost technology, organic farming and business management for farm women (16-8-2004 to 15-9-2004, 13-10-2005 to 11-11-2005 and 17-7-2006 to 16-8-2006)
9. Thrissur Chapter of Indian Society of Soil Science conducted Dr. Matiramani Endowment Lecture on "Organic Farming for Sustainability" by Dr. K.M. Ramanthan on 13th December 2006
10. ICAR sponsored Winter School on "GIS based watershed planning in agriculture" (2-12-2006 to 22-12-2006)

Associated Centres

1. AICRP on Soil Test Crop Response Studies (STCR)

The STCR center, College of Horticulture, Vellanikkara was sanctioned in November 1996 had been conducting experiments in diversified crops for the last 9 years. List of crops included food crop like rice, bulky fruit crop like banana, vegetables like ash gourd, amaranth, bitter gourd, snake gourd, bhindi, brinjal, root crops like coleus, sweet potato, cassava and spices like ginger and turmeric and oil seed crop like groundnut.

In the case of rice, the equations developed by the Hyderabad centre for the black soils were test verified and found to be fitting well with good yield response when test verified in the black soils of Chittur area of Palakkad district. Among root crops, sweet potato recorded a heavy yield of 46t/ha as compared to the yield obtained by the farmers. Amaranth also showed a good yield of 65t/ha. STCR equations had been developed for banana (nendran),

ginger turmeric, rice (Khariff and Rabi) sweet potato, ash gourd, coleus, groundnut, cucumber bitter gourd and amaranth.

Experiments conducted in farmers' filed for banana, cassava and ginger in different locations got very good results by the STCR technology developed. Front Line Demonstration trials (FLD) on banana were also successful and STCR technology proved to be superior to other treatments. Now an experiment on brinjal based on the new design proposed by IASRI is going on. . The field verification trials of turmeric and ginger and FLD on cassava and a complex experiment on chilli are being planed for the year 2007-08. After the completion of the test verification and Front Line Demonstration trials, it will be able to disseminate the knowledge obtained through STCR experiments to the farming community through the Department of Agriculture.

2. ATIC - ABARD SAIU on Vermi-composting

The Agricultural Technology Information Centre (ATIC) of Kerala Agricultural University is a single window support system for prescribing a package of services such as technology, products, diagnostic assistance and information in agriculture and allied branches of science to community. The unit, which is attached to this Department aims at providing employment generation for unemployed youth. At present the unit offers employment to 8 youths from the unemployed sector. These persons are now well trained in the various aspect of composting and their competency in this field is attracting lot of attention both from the academic and farming communities.

3. Radiotracer Laboratory

The Radiotracer Laboratory at Kerala Agricultural University was established in the year 1982. Over the past years this laboratory has served as a central facility for research, employing radioisotopes and radiations for the faculty and students from different institutions of the university. The laboratory is also equipped except for the facility for analysis of stable isotope of nitrogen, N.

4. Soil Plant Diagnostic Laboratory (SPDL)

Analysis of the manure samples provided by Commercial Firms on payment basis under revolving fund scheme is functioning in this department.

5. Thrissur Chapter of the Indian Society of Soil Science

The started in 1997 in this Department and at present there are 30 members. The major activities of the chapter are being operated from this division. The activities of the Chapter, apart from helping the Society has been to initiate the genuine interest in the field of Soil Science, especially to those students with an innate inclination towards this subject.

AWARDS/ SHOLARSHIPS

A. Awards

1. **Gold medal from Udaipur University,** Rajsthan for obtaining 1st Rank in M. Sc. (Ag.) Soil Science in 1974 (Winner: Dr. K.C.Marykutty)
2. **Dr. C.S. Venketa Ram Memorial Award** for the best research paper published in the journal of Indian Society for Plantation crops (Twice) in 1988-90 and 2002-2004

   Authors: a) Jayasree Sankar, Wahid and Kamalam (1988-90)
   b) Betty Bastin and Wahid P.A (2002-2004)
3. **Dr. S. P. Raychaudhuri Gold Medal for the best Ph.D. thesis** from India Society of Soil Science. (Winner: Dr.P.Sureshkumar)
4. **Young Scientist Award of the Kerala Science congress**
   i. The paper entitled "An innovative soil test method-validation based on a case study with reference to zinc status in soils" VII Kerala Science Congress, 1995, Palakkad, 132-136 (Author: Dr. P. Sureshkumar)
   ii. The paper entitled "Enriched compost from Oushadhi waste" for the year 2004 (Authors: Preetha, D, Sushama, P.K. and K.C.Marykutty)
5. **H.S. Mehta memorial National Award** in 2003 for the best paper in 9th National Seminar on new perspectives in spices, medicinal and aromatic plants, Indian Soc. For spices, ICAR Research complex, Goa. (Winner: Dr. P.Sureshkumar)
6. **ISSS Zonal Award** - South zone, for 2004 for best M. Sc. (Ag) thesis entitled "Availability indices for stressed nutrients for coconut in an Ultisol" (Winner: Ms. Priya, P.)

B. Scholorships for M. Sc. (Ag.)

Senior research fellowships	: 1
Junior research fellowships	: 32
Placements (ICAR)	: 12

SALIENT FEATURES

Basic soil studies

- A new chemical method was evolved for the evaluation of Available Phosphorus and Potassium in soil employing a common extractant which simplified the soil testing procedure
- Significance of cationic ratio K/ $(Ca + Mg + Fe + Mn)^{1/2} + (Al)^{1/3}$ based on ratio law in fertility evaluation was established
- Soil fertility classes and maps for the main campus of KAU, RARS Pattambi and BRS, Kannara have been prepared
- Soil resource inventory of the KAU Main Campus, has been successfully attempted

- Exchangeable aluminium has been standardized as an index of the laterite soils of Kerala
- Iron toxicity in rice in laterite soils could be reduced by lime application at a rate of 600 kg ha^{-1} along with P and K at 35 and 105 kg ha^{-1} respectively.

Fertility management

- Availability indices for stressed nutrients for coconut (*Cocos nucifera* L.) in Ultisol have been assessed
- In the acidic soil of Kerala, iron (Fe-P) followed by aluminum phosphate (Al-P) and calcium phosphate (Ca-P) are the major fractions formed from Maton rock phosphate
- Tunisia (Gafsa) rock phosphate has been found to be a good substitute of SSP for direct application in acid soils of Kerala.
- Performance of slow release fertilizers for rice was found to be poor in acidic wetlands as compared to garden lands.
- Developed fertilizer prescription equations for various yield targets of the crops - Banana (Nendran), ginger, turmeric, rice (Khahrif & Rabi), sweet potato, ash gourd, coleus and ground nut

Organic farming

- Composting time and C: N ratio of Oushadhi waste have been considerably reduced with the introduction of earth worms sp. *Eisenia foeitda*
- Aerobic composting of Oushadhi waste was effectively achieved by mixing the compost with cowdung, poultry manure neem cake at 10 % of the waste materials
- Combined addition of *Pleurotus sajor- caju* and mineral nitrogen in the form of urea was observed to enhance the mineralization of lignin rich coir pith
- Addition of coirpith application was reported to enhance the moisture retention capacity of coastal sandy soils, laterite soils and red soils of Kerala
- Vermiwash, the aqueous extract of the bioactive column, contain interactive bio agents and nutrients of substrate material.
- Organically produced cardamom registered better size colour, oleoresin and volatile oil content when compared to conventionally produced crop.

Foliar diagnosis

- Methods of foliar diagnosis in pepper, ginger, turmeric and coconut were standardized in relation to major plant nutrients

Pesticide residue studies

- While assessing the carbofuran residues in banana, application of recommended dose at planting and later on 2nd and 5th month after planting indicated that the fruit was totally free from residual carbofuran

- Studies on the fate of carbofuran applied to the soil basin of the black pepper revealed that the half life of the chemical in soil ranged from 20 to 46 days. The chemical is readily translocated to leaves, berries and rachis.
- 2-4-D residue studies in rice revealed that the present POP recommendation for weed control has not created any adverse effect in soil or crop produce

Heavy metal

- Selective retention of heavy metals especially cadmium and lead in chillies have been had identified and quantified and found that chilli fruits are relatively free from heavy metal contamination while roots retained lead and shoots retained cadmium.
- Studies on the effect of cadmium in tomato indicated that it had a negetative effect on growth and development while there was no such effect for lead

Radiotracer studies

- Chemistry and dynamics of iron and sulphur under submerged condition was traced using Fe-59 and S-32 respectively
- Net Ionic Equilibrium (NIE) was defined and established as an index of soil fertility and nutrient status in plants. The significance of this NIE in yield limiting parameters in coconut was established.
- Foliar absorption of ^{14}C labelled urea by vanilla and nitrogen absorption as urea molecule by rice was traced out using labelled fertilizers.

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