

**ORGANIC CARBON, NUTRIENT STATUS AND PHYSICAL  
PROPERTIES AS INFLUENCED BY VARYING EXISTING  
AGRICULTURAL LAND USE AND MANAGEMENT OF SOILS IN  
NAVSARI CAMPUS**

**A**

**THESIS  
SUBMITTED TO THE  
NAVSARI AGRICULTURAL UNIVERSITY  
NAVSARI  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS  
FOR  
THE AWARD OF THE DEGREE**

**OF**

**MASTER OF SCIENCE  
(AGRICULTURE)**

**IN**

**SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**

**BY**

**Md. ZUBER ANSARI Md. GOUSE ANSARI  
B.Sc. (Agri.)**

**DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL  
CHEMISTRY  
N. M. COLLEGE OF AGRICULTURE  
NAVSARI AGRICULTURAL UNIVERSITY**

**GUJARAT STATE**

**MAY- 2010**

**Registration No. 04-00307-2007**



# *ABSTRACT*



**ORGANIC CARBON, NUTRIENT STATUS AND PHYSICAL  
PROPERTIES AS INFLUENCED BY VARYING EXISTING  
AGRICULTURAL LAND USE AND MANAGEMENT OF SOILS IN  
NAVSARI CAMPUS**

---

**Name of Student**

**Mr. Md. Zuber Ansari**

**Major Advisor**

**Dr. A. Das**

---

**Department of Soil Science and Agricultural Chemistry**

**N. M. College of Agriculture**

**Navsari Agricultural University**

**Navsari – 396 450**

**ABSTRACT**

Soils with same characters and physiography and under the same agro-climatic condition, when put to varying agricultural land use *i.e.*, under different trees species/plantation, field crops, horticultural crops *etc.* along with varying management practices, there would be continuous addition of varying quantum of organic materials in soil, in the form of litter, twigs, stem, flowers, fruits and roots *etc.* which on *decomposition or mineralization* and subsequent plant uptake would ultimately exhibit varying status of soil organic carbon, nutrients status, soil physical and physico-chemical properties, especially in surface soil. Keeping the above points in view an investigation was carried out with objectives to study organic carbon, available nutrients and physical properties in soils of Navsari Agricultural University, campus as influenced by varying existing agricultural land use and management. Ten different land use systems namely 1) Oil palm plantation 2) Sapota plantation 3) Mango plantation 4) Sugarcane crop 5) Rice crop 6) Pulses and oilseed crops 7) Banana plantation 8) Vegetable crops 9) Floriculture

crops and 10) Barren land were identified in the NAU campus and taken under study. Hundred surface soil samples, of which ten from each land use systems were collected and subjected to laboratory analysis for organic carbon, available major (N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O), secondary (S) and micro nutrients (Zn, Fe, Mn and Cu) as well as physical properties [bulk density and water stable aggregates (WSA) of size > 0.5 mm] of the soils. The correlation coefficients of organic carbon with other soil parameters were worked out for all categories of land uses.

The results revealed that organic carbon under different land uses varied from 2.4 to 9.7 g kg<sup>-1</sup> and showed the following descending order: Oil palm > mango > sapota > sugarcane > pulses & oil seeds > banana > rice > vegetables > floriculture > barren land. "Tree/plantation land use group (oil palm, sapota, mango)" showed higher soil organic carbon as compared to those under "Agricultural land use group (sugarcane, rice, pulses & oilseed)", "Horticultural land use group (banana, floriculture, vegetables)" and "Barren land". Soil EC<sub>2.5</sub> under different land use systems varied from 0.27 to 0.52 dS m<sup>-1</sup> and was below problematic limit. Soil pH<sub>2.5</sub> under different land use systems varied from 5.82 to 8.00 with no appreciable difference amongst land uses, except for rice which showed acidic (pH. 5.82) soil reaction. Sapota soil was moderately alkaline and others were more or less, normal in soil reaction.

Pulses and oil seeds land use system recorded higher available soil nitrogen (494 kg ha<sup>-1</sup>) as compared to other land use systems of which three medium, two marginally medium, one low to marginally medium, one highly medium and three were showed low status of available nitrogen, and followed descending order as: Pulses and oil seeds > oil palm > mango > sapota > sugarcane > banana > rice > floriculture > barren > vegetables. Available soil phosphorus varying

widely from 33.29 to 60.30 kg ha<sup>-1</sup> exhibited medium to high status under varying land use systems, which maintained the following order: Sugarcane > oil palm > mango > sapota > pulses and oilseeds > vegetables > banana > floriculture > rice > barren. Soil potassium in different land use systems varying from 143.2 to 421.3 kg K<sub>2</sub>O ha<sup>-1</sup> depicted marginally medium to high status. Except rice soil which showed 143.2 K<sub>2</sub>O kg ha<sup>-1</sup>, all other land use systems showed high available potassium status. Available sulphur varying from 15.03 to 23.25 mg kg<sup>-1</sup> showed medium to high status in varying land uses which showed the following order : Banana > sapota > pulses and oil seeds > mango > oil palm > barren > rice > vegetables > sugarcane > floriculture.

Available zinc ranged widely from 0.21 to 0.63 mg kg<sup>-1</sup> showing deficient status in most soils, except rice and oil palm soil. Available iron ranged from 4.19 to 20.48 mg kg<sup>-1</sup>, exhibiting its low to high available status with the highest and the lowest value being associated with rice soil and vegetable soil respectively. Available manganese showed wide variation in available status (low to high) having range from 4.95 to 19.24 mg kg<sup>-1</sup>, with the highest and the lowest value being associated with rice and sapota soil respectively. The mean available copper under varying land use systems varied from 0.11 to 0.28 mg kg<sup>-1</sup> indicating deficient to marginal status. Oil palm, sapota, mango, sugarcane and rice land use systems, exhibited marginal level of copper, while in rest of the systems the same were deficient.

Bulk density of soils under different land uses varied from 1.45 to 1.83 Mg m<sup>-3</sup> and was of following descending order with respect to land uses: Barren > floriculture > vegetable > rice > banana > pulses and oilseed > sugarcane > oil palm > sapota > mango. Water stable aggregates of size > 0.5mm (macro aggregates) varied from 24.19 to

66.53 per cent, the highest and the lowest values being associated with sapota and rice land use system respectively. Land uses with respect to water stable macro aggregates were: Sapota > mango > oil palm > pulses and oilseeds > sugarcane > banana > vegetables > floriculture > barren > rice.

Amongst different correlations between organic carbon and other soil parameters, some important and significant or highly significant correlations of organic carbon were observed with bulk density, available nitrogen, sulphur and water stable aggregates.


The overall results suggested that no land should be kept barren and efforts should be made for improving soil organic carbon in the systems having low status. For soils having low to marginally medium status of available nitrogen, phosphorus and potassium, proper care should be taken for their management. Corrective measures inclusive of organic manure application should be adopted to avoid Zn, Fe, Mn and Cu deficiency in the soil systems having their low/deficient status. Addition of organic manure/ matter is essential to maintain soil bulk density at optimum level and excessive cultivation practices may be avoided to maintain higher per cent of WSA.

**From,**  
**Dr. A. Das**  
Research Scientist (Soil Science),  
Department of Soil Science,  
Navsari Agricultural University,  
Navsari - 396 450.

## **C E R T I F I C A T E**

**This is to certify that the thesis entitled, "Organic carbon, nutrient status and physical properties as influenced by varying existing agricultural land use and management of soils in Navsari Campus " submitted by Mr. Md. Zuber Ansari Md. Gouse Ansari in partial fulfillment of the requirements for the award of the degree of MASTER OF SCIENCE (Agriculture) in the subject Soil Science and Agricultural Chemistry of Navsari Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and that the thesis has not been previously formed the basis for the award of any degree, diploma or has been published for other similar title. All the assistance and help received during the course of the investigation have been duly acknowledged by him.**

**Place: Navsari**  
**Date : 3<sup>rd</sup> May 2010**

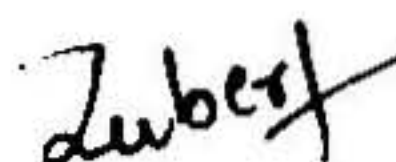
  
**(A. Das)**  
**Major Advisor**

## DECLARATION

This is to declare that the whole of the research work reported here in the thesis for the partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in Soil Science and Agricultural Chemistry by the undersigned is the result of investigation done by him under direct guidance and supervision of **Dr. A. Das**, Research Scientist (Soil Science), Department of Soil Science, Navsari Agricultural University, Navsari, and no part of the work has been submitted for any other degree so far.

**Place:** Navsari

**Date :** 3<sup>rd</sup> May 2010



**(Md .Zuber Ansari)**

**Countersigned by**



**(A. Das)**

**Research Scientist (Soil Science)  
Department of Soil Science  
Navsari Agricultural University  
Navsari -396 450**

## ACKNOWLEDGMENT

*It was very easy to measure the growth and development of a plant and to depict them with some charts and graphs. Since the plant wouldn't agitate far any lapse on my part but it is far more difficult as more number of memories rush through my minds which are full of gratitude to those who encourage me throughout the course of my M. Sc. studies in commensurate language.*

*To begin with, it was Dr. A. Das, Research Scientist, Soil Science, Department of Soil Science, Navsari Agricultural University, Navsari as Major Advisor for his help and kind co-operation in planning out this investigation. His valuable and versatile advise, constant inspiration and encouragement, valuable suggestions, helpful and constructive criticism, unending readiness and his nice scholastic behavior help in solving the intricate problems throughout the course of present investigation and in the preparation of this manuscript. No words are adequate to express my thanks to him.*

*During the course of this study, for their counsel generous guidance and useful suggestion, special thanks are rendered to the members of advisory committee, Dr. M. K. Arvadia, Head and professor, Department of Agronomy, Dr. A.M. Bafna, Head and professor, Department of Soil Science and Agricultural chemistry and Dr .R .K. Parikh, I/C Professor, Department of Agricultural Statistics, NAVU, Navsari. My special thanks to Dr. R.M. Desai for providing the scientific atmosphere and all the great discussion on science and life, encouragement and help during the soil analysis and giving valuable time for critically examining the manuscript and co-operation throughout the study. His enthusiastic attitude towards science in general has been a motivation for me during my time at Navsari.*

*I am grateful to the Honorable Vice Chancellor Dr. A.R. Pathak and the Registrar Dr. P. S. Vashi , the Director of Research and Dean, P. G. Dr. H.C. Pathak as well as Principal Dr. C. L. Patel, N. M. College of Agriculture, Navsari Agricultural University, Navsari for giving me an opportunity to undergo higher studies leading to M.Sc. (Agri.) degree.*

*I asseverated my deep sense of gratitude to Dr. K. G. Patel, , Dr. R. G. Patil, Dr. Z.N. Patel, Dr. Sonal Tripathi, Shri Jayeshbhai Patel, Shri R.B. Patel, Dr .Dhirajbhai Patel, Prof. M.C. Patel, Dr. G.G. Patel, Dr. M. N. Gami for assisting their altruistic help during my course work and investigation and whole staff of Soil Science and Agricultural Chemistry and Soil and Water Management Research Unit, N.M. College of Agriculture, N.A.U, Navsari providing guidance and necessary help to me during course work and investigation.*

*I also gratefully acknowledge the most willing help rendered by Dr. J. D. Awadaria and Prof. J.R. Naik for statistical analysis.*

*My special thanks to Shri. M.K. Malek for neat typing, excellent word processing and formatting of this manuscript.*

*I also express my thanks to Shri Natvarbhai, Bhartabhai, Dhansukhbhai Surtibhai, Sarojben, and Ushaben who indirectly helped me during chemical analysis work, I am also thankful to Manish Ahir (SRF), Keyurbhai, Mahidabhai ,Gignaben, Babarbai, , Sunil patel (SRF), Vipulbhai (SRF), Farhan and all other staff of Soil Science Department for their kind co-operation during the course of investigation.*

*I express my sincere thanks to Friend, Philosophers, Guide Sujit, Umesh, Pawade, Ade, Asif, Rajesh, Akram, Omkar, Dr. Arif, Somnath , Rizwan, Ganesh, Sohail and Deepak for their support and encouragement during the period of my P.G. studies.*

*I am sincerely thankful to all batchmates, Harish, Niraj, Gonge, Chetan, Sushil, Pradip, Bagal, Sunil, Bhanu, Lodham, PP, Sumit, Shailesh, Anil, Dheeraj, Ganesh, Vikas, Mali, Pratik their kind help during my work.*

*I acknowledge with special thanks to sweet junior brothers, Nilkhant, Sainath, Krishna ,Natesh, Dinesh, Naveed, Sagar, Zambare, Fauzan, Rajkumar, Mauli, Swami, Rupesh, Sandy, Chaitanya, Jaywant, Mukesh, Girish, Atul, Ajit, Avinash, Mahesh, Ashok, and other friend whose unfailing support has*

greatly helped me in completion of this venture. All might have not been mentioned but, none is forgotten.

My sincere thanks to Govindbhai Chaudhary and Anuben Chaudhary for providing financial support during my course of study.

Words run short to express my indebtedness to my beloved parents Mr. Md. Gouse Ansari and Smt. Raziya Parveen to whom I owe my existence and above all my genetic blue print, who always wanted my success, nourished and inspired me with their love and affections and my brothers Junied, Saber and little Taffazzul and my bliabhi Mujtaba Anjum also all family members for their unselfish help, constant encouragement, blessing and everlasting love throughout my educational career without which it would have remained a sweet dream for me to receive this higher education and career. I also wish to express my deepest gratitude and respect my grandfather and grandmother and my uncle Mohd. Fasseh for their pray for my success.

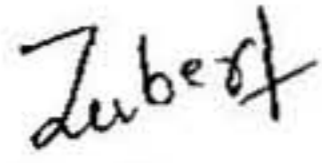
I am also thankful to those who helped me directly or indirectly during the course of my study, whose names, don't appear due to short of space.

I salute the city Navsari.....where I spent most memorable time of life and meet many wonderful people!

Last, but far from the least, I wish to express my deepest gratitude and sole full respect to "Allah" who help me on every path of my life and make every step a great success.

Place : Navsari

Date : 3<sup>rd</sup> May, 2010

  
(Md. Zuber Ansari)

## SYMBOLS AND ABBREVIATIONS USED

---

%	= Per cent
@	= At the rate of
>	= Greater than
AES	= Agro ecological situation
B.D	= Bulk density
cm	= Centimeter (s)
Cu	= Copper
dSm <sup>-1</sup>	= Deci Siemens per meter
DTPA	= Diethylene Triamine Penta Acetic Acid
EC <sub>2.5</sub>	= Electrical conductivity of 1:2.5 soil : water ratio
<i>et al.</i>	= And others
<i>etc.</i>	= et cetera (and so on)
Fe	= Iron
Fig.	= Figure
g kg <sup>-1</sup>	= Gram per kilogram
ha	= Hectare (s)
<i>i.e.</i>	= id est (That is)
K	= Potassium
K <sub>2</sub> O	= Potash
kg ha <sup>-1</sup>	= Kilogram per hectare
LU	= Land Use
m	= Meter (s)
m <sup>2</sup>	= Meter square (s)
mg	= Milligram
mg kg <sup>-1</sup>	= Miligram per Kilogram
Mn	= Manganese
N	= Nitrogen
NAU	= Navsari Agriculture University
O.C	= Organic carbon
P	= Phosphorus

$P_2O_5$  = Phosphoric acid  
 $H_{2.5}$  = pH of 1:2.5 soil : water ratio  
 $r$  = Correlation coefficient  
 $S$  = Sulphur  
*viz.*, = Videlicet (Namely)  
WSA = Water stable aggregates  
 $Zn$  = Zinc

## CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
I	INTRODUCTION	1 - 4
II	REVIEW OF LITERATURE	5 - 20
III	MATERIAL AND METHODS	21 - 34
IV	RESULTS & DISCUSSION	35 - 73
VI	SUMMARY AND CONCLUSIONS	74 - 82
	REFERENCES	i - ix

## LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1	General Physico-chemical properties of soil of Navsari Agricultural University Campus	23
2	Details of existing land use and management practices being followed in soils of NAU Campus	27
3	Methods used for the determination of chemical and physical properties of soil	30
4	The ratings for soil pH (SSSA, 1962)	32
5	The ratings for soil electrical conductivity (Seth, 1967)	32
6	The ratings for soil organic carbon content (Walkley and Black, 1934)	32
7	The ratings for soil available N content (Subbiah and Asija, 1956)	33
8	The ratings for soil available P <sub>2</sub> O <sub>5</sub> content (Olsen <i>et al.</i> 1954)	33
9	The ratings for soil available K <sub>2</sub> O content (Hanway and Heidel, 1952)	33
10	The ratings for soil available S content.	33
11	The ratings for soil available micronutrients (Lindsay and Norvell, 1978)	34
12	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under oil palm land use and management.	36

TABLE NO.	TITLE	PAGE NO.
13	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under sapota land use and management	37
14	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under mango land use and management	38
15	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under sugarcane land use and management	39
16	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under rice land use and management	40
17	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under pulses and oilseed land use and management	41
18	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under banana land use and management	42
19	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under vegetable land use and management	43
20	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under floriculture land use and management	44

TABLE NO.	TITLE	PAGE NO.
21	Status of Organic carbon, pH <sub>2.5</sub> , EC <sub>2.5</sub> and available N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O and S of soils under barren land and management	45
22	Status of available micronutrients and physical properties of soils under oil palm land use and management	53
23	Status of available micronutrients and physical properties of soils under sapota land use and management	54
24	Status of available micronutrients and physical properties of soils under mango land use and management	55
25	Status of available micronutrients and physical properties of soils under sugarcane land use and management	56
26	Status of available micronutrients and physical properties of soils under rice land use and management	57
27	Status of available micronutrients and physical properties of soils under pulses and oilseed land use and management	58
28	Status of available micronutrients and physical properties of soils under banana land use and management.	59

TABLE NO.	TITLE	PAGE NO.
29	Status of available micronutrients and physical properties of soils under vegetable land use and management	60
30	Status of available micronutrients and physical properties of soils under horticulture land use and management	61
31	Status of available micronutrients and physical properties of soils under barren land and management	62
32	Simple Correlation between Organic carbon and other soil parameters of representative soils under different land use systems	68

## LIST OF FIGURES

FIGURE NO.	TITLE	AFTER PAGE NO.
1	Effect of different land use and management on soil Organic carbon	46
2	Effect of different land use and management on soil pH <sub>2.5</sub>	47
3	Effect of different land use and management on soil Electrical conductivity	48
4	Effect of different land use and management on soil available Nitrogen	49
5	Effect of different land use and management on soil available Phosphorus	50
6	Effect of different land use and management on soil available Potassium.	51
7	Effect of different land use and management on soil available Sulphur	51
8	Effect of different land use and management on available Zinc	62
9	Effect of different land use and management on soil available Iron	63
10	Effect of different land use and management on soil available Manganese	64
11	Effect of different land use and management on soil available Cupper	64
12	Effect of different land use and management on soil Bulk Density	65
13	Effect of different land use and management on soil WSA > 0.5 mm	66



# *INTRODUCTION*



## I. INTRODUCTION

In the whole universe, soil is the largest store house of food and minerals for organisms and plants. Soil, to different class or discipline of people means different things. The soil scientists perceive soil as unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors such as climate, vegetation, topography and land use pattern acting over a period of time and producing product soil that differs from the material from which it was derived.

Plant growth under field condition is one of the most complex physical, chemical and biological systems known to man. In the 21<sup>st</sup> century agriculture needs to be practiced under quite different ecological, technical and socio-economic conditions than in the decades before. There is not only increasing competition for the space for food production through an exponential growth of population in urban and sub-urban areas but also severe competition between food production on one side and decrease in land surface for agricultural production at another side. Plant growth on soil depends on many factors viz., soil organic matter, major, secondary and micronutrients in soil and state of soil conditions such as, soil-pH, soil-EC and moisture content etc. The ability of soil to supply nutrients in available form varies with the change in soil properties and status of soil conditions.

Carbon stock, especially soil organic carbon (SOC) is a good indicator of soil productivity potential. It affects physical, chemical and biological properties of the soil and plays a crucial role in sustaining soil quality, agricultural production and environmental quality (Zhang *et al.*, 2003 and Andrews *et al.*, 2004). Amongst different soil order, *Histosols* contain

maximum and *Vertisols* contain minimum carbon. Soil organic carbon is very stable but is very reactive and a large quantity can be lost through changes in agricultural land use particularly from ploughing, erosion, fallowing, deforestation as well as different management practices (Yang *et al.*, 2003). This means that in the future, food production will continue to occur on increasingly reduced areas which will further deteriorate the soil health.

Organic materials and their humic decomposition products have large bearing on the nutrient content of soil. So, in order to maintain soil health and at the same time to increase food production, different land use systems like, agriculture, agro-horti-silvi-pastoral, forestry, livestock based system, natural fallow and shifting cultivation have been recommended for implementation as would help to increase or sustain physical properties and nutrient status of the soil on sustainable basis.

Continuous heavy depletion of nutrients from soil by crop without much replenishment might sooner or later result in exhaustion of reserve of these nutrients to deficiency level and as a result proper monitoring and replenishment of those would be needed to have required nutrients- pool in soil system. So, for getting sustainable higher food production in less area and without deteriorating the soil health, we have to use different land use planning and cropping pattern.

Amongst soil physical properties, water stable aggregate, bulk density and hydraulic conductivity are some major parameters. Soil aggregate stability as a key indicator of soil structure is a product of interaction between soil environment, management practices and land use patterns (Zhang *et al.*, 2008). Soil structure problems in different region of India are associated with texture, topography and rainfall.

There is always an improvement in the organic matter of soil due to tree association of different species. However, when same soils, (with same texture and topography) under the same agro-climatic situation are put to varying agricultural land use *i.e.*, under specific plant or tree species, field crops (cereals, oilseed, pulses, vegetable and flower vegetation cover, fallow or barren *etc.*) and varying management practices (like, tillage operation, irrigation, mulching, inputs *etc.*) would continuously lead to add in soil varying quantum of organic material, in the form of litter, twigs, stem, flowers, fruits, roots *etc.* which on decomposition or mineralization and subsequent plant uptake would ultimately exhibit varying status of soil organic carbon, nutrients status, soil physical and physico-chemical properties.

Soils of Navsari Agricultural University campus comes under Jalalpur, Eru and Bodali series, having great group *Chromustert*, sub-order *Ustert* and order *Vertisol* as per the USDA soil classification (7<sup>th</sup> approximation). As the soils of the entire campus comes under same classification and situated at the same agro-ecological zone (Heavy rainfall agro ecological zone-I), but differ in land use practices, it is quite likely that soils of NAU, campus under different existing agricultural land use and management, will exhibit varying status of organic carbon, nutrients status and physical properties.

Thus, it is highly essential to understand the effects of varying existing agricultural land use and management practices in soils of Navsari campus on the organic carbon content, nutrient status and physical properties in order to come out with some suggestions for improvement of SOC, nutrient status as well as physical properties of soils of NAU, campus and also for sustaining /improving crop yield.

The work relating to above aspect on the soils of Navsari Agricultural University campus is not available and hence, the present investigation "Organic carbon, nutrient status and physical properties as influenced by varying existing agricultural land use and management of soils in Navsari Campus " was carried out with following objectives:-

- I. To determine soil-pH, soil-EC, organic carbon, major, secondary (sulphur) and micronutrient status as well as BD and WSA under different existing agricultural land use and management practices of soils in Navsari Agricultural University, Navsari campus.
- II. To find out the influence of different existing agricultural land use and management on organic carbon, nutritional status and physical properties of soils in Navsari Agricultural University, Navsari campus.
- III. To work out correlation between organic carbon and other soil parameters under study.



*REVIEW  
OF  
LITERATURE*



## **II. REVIEW OF LITERATURE**

Soil organic carbon, nutrient status, and physical properties mainly depends on response of soil to different land use system and management practices over a period of time which may often modify the above soil properties. Several scientists and researchers from India and abroad have worked on the effect of varying land uses and management on soil physical and chemical properties. However, the domain of their research works mainly confined to either agricultural (cultivated land) land use or horticultural land use or forest land use or shifting cultivation or pasture land use or agro-forestry or barren/wasteland or specific crop based system or comparison of these land uses in respect to physical and chemical characteristics of soils. Though, literatures on the comparison of influence of varying plants/crops within the same land use system (agricultural or horticultural or pasture or forestry or wasteland) are very scanty, some relevant works done in India and abroad on the effect of various major land use systems (stated above) on soil physical and chemical properties are narrated here in brief under the following heads.

- 2.1 Effect of various land use system on soil organic carbon and physico-chemical properties of soil**
- 2.2 Effect of various land use system on available nutrients of soil**
- 2.3 Effect of various land use system on physical properties of soil**
- 2.4 Correlation of soil organic carbon with other soil parameter under different land use system**

## 2.1 Effect of various land use system on soil organic carbon and physico- chemical properties of soil

### 2.1.1 Organic carbon

Singhal and Panwar (1991) in a study, of cropping pattern of poplar based Agroforestry system in North-Western (U.P), compared physico-chemical characteristics of the soil under agro-forestry and under agriculture land use system after a period of six years. They concluded that organic carbon were higher in agroforestry plot while pH of the soil was lower as compared to agricultural plot.

Das *et al.* (1997) reported the effect of major land use on characteristics for Alfisols of Meghalaya. They showed that soil organic carbon content was higher under dairy farming (1.63 %) than horticulture and agro-forestry land use system.

Sharma and Bali (2000) studied the effect of different cropping systems on physico-chemical properties and soil fertility at Regional Agricultural Research Station, Shere-e-Kashmir University of Agricultural Science and Technology (J&K) and reported that soils under rice based system as compared to uncultivated soil contained higher amount of organic carbon.

An investigation was taken at ICAR Research complex for NEH Region, Lembucherra, Tripura concluded that shifting cultivation caused striking decrease in soil organic carbon leading to tangible decline in soil fertility over a period of three years. (Datta *et al.*, 2001)

Osman *et al.* (2001) studied the effect of some forest tree species on soil properties in Chittagong University Campus, Bangladesh and found

that soil under plantation had significantly higher organic carbon than adjacent unplanted plots.

An investigation was planned by Sharma (2001) on soil erosion behavior under different land uses in a watershed at University of Horticulture and Forestry, Solan (HP) and found that organic carbon content in soils under forest land was higher (3.01 %) as compared to those of cultivated land (1.30%) and grass land (1.05 %).

A study on changes in some soil properties under litchi and mango plantation was carried out by Aggarwal *et al.* (2005) at Punjab Agricultural University, Ludhiana and revealed that soil organic carbon were significantly higher under mango land use than under litchi land use system.

Kumar *et al.* (2006) studied the effect of land uses on relationship between organic carbon and available nutrients in dry temperate zone of Himachal Pradesh, at CSK, Himachal Pradesh Krishi Vishvavidyalaya, Palampur. They observed the highest average value of organic carbon ( $20.4 \text{ g kg}^{-1}$ ) under forest land followed by wasteland ( $19.2 \text{ g kg}^{-1}$ ) and minimum ( $12.3 \text{ g kg}^{-1}$ ) under agriculture land.

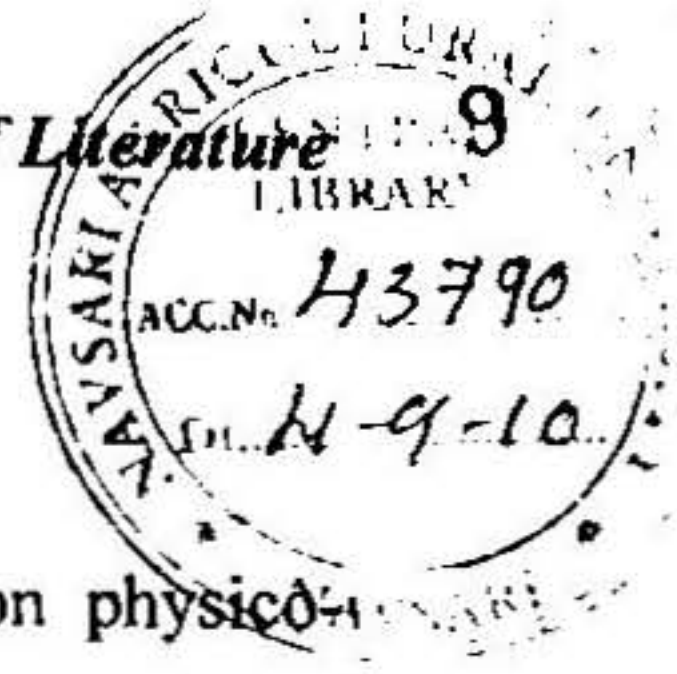
An investigation was laid out by Pal and Shurpali (2006) on variation in soil organic carbon as influenced by climate under different cropping systems in India at Cropping Systems Research, Modipuram, Meerut, Uttar Pradesh and revealed that rice-fallow system had the highest mean SOC content ( $8.7 \text{ g kg}^{-1}$ ) followed by rice-rice, maize-wheat, rice-pulse, soybean based, rice-wheat and pearl millet based system.

At Division of NRM and FS, Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR), Almora, Singh *et al.* (2006) studied different parameters of soils under different vegetation in Uttaranchal Hills, and reported that average organic carbon of oak, pine, deoder mixed, orchard and agriculture field soil were 4.63, 1.96, 4.32, 2.82 and 1.35 per cent, respectively.

Zhang *et al.* (2006) studied the effects of agriculture land use and management practices on soil organic carbon (SOC) in Yanhuai Basin, at Research Center for Eco-Environmental sciences, Chinese Academy of Sciences, Beijing (China) and showed that effects of land use and management practices on SOC primarily occurred in the top soil (0.25 cm) and sharply decreased with the increase in soil depth. They further concluded that SOC content values of orchard, vegetable and high input corn fields were higher than those of soybean, mid and low input corn fields.

A study was conducted by Wankhede and Jagdish (2008) on characterization of soils in teak forests, grassland and agricultural lands of basaltic origin in central India at NBSS & LUP, Nagpur, in relation to their characteristics and found that forest land are comparatively richer in organic carbon (3.2 to 26.1 g kg<sup>-1</sup>) followed by grassland soils (4.7 to 15.6 g kg<sup>-1</sup>) and cultivated soils (3.1 to 12.7 g kg<sup>-1</sup>).

Soil characters under four land use systems in submontaneous tract of Punjab were studied by Dhaliwal *et al.* (2008) and found that soils in forest and cultivated land use systems possessed significantly higher level of organic carbon respectively 0.56 and 0.52 per cent as compared to those under undisturbed and pasture land use systems.



### 2.1.2 Physicochemical properties

Various land use system may have direct impact on physico-chemical properties of soil like, pH and EC on long term basis. The variation in physico-chemical properties of soil as influenced by variable land use systems are discussed here as reported by other researchers and scientists.

Sharma and Gupta (1989) studied the effect of tree cover on soil fertility in western Rajasthan and reported that overall fertility was improved under tree cover in comparison to barren sand dunes. The pH of the soils reduced under tree cover as compared to barren sand dunes.

In a study, Singhal and Panwar (1991) compared physico-chemical characteristics of the soil under agro-forestry and under agriculture land use system after a period of six years. They concluded that pH of the soil was lower in agro-forestry plot as compared to agricultural plot.

Karlen *et al.* (1998) compared pH and EC values under three different land use systems in surface soils (0-10 cm) and suggested that cultivated systems had higher pH (6.3) compared with forest system (5.9) followed by organic system (5.8).

In a study at ICAR Research complex for NEH Region, Lembucherra, Tripura, Datta *et al.* (2001) concluded that shifting cultivation caused striking decrease in soil pH thus, leading to tangible decline in soil fertility over a period of three years.

Osman *et al.* (2001) planned out an experiment on effect of some forest tree species on soil properties in Chittagong University Campus, Bangladesh and found that pH was lower in soil under plantation than adjacent unplanted plots.

Aggarwal *et al.* (2005) studied changes in some soil properties under litchi and mango plantation, at Punjab Agricultural University, Ludhiana and revealed that the soil pH was significantly lower under litchi land use than mango land whereas, soil EC was significantly higher under mango land use than under litchi land use system.

The result of an experiment conducted at CSK, Himachal Pradesh Krishi Vishvavidyalaya, Palampur by Kumar *et al.* (2006) recorded that higher pH range (5.4-7.9) in soils under agriculture, followed by forest (5.2-7.6), wastelands (5.6-7.6), hops cultivation (6.0-7.9), grasses lands (5.7-7.3) and minimum under orchard (5.8-7.1) land uses.

While studying the pH status of soils under different vegetation in Uttaranchal Hills, Singh *et al.* (2006) found that the average pH value of oak, pine, deoder mixed, orchards and agriculture field soils were 6.1, 6.5, 6.5, 6.9 and 6.3, respectively.

Chandran *et al.* (2008) work out the scope of horticultural land use system in enhancing carbon sequestration in ferruginous soils of the semi-arid tropics at national bureau of soil survey and land use planning, (NBSS&LUP), Nagpur and found that soils of horticultural systems had the highest pH (8.4) and the agricultural soil had the lowest pH (5.9) indicating that agricultural management interventions increased the acidity of these soils.

An experiment was work out by Dhaliwal *et al.* (2008) on different soil characters under four land use systems of *Sadh Di Khad* watershed of Punjab and found that soils in cultivated and forest land use systems possessed significantly higher level of EC (0.29 and 0.26  $\text{dSm}^{-1}$ ) as compared to those under undisturbed and pasture land use systems. In case of soil pH, pasture and undisturbed land use systems possessed significantly

higher level of pH (7.84 and 7.81 respectively) as compared to those under forest and cultivated land use systems.

While studying the soils of teak forests, grass land and agricultural lands of basaltic origin in central India at NBSS& LUP, Nagpur, in relation to their characteristics found that pH in forest soil ranged from 6.8 to 7.3 and that of grassland and cultivated soils from 6.9 to 8.5 and 7.3 to 8.6, respectively (Wankhede and Jagdish 2008).

Ganeshamurthy and Srinivasrao (2009) compared three types of soil viz., long term cultivated pulse soil, farmers field and barren land in respect to different soil properties at IIPR Kanpur, (Uttar Pradesh). They observed that the quite low range of pH in soils under continuous pulse crop as compared to farmers field and barren land.

Somasundaram *et al.* (2009) studied different land use system at Central Soil and Water Conservation Research and Training Institute, Research Center, Kota (Rajasthan) and remarked that soil pH value did not show marked variations under different land use systems. However, soil under perennial vegetation had lower pH (7.06 - 7.44) as compared to cultivated land and ravine areas.

## **2.2 Effect of various land use system on available nutrients of soil**

### **2.2.1 Available major nutrients**

A study of cropping pattern of poplar based Agroforestry system in North-West UP, was carried out by Singhal and Panwar (1991) to compare physico-chemical characteristics of the soil under agro-forestry and under agriculture after a period of six years. They found that available N, P and K were higher in agro-forestry plot as compared to agricultural plot.

Kenjale *et al.* (1994) conducted experiment on recycling of nutrients by some forest tree species *viz.*, *Gmelina arborea*, *Derris indica*, *Tectona grandis* and *Terminalia tomentosa* etc. in Konkan region of Maharashtra. They observed that available nitrogen, phosphorus and potassium were significantly higher under all forest species than barren soil.

Parthiban and Rai (1994) reported that the sites of seven tree species *viz.*, *Bambus bambos*, *Cassia siamea*, *Casuarina equisetifolia*, *Eucalyptus tereticornis*, *Leucouena leucocephale*, *Tectona grandis*, and *Ceiba pentendra* were compared for soil fertility with a vegetationless site and a cultivated field. Under tree cover and agricultural soil nitrogen, phosphorus and potassium registered to be significantly higher compared to barren or uncultivated land.

Ashoka (1998) reported that forest tree species recorded higher available nutrients such as nitrogen, phosphorus, potassium and sulphur both at surface and sub-surface soils, respectively, While, lower values were recorded in surface and sub-surface soils for agricultural lands. Changes in nutrients status were due to decomposition of organic matter added through the leaf litter.

Sreerangappa (1998) observed that available nutrients like nitrogen, phosphorus, potassium and sulphur contents were increased in both surface and sub-surface soils of agriculture followed by agri-horti system.

A study was carried out by Sharma and Bali (2000) at Regional Agricultural Research Station, Shere-e-Kashmir University of Agricultural Science and Technology (J&K) to know the effect of different cropping systems on physico-chemical properties and soil fertility. They reported that

soils under rice based system as compared to uncultivated soil contained higher amount of available nutrients (Nitrogen, Phosphorus, and Potassium).

In an experiment at ICAR Research complex for NEH Region, Lembucherra (Tripura), Datta *et al.* (2001) concluded that shifting cultivation caused striking decrease in soil phosphorus and potassium availability leading to tangible decline in soil fertility over a period of three years.

A study on changes in some soil properties under litchi and mango plantation was carried out by Aggarwal *et al.* (2005) at Punjab Agricultural University, Ludhiana and they revealed that the available phosphorus and potassium were significantly greater in soils under litchi land use than soils under mango land use.

An investigation was carried on Terai soils of Eastern India at CKV, North Bengal Campus, coach Bihar by Pal and Modal (2005) and found that ratio of total inorganic P to organic P decreased in the following sequence: Cultivated land > orchard > forest > tea garden.

Kumar *et al.* (2006) studied soils under different land use pattern and observed that the highest average value of available nitrogen ( $173.0 \text{ kg ha}^{-1}$ ) was present in orchards soil followed by grassland ( $166.6 \text{ kg ha}^{-1}$ ) and minimum ( $147.0 \text{ kg ha}^{-1}$ ) under hops cultivation. They also observed that the highest value of available phosphorus under agriculture soils ( $47.4 \text{ kg ha}^{-1}$ ) followed by wastelands ( $44.5 \text{ kg ha}^{-1}$ ), hops cultivation ( $44.1 \text{ kg ha}^{-1}$ ) and minimum ( $38.1 \text{ kg ha}^{-1}$ ) under forest land use. In case of available potassium, the maximum average value was observed under wastelands ( $220.8 \text{ kg ha}^{-1}$ ) followed by forest land ( $217.3 \text{ kg ha}^{-1}$ ) and minimum ( $169.0 \text{ kg ha}^{-1}$ ) in soils for agriculture land use.

An experiment was carried out by Rudramurthy *et al.* (2007) on chemical properties of soils under different land use systems in Shimoga district of Karnataka at Zonal Agricultural Research Station, Shimoga (Bangalore) and revealed that the soil under mixed forest land use system recorded higher fixation of both phosphorus and potassium than the soils under cultivated land use systems, indicating lower status of available phosphorus and potassium.

In submontaneous tract of Punjab soil characters under four land use systems were studied by Dhaliwal *et al.* (2008) and found that soils in cultivated and forest land use system possessed significantly higher level of available nitrogen (293 and 287 kg ha<sup>-1</sup>), phosphorus (19.1 and 17.7 kg ha<sup>-1</sup>) and potassium (356 and 352 kg ha<sup>-1</sup>) respectively, as compared to those under undisturbed and pasture land use system.

A experiment was carried out by Wankhede and Jagdish (2008) to study the characterization of soils in teak forests, grassland and agricultural lands of basaltic origin in central India at NBSS & LUP, Nagpur and found that available phosphorus in forest land were higher as compared to cultivated soil.

Desai *et al.* (2009) studied the effect of INM on yield, uptake and soil properties in rice-rice system at Navsari Agricultural University Campus on *Vertic Haplustepts*. They found that available sulphur ranged from 18.8 to 20.00 mg kg<sup>-1</sup> under inorganic fertilizer management practices, while it varied from 26.7 to 31.6 mg kg<sup>-1</sup> in soils under integrated nutrient management practices.

Moutusi and Chattopadhyay (2009) conducted experiment at department of spices and plantation crops, BCKV, Mohanpur (W.B). The field

trial was conducted with eight cropping sequences and found that phosphorus and potassium content of the soil after harvesting of last crop showed improvement, while pH and organic carbon content of the soil exhibited a decreasing trend than the initial value, whereas nitrogen content remain almost unchanged.

### 2.2.2 Available micronutrients.

Singh *et al.* (1993) found the highest DTPA extractable Zn and Mn in forest and agricultural soils but did not show marked differences with waste lands. Rainfed agricultural lands were poorer in micronutrients than irrigated agricultural lands.

Ashoka (1998) reported that DTPA extractable iron, manganese, zinc and copper content of surface and sub-surface soils were higher in the lands of forest trees as compared to agricultural lands.

Sreerangappa (1998) observed that DTPA extractable micronutrients like, iron, manganese, zinc and copper were higher in surface and subsurface soils of silvi-pasture system as compared to agricultural lands.

While studying on effect of some forest tree species on soil properties in Chittagong University Campus, Bangladesh, it was observed that soil under plantation had significantly higher available nitrogen and available potassium than adjacent unplanted plots. (Osman *et al.*, 2001).

Aggarwal *et al.* (2005) studied changes in some soil properties under litchi and mango plantation at Punjab Agricultural University, Ludhiana and revealed that the DTPA extractable iron, manganese and zinc were significantly greater in soils under litchi land use than soils under mango land use whereas the reverse was true for DTPA-Cu.

At Division of NRM and FS, Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR), Almora, Singh *et al.* (2006) studied the DTPA-extractable micronutrient status of soils under different vegetation in Uttarakhand Hills and found that the DTPA-extractable Cu ranged from 0.79 to 6.44 mg kg<sup>-1</sup> under different land use system. The orchard soil recorded the highest content (2.77 mg kg<sup>-1</sup>) whereas, oak vegetation registered the lowest value (1.36 mg kg<sup>-1</sup>). The DTPA-extractable Mn ranged from 4.52 to 35.55 mg kg<sup>-1</sup> with its maximum content in pine vegetation soil (21.70 mg kg<sup>-1</sup>) and minimum in agricultural field soil (11.19 mg kg<sup>-1</sup>). The DTPA-extractable Fe ranged from 14 to 284 mg kg<sup>-1</sup> and the highest value was associated with oak vegetation soil (206.4 mg kg<sup>-1</sup>), while the lowest in agricultural field soil (81.73 mg kg<sup>-1</sup>). The DTPA-extractable Zn ranged from 0.09 to 8.49 mg kg<sup>-1</sup> and the highest content was associated with deodar mixed soil (3.68 mg kg<sup>-1</sup>), while the lowest in agricultural field soil (1.42 mg kg<sup>-1</sup>).

Dhaliwal *et al.* (2008) studied different soil characters under four land use system in *Sadh Di Khad* watershed of Punjab and found that soils in cultivated and forest land use system possessed significantly higher level of available Zn, Cu, Fe and Mn *i.e.*, 1.20-1.12, 0.56-0.48, 9.78-8.92 and 9.46-9.10 mg kg<sup>-1</sup>, respectively as compared to those under undisturbed and pasture land use system.

Study was carried out at Central Soil and Water Conservation Research and Training Institute, Research Center, Kota by Somasundaram *et al.* (2009) on DTPA-extractable micronutrient in soils under different land uses and they expressed that a wide variation was present in DTPA-extractable micronutrient in soils under different land uses. Micronutrient content was low in agricultural soils and ravine lands as compared to other land use systems.

Irrespective of land use, content of micronutrient was in order, Mn > Fe > Zn > Cu. Mean value of DTPA-extractable Mn, Fe, Zn & Cu in surface soil varied from 6.98 to 23.85, 0.44 to 1.41, 2.14 to 11.59 and 0.23 to 2.88 mg kg<sup>-1</sup>, respectively.

### 2.3 Effect of various land use system on physical properties of soil

The type of land use or soil use may have directly impact on soil physical properties like Bulk Density, WSA *etc.* Different land use patterns and soil management affect the accumulation and conservation of soil organic matter, especially soil aggregates quality (Zhang *et al.*, 2008).

While studying some physical properties of soil under different forest cover and land uses in Himachal Pradesh, Gupta and Singh (1990) observed that bulk density of soil was minimum under *Quercus leucotrichophora* and maximum in scrub area soil.

Nitant *et al.* (1992) studied properties of some soil in Yamuna ravines under forest land use and agriculture land use system and observed that WHC of soil under forest cover was higher than that under agriculture soil. On the contrary, bulk density of soil under forest cover was lower (1.43 to 1.51 g cm<sup>-3</sup>) than the agricultural land.

Sreerangappa (1998) observed that maximum WHC of soils in surface and sub-surface soils of horti-pasture as compared to agricultural system. This may be due to moderate amount of clay contents and improvement of soil structure in horti-pasture system.

At Regional Agricultural Research Station, Shere-e-Kashmir University of Agricultural Science and Technology (J&K), Sharma and Bali (2000) studied the effect of different cropping systems on physico-chemical

properties and soil fertility. They reported that soils under rice based system contained lower value of bulk density as compared to uncultivated soil.

Kahlon (2006) investigated on soil erodibility under different land use patterns of certain soils of submontaneous Punjab, at Punjab Agricultural University, Ludhiana, (Punjab). They reported that water stable aggregate per cent was the highest under forest plantation ( $52.7 \text{ Mg m}^{-3}$ ) followed by grass land ( $50.5 \text{ Mg m}^{-3}$ ) arable land ( $45.3 \text{ Mg m}^{-3}$ ) and bare land ( $39.7 \text{ Mg m}^{-3}$ ) use pattern while, bulk density followed the reverse trend.

Saha and Mishra (2007) studied the long-term effects of different land use systems on some physical properties with an objective to recommend the most suitable alternative land use system for maintenance of soil physical health. The maximum reduction in bulk density was recorded over shifting cultivation in forest followed by agro-hort-silvi-pastoral, livestock based, natural fallow and agricultural system. However, in case of soil aggregate, percentage of macro-aggregate was in the order of forestry > agri-horti > silvi-pastoral > natural fallow > livestock based system > agriculture > shifting cultivation.

Chandran *et al.* (2009) worked out the scope of horticultural land use system in enhancing carbon sequestration in ferruginous soils of the semi-arid tropics at (NBSS &LUP), Nagpur and found that average bulk density of the surface soils in the forest system ( $1.5 \text{ Mg m}^{-3}$ ) was low due to high SOC as compared to horticultural and agricultural land use system.

A study on different soil characters under four land use systems in submontaneous tract of Punjab was carried out by Dhaliwal *et al.* (2008) and found that soils in cultivated and forest land use system possessed significantly

higher level of aggregate stability *i.e.*, 0.77 and 0.75 respectively as compared to those under undisturbed and pasture land use system.

Zhang *et al.* (2008) studied the effect of land use patterns on soil aggregate stability in Sichuan Basin, (China) and found that contents of WSA (%) was the highest under barren land followed by forest land, orchards and crop land. They mentioned that barren land as well as forest land contained comparatively higher organic matter as those under crop land and orchard.

#### 2.4 Correlation studies of organic carbon with other soil parameters

Reddy and Agarwala (1972) studied influence of soil organic carbon on iron content and found that iron was negatively and significantly correlated with organic carbon ( $r=-0.62^{**}$ ).

Mathan and Kannan (1993) studied the influence of different vegetation on physico-chemical properties of soil and observed close dependence ( $r=0.493^{***}$ ) of bulk density on organic matter.

Das *et al.* (1997) observed that the available phosphorus, copper and iron was significantly negatively correlated ( $r=-0.90^{**}$ ,  $r=-0.62^{**}$ ) with organic carbon.

Venkatesh *et al.* (2003) determined the status of micronutrients cations under various land use systems of Meghalaya and found that available Zn and Cu were positively and significantly correlated ( $r=0.54^*$  and  $0.49^*$ , respectively) with organic carbon.

Kumar *et al.* (2006) studied the effect of land uses on relationship between organic carbon and available nutrients of soils of Himachal Pradesh and found that available nitrogen was strongly associated with SOC in soils under all the land uses except in orchard soils. A significantly linear positive relationship between SOC and available nitrogen was anticipated as 98 per

cent of nitrogen comes from the organic sources. Similarly, available phosphorus under all the land uses, except orchards, showed a positive and highly significant relationship with SOC. They further observed that available potassium showed positive and significant association with soil SOC under all land uses except agricultural and orchard soils. The highest relationship was observed for hops soils ( $r = 0.624^{**}$ ) followed by forest soils ( $r = 0.508^{**}$ ).

While studying the variation in soil organic carbon as influenced by climate under different cropping system in India Pal and Shurpali, (2006) found that significant correlation was existing between SOC content and soil pH. The regression results indicated negative relationship ( $r = -0.47^*$ ) of SOC with soil pH implying that the SOC content decreased with increasing soil pH.

Singh *et al.* (2006) studied the micronutrient status (such as Mn, Fe, Cu & Zn) of soils under different vegetation in Uttarakhand Hills and found that Fe showed a highly significant positive correlation ( $r = 0.556^{**}$ ) with organic carbon.

Bhattacharyya (2007) observed negative correlation between bulk density and organic carbon in soils of different bioclimatic zones of India.

Dhaliwal *et al.* (2008) studied four land use system in submontanouse tract of Punjab and observed significant co-efficient of correlation ( $r = 0.46^*$ ) between organic carbon and pH as well as between available nitrogen and organic carbon ( $r = 0.44^*$ ) in forest land use system. In case of micronutrients, significant co-efficient of correlation ( $r$ ) of organic carbon were observed with available Zn ( $r=0.48^*$ ), available Mn ( $r=0.67^*$ ) and available Fe ( $r=0.48^*$ ) in forest land use system, respectively.

Zhang *et al.* (2008) reported that soil organic matters were related positively ( $r=0.647^{**}$ ) to water stable aggregates of purple soils.



*MATERIALS  
AND  
METHODS*



### **III. MATERIALS AND METHODS**

The details regarding study area, plan of research work, material used, methods, criteria and techniques followed during the course of investigation are presented in this chapter. The analytical work was carried out in the laboratory of Department of Soil Science, NAU, Navsari.

#### **3.1 Study area: Location and extent of the study Area**

##### **3.1.1 Location**

Navsari Agricultural University, main campus, Navsari is situated at 20° 57' North Latitude and 72° 54' East Longitude and at an altitude of 10 meter above the Mean Sea Level (MSL). The NAU, campus is located 12 km away in the east from the Arabian seashore, Dandi a historical place well known for "Salt Satyagraha" of Mahatma Gandhi.

##### **3.1.2 Extent of the study area**

The area under study covers 333.42 hectares (excluding roads, buildings, residential colonies and offices) of land under varying uses of agricultural, horticultural and plantation purpose and barren land in the Navsari Agricultural University (NAU), Navsari main campus, in the Navsari district of Gujarat state. The land of the NAU campus is generally flat. Soils of whole Navsari Agricultural University campus comes under three series viz., Jalalpur, Eru & Bodali, having great group *Chromustert*, sub-order *Ustert* and order *Vertisol* as per 7<sup>th</sup> approximation. It includes deep moderately drained clayey soils, classified as deep black soil. It is having good water holding capacity, medium to poor drainage with flat topography. The clay content ranges from 42 to 50 per cent pre-dominated with montmorillonite type of clay mineral.

The study area of the NAU, Navsari campus includes,

- 1) Soil and Water Management Research Farm
- 2) Regional Horticulture Research Station
- 3) Regional Floriculture Research Station
- 4) NARP, Rice Research Station
- 5) Regional Sugarcane Research Station
- 6) Pulses and Oilseed Research Station
- 7) Instructional Farm and other general farm area
- 8) Barren Land

### **3.1.3 Climate and weather condition**

Climatically, this region is typically characterized by fairly hot summer, moderately cold winter and more humid and warm monsoon with heavy rain. The average annual precipitation is 1355mm. According to agro-climatic situation, Navsari falls in south Gujarat heavy rainfall zone-I, AES-III. Monsoon commences mostly from the second week of June and last up to the first week of October. Most of the rainfall is received from South-West monsoon, concentrating in the months of July and August. Winter starts from November with mild cold and lasts up to February. December and January are coldest months with mean monthly minimum temperature ranges from 25 to 35<sup>0</sup> C. Summer commences during mid-February and lasts up to mid-June. April and May are the hottest months during which the mean monthly maximum temperature ranges from 33<sup>0</sup> C to 35<sup>0</sup> C. The highest monthly mean relative humidity is recorded in the month of July and ranges from 81 to 93 per cent.

### 3.2 Physico-chemical properties of soils of NAU campus

Before the commencement of rain, soil samples were collected randomly from different places of the campus. All samples were mixed thoroughly in equal quantity to make a representative sample and were used to determine certain physical and chemical parameters.

**Table 1: General Physico-chemical properties of soil of Navsari Agricultural University Campus**

Soil Characteristics	Value
<b>(A) Physical</b>	
Sand (%)	14.43
Silt (%)	23.42
Clay (%)	62.15
Texture	Clay
<b>(B) Chemical</b>	
pH (1:2.5)	7.4
EC <sub>2.5</sub> (dS m <sup>-1</sup> at 25°C)	0.21
Organic carbon (%)	0.59
Available N (kg ha <sup>-1</sup> )	254
Available P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	45.6
Available K <sub>2</sub> O (kg ha <sup>-1</sup> )	362
Available S (mg kg <sup>-1</sup> )	17.1
DTPA extractable Fe (mg kg <sup>-1</sup> )	16.2
DTPA extractable Mn (mg kg <sup>-1</sup> )	14.4
DTPA extractable Zn (mg kg <sup>-1</sup> )	0.64
DTPA extractable Cu (mg kg <sup>-1</sup> )	0.19
Bulk Density (Mg m <sup>-3</sup> )	1.53
Water Stable Aggregates (mm)	49.51

### 3.3 Plan of research work

Depending upon the type of crop, vegetation or existing agricultural land use at NAU campus, the campus soils are sub-divided into different categories of land use as below. The research problem has been framed out to find out the effect of varying existing agricultural land use and management on soil-pH, soil-EC, soil organic carbon, available major, secondary (sulphur) and micronutrients as well as bulk density and WSA of soils in NAU campus.

**The different categories of land use (Land under crop/plantation/vegetation):-**

- LU<sub>1</sub> = Oil palm plantation
- LU<sub>2</sub> = Sapota plantation
- LU<sub>3</sub> = Mango plantation
- LU<sub>4</sub> = Sugarcane crop
- LU<sub>5</sub> = Rice crop
- LU<sub>6</sub> = Pulses and Oilseed crops
- LU<sub>7</sub> = Banana plantation
- LU<sub>8</sub> = Vegetable plants
- LU<sub>9</sub> = Floriculture crops
- LU<sub>10</sub> = Barren land

Results are obtained and interpreted as based on ten above land use systems. However, for simplicity of interpretation, some land uses are put in a group and total four such groups are made namely 1) "Tree/Plantation

land use group" 2) "Agricultural land use group" 3) "Horticultural land use group" and 4) "Barren land ". Oil palm (LU<sub>1</sub>), Sapota (LU<sub>2</sub>) and Mango plantation (LU<sub>3</sub>) are placed under "Tree/Plantation land use group", while Sugarcane (LU<sub>4</sub>), Rice (LU<sub>5</sub>), Pulses and oilseed crops (LU<sub>6</sub>) are placed under "Agricultural land use group". In the same way, under "Horticultural land use group", Banana plantation (LU<sub>7</sub>), Vegetable crops (LU<sub>8</sub>) and Floricultural plants (LU<sub>9</sub>) are considered, in cases, apart from each category of land use discussion are made as based on above group of land uses. Even though, the climate including rainfall as well as topography of land over the entire area of the campus remains same, the difference in vegetation / existing land use, their management including varying inputs may play a major role in creating differences in the content of organic carbon, available nutrients as well as in the status of physical properties.

### 3.4 Collection and preparation of soil sample

As the area under each land use category within NAU campus is different, irrespective of inputs applied and farming practices (inorganic/organic/integrated), land area under each category of land use are subdivided in to 10 parts for sampling purpose. From each part six random samples were taken from a depth of 0-22.5 cm (except for mango, sapota and oil palm plantation, where depth of sample was 0-30 cm) and samples were mixed together to make one composite representative sample. Following the same procedure ten representative samples were collected from each land use system and samples from each category of land use were marked 1 to 10 samples.

For sampling of soft and moist soil a tube auger, spade or khurpi were used. A screw type auger was used for hard or dry soil, while the post-hole auger was utilized for sampling excessively wet area like rice field. When

a spade or khurpi was used “V” shaped cuts were made up to desired vertical depth and about 2 cm uniformly thick slice was taken out from one clean side.

Apart from collection of samples, crop/fertilizer and other relevant informations of each land use system were also collected (Table 2).

Samples were air-dried, cleaned and properly grinded by wooden mortar and pestle to pass through 2 mm sieve. The processed soils were transferred to clean bags and labeled (one label was kept inside the bag and another pasted outside) indicating sample number, date of sampling, name of land use system, depth of sampling, identification mark *etc.* These samples were kept in proper place for laboratory analysis purposes.

### 3.5 Technical programme of research work

Details pertaining to technical programme of research work are given as under:

- i) **Name of research work** : “Organic carbon, nutrient status and physical properties as influenced by varying existing agricultural land use and management of soils in Navsari Campus”
- ii) **Location** : Navsari Agricultural University campus, Navsari.
- iii) **Sampling time** : May-2008

**Table 2: Details of existing land use and management practices being followed in soils (during sampling year) of NAU Campus**

Varying Land use / Management practices	Fertilizer/other inputs (As per Univ. recommendation)	Age/State of land use Plantation/vegetation	Green manuring	Irrigation	Herbicides & their name
Oil Palm Var. Tanera	<b>Organic</b> (Vermicompost) <b>Inorganic</b> Urea, SSP, MOP.	Plantation since 2000	Yes (Sesbenia)	Drip irrigation/ Sprinkler irrigation.	2,4-D
Sapota (Var. Kali Patti, Cricket ball)	<b>Organic</b> (FYM, Castor cake) <b>Inorganic</b> (Urea, DAP,MOP)	Plantation since 1975	Yes ( Sunhemp)	Drip irrigation	Dalopan
Mango(Var. Alphanso, Kesar, Rajapuri)	<b>Organic</b> (Vermicompost) <b>Inorganic</b> (Urea,SSP,MOP)	Plantation since 1976	Yes (Calocasia, Glyricidia)	Drip irrigation	Biota, Koltar
Sugarcane( Var. CoN-95132, CoN 91131, CoN 85134)  (Sugarcane-Sugarcane ratoon, Sugarcane-Mung)	<b>Organic</b> (Sugarcane trash mulching, Decomposed material) <b>Inorganic</b> (DAP, SSP- at the time of transplanting, Urea)	Planted in 23Dec. 2007	Yes (Sunhemp, Karanj)	Flood irrigation at 15 days interval & Drip Irrigation	Glyphosate.

<b>Rice</b> (NVSR-1, NVSR-5)	<b>Organic</b> (Biocompost) <b>Inorganic</b> (Amonium Sulphate, SSP,Zn Sulphate)	Transplanted 5 <sup>th</sup> Jan.2008	No	Flood irrigation as per recommendation	2,4-D, Butachlor
<b>Pulses &amp; Oil seed</b> (Var. Gram GG- 1,GG-2 /Gujarat Castor hybrid, CCH- 20, GCH-8)	<b>Organic</b> (Biocompost, FYM, Biofertilizer, <i>Rhizobium</i> , PSB, <i>Azotobactor</i> ) <b>Inorganic</b> (DAP)	Sown 2 <sup>th</sup> Dec.2007	Mungbean, Indianbean	Flat bad Irrigation system & furrow.	2,4-D
<b>Banana</b> (Var.Grand Nine) (Banana-Banana ratoon-Banana)	<b>Organic</b> , Biocompost, Castor cake, Neem Cake) <b>Inorganic</b> (Urea, SSP ,MOP)	Plant crop planted in 11 <sup>th</sup> Aug, 2006	Yes (Sunhemp)	Drip irrigation in line	Butachlore
<b>Vegetable</b> Brinjal(Var.Surti, ravaiya)	<b>Organic</b> ( Frequently Vermicompost Biocompost,Castor Cake, Neem Cake) <b>Inorganic</b> (Urea, SSP, MOP)	Since 2008	No	Furrow irrigation	Fluchloraline, Pendamethaline
<b>Floriculture:</b> (Spiderlily Rose )	<b>Organic</b> ( Frequently Vermicompost) <b>Inorganic</b> (Urea, SSP ,MOP)	Since 2007	No	Ridges & furrow Drip irrigation	Not used
<b>Barren</b>	Not used	Since 5 years it is barren	Nil	Nil	Nil

**iv) Details of sampling :**

- a) Total study area approximately 333.42 ha. (excluding roads, buildings, residential colonies and offices).
- b) Total categories of land use: 10
- c) Method of soil sampling: Zig- Zag method of soil sampling
- d) Depth of sampling:-
  - i. 0-22.5 cm for Sugarcane, Rice, Pulses and Oilseed crops, Banana plantation, Vegetable plants, Floriculture crops and Barren land.
  - ii. 0-30 cm for Oil palm, Sapota and Mango plantation.
- e) Number of samples for each category of land use: 10
- f) Total number of samples under study: 100
- g) Techniques for collection of soil sample:

As the area under each land use category within NAU, campus spread widely, irrespective of inputs applied and farming practiced (organic /inorganic/Integrated) area under each category of land use are sub divided into ten part for sampling purpose. From each part, random samplings from six places following Zig- Zag method of sampling were done. Samples were mixed together and one composite sample was prepared and was named sample 1. Following the same procedure ten composite soil samples were taken from a particular category of land use and were named sample 1 to 10. Using the same techniques sampling from all categories of land use were completed.

### 3.6 Laboratory analysis done for

The air dried, processed samples from each category of land use were utilized for following laboratory analysis as per the standard procedure.

- a. Organic Carbon
- b. EC, pH
- c. Available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S
- d. Available Fe, Mn, Zn, Cu
- e. Bulk density and Water stable aggregate of size > 0.5 mm (which also considered as macro -aggregates)

### 3.7 Methods of soil analysis

The methods followed for the determination of various chemical and physical properties of soil are mentioned in Table.3.

**Table 3: Methods used for the determination of chemical and physical properties of soil**

Properties	Method adopted	Reference
<b>A. Mechanical</b>		
Sand, Silt and clay	International Pipette Method	Pipper (1966)
<b>B. Chemical</b>		
pH(1:2.5::soil:water)	Potentiometric	Jackson (1979)
EC(1:2.5::soil:water)	Conductometric	Jackson (1979)
Organic carbon	Walkley and Black rapid titration method	Jackson (1979)
Available -N	0.32% Alkaline Potassium permanganate method.	Subbiah and Asija (1956)

Contd.. Table 3

Properties	Method adopted	Reference
<b>B. Chemical</b>		
Available - P <sub>2</sub> O <sub>5</sub>	0.5 M NaHCO <sub>3</sub> (pH 8.5)	Olsen <i>et al.</i> (1954)
Available -K <sub>2</sub> O	Flame photometric (Extraction with 1 N NH <sub>4</sub> OAc)	Jackson (1979)
Available S	Turbidometric ( extraction with 0.15% CaCl <sub>2</sub> )	Chopra and Kanwar (1980)
DTPA Extractable Fe, Mn, Zn and Cu	0.05 M DTPA and estimated on AAS spectrophotometer	Lindsay and Norvell (1978)
<b>C. Physical</b>		
Bulk density	Black method	Black, 1965
Water Stable Aggregate (>0.5mm )	Yoder's method	Yoder, 1936

### 3.8 Soil fertility ratings

The different ratings used for soil fertility evaluation of soils under varying categories of land use of NAU, campus are presented in Table. 4 to 10.

### 3.9 Statistical analysis

The data obtained from each sample were subjected to descriptive statistics and for all categories of land use soil correlation matrices were worked out between soil organic carbon and other soil parameters at computer center of department of agriculture statistics and computer centre, N.M.

College of Agriculture, NAU, Navsari using the methods given by Panse and Sukhatme (1967).

**Table 4: The ratings for soil pH<sub>2.5</sub> (SSSA, 1962)**

Sr. No.	Ratings	pH Range	Sr. No.	Ratings	pH Range
i	Extremely acid	Below 4.5	vi	Neutral	6.6 - 7.3
ii	Very strongly acid	4.5 - 5.0	vii	Mildly alkaline	7.4 - 7.8
iii	Strongly acid	5.1 - 5.5	viii	Moderately alkaline	7.9 - 8.4
iv	Medium acid	5.6 - 6.0	ix	Strongly alkaline	8.5 - 9.0
v	Slightly acid	6.1 - 6.5	x	Very strongly alkaline	Above 9.0

**Table 5: The ratings for soil electrical conductivity (Seth, 1967)**

Sr. No.	Ratings	EC <sub>2.5</sub> range (dS m <sup>-1</sup> )
i	Normal	< 1.0
ii	Tending to become saline	1.0-2.0
iii	Saline	2.0-3.0
iv	Highly saline	> 3.0

**Table 6: The ratings for soil organic carbon content (Walkley and Black, 1934)**

Sr. No.	Ratings	OC range (%)
i	Low	<0.50
ii	Medium	0.50-0.75
iii	High	>0.75

**Table 7: The ratings for soil available N content (Subbiah and Asija, 1956)**

Sr. No.	Ratings	Available N range (kg ha <sup>-1</sup> )
i	Low	<250
ii	Medium	250-500
iii	High	>500

**Table 8: The ratings for soil available P<sub>2</sub>O<sub>5</sub> content (Olsen *et al.*, 1954)**

Sr. No.	Ratings	Available P <sub>2</sub> O <sub>5</sub> range (kg ha <sup>-1</sup> )
i	Low	<28
ii	Medium	28-56
iii	High	>56

**Table 9: The ratings for soil available K<sub>2</sub>O content (Hanway and Heidel, 1952)**

Sr. No.	Ratings	Available K <sub>2</sub> O range (kg ha <sup>-1</sup> )
i	Low	<140
ii	Medium	140-280
iii	High	>280

**Table 10: The ratings for soil available S content. (Chopra and Kanwar, 1980)**

Sr. No.	Ratings	Available S range (mg kg <sup>-1</sup> )
i	Low	<10
ii	Medium	10-20
iii	High	>20

**Table 11: The ratings for soil available micronutrients**  
**(Lindsay and Norvell, 1978)**

Sr. No.	Available micronutrients (mgkg <sup>-1</sup> )	Ratings		
		Deficient	Marginal	Adequate
i	Iron (Fe)	<5	5-10	>10
ii	Manganese (Mn)	<5	5-10	>10
iii	Zinc (Zn)	<0.5	0.5-1.0	>1.0
iv	Copper (Cu)	<0.2	0.2-0.4	>0.4



*RESULTS  
AND  
DISCUSSION*



## **IV. RESULTS AND DISCUSSION**

The results of the present research study entitled "Organic carbon, nutrient status and physical properties as influenced by varying existing agricultural land use and management of soils in Navsari Campus" are presented in this chapter along with the statistical inferences under the following heads.

- 4.1 Status of organic carbon,  $\text{pH}_{2.5}$ ,  $\text{EC}_{2.5}$  and available N,  $\text{P}_2\text{O}_5$ ,  $\text{K}_2\text{O}$  and S of soils under different existing land use and management
- 4.2 Effect of different existing land use and management on organic carbon,  $\text{pH}_{2.5}$ ,  $\text{EC}_{2.5}$  and available N,  $\text{P}_2\text{O}_5$ ,  $\text{K}_2\text{O}$  and S of soils
- 4.3 Status of available micronutrients and physical properties of soils under different existing land use and management
- 4.4 Effect of different existing land use and management on available micronutrients and physical properties of soils
- 4.5 Simple correlation (r) of organic carbon with  $\text{pH}_{2.5}$ ,  $\text{EC}_{2.5}$ , available N,  $\text{P}_2\text{O}_5$ ,  $\text{K}_2\text{O}$ , S and with available micronutrients and physical properties of soils under different land use and management
- 4.1 Status of organic carbon,  $\text{pH}_{2.5}$ ,  $\text{EC}_{2.5}$  and available N,  $\text{P}_2\text{O}_5$ ,  $\text{K}_2\text{O}$  and S of soils under different existing land use and management**
- 4.1.1 Soil under existing oil palm land use and management**

Analysis of soil samples obtained from existing oil palm land use system revealed (Table 12) that organic carbon content range from 9.2 to 10.2  $\text{g kg}^{-1}$  with a mean value of 9.7  $\text{g kg}^{-1}$  indicating its higher rating.  $\text{pH}_{2.5}$  of soils

range from 7.20 to 7.60 with mean value of 7.33 indicating neutral in reaction, while soil  $EC_{2.5}$  varies from 0.30 to 0.46  $dSm^{-1}$  having mean of 0.36  $dSm^{-1}$ .

So far as soil available nutrients are concerned, available nitrogen, phosphorus and potassium have been found to range from 318 to 349, 54.23 to 59.11 and 363 to 376  $kg\ ha^{-1}$  respectively with corresponding mean value of 334.5, 56.99 and 372.3  $kg\ ha^{-1}$  respectively, while available sulphur ranges from 18.00 to 20.71  $mg\ kg^{-1}$  with a mean value of 19.32  $mg\ kg^{-1}$ . The mean values of available nutrients indicated that soil under existing oil palm system come under the category of medium, marginally high, high and highly medium with respect to available nitrogen, phosphorus, potassium and sulphur respectively.

**Table 12: Organic carbon,  $pH_{2.5}$ ,  $EC_{2.5}$  and available nutrients of soils samples from oil palm land use and management**

Sample	OC	$pH_{2.5}$	$EC_{2.5}$	N	$P_2O_5$	$K_2O$	S
	$g\ kg^{-1}$		$dS\ m^{-1}$		$Kg\ ha^{-1}$		$mg\ kg^{-1}$
1	9.5	7.46	0.39	341	55.17	371	18.22
2	9.2	7.35	0.31	322	57.23	376	19.97
3	9.7	7.30	0.36	341	58.19	375	19.72
4	9.8	7.45	0.35	335	56.23	373	18.29
5	9.9	7.22	0.31	335	58.23	376	20.71
6	10.1	7.20	0.41	347	54.23	372	20.17
7	9.3	7.30	0.40	318	57.13	363	18.38
8	10.2	7.60	0.46	349	59.11	375	19.79
9	9.5	7.20	0.30	322	58.23	371	19.97
10	9.8	7.21	0.35	335	56.11	371	18.00
<b>Mean</b>	9.7	7.33	0.36	334.5	56.99	372.3	19.32
<b>Range</b>	(9.2-10.2)	(7.20-7.60)	(0.30-0.46)	(318-349)	(54.23-59.11)	(363-376)	(18.00-20.71)

#### 4.1.2 Soil under existing sapota land use and management

The results obtained (Table 13) from soil sample taken from existing sapota plantation indicate that organic carbon content ranges from 9.1 to 9.7 g kg<sup>-1</sup> with a mean value of 9.5 g kg<sup>-1</sup> indicating its high status in soil, while pH<sub>2.5</sub> ranges from 7.91 to 8.08 with a mean value of 8.00 indicating moderately alkaline in reaction. The range and mean value for soil EC<sub>2.5</sub> are recorded to be 0.32 to 0.37 dSm<sup>-1</sup> and 0.35 dSm<sup>-1</sup> respectively.

Soil available nitrogen, phosphorus and potassium have been found to be range from 273 to 297, 50.90 to 56.01 and 341 to 348 kg ha<sup>-1</sup> respectively with corresponding mean values of 284.8, 53.48 and 344.4 kg ha<sup>-1</sup> respectively, showing medium, highly medium and high status, respectively for available nitrogen, phosphorus and potassium. Available sulphur, the secondary nutrient, ranged from 20.11 to 25.11 mg kg<sup>-1</sup> with a mean value of 23.18 mg kg<sup>-1</sup> indicating its high available status in soil.

**Table 13: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available nutrients of soils samples from sapota land use and management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		mg kg <sup>-1</sup>
1	9.1	8.03	0.34	276	52.71	345	20.11
2	9.3	8.01	0.36	279	53.11	343	21.73
3	9.6	8.02	0.35	289	56.01	344	24.85
4	9.6	8.01	0.33	291	55.31	347	22.17
5	9.4	7.92	0.35	296	54.12	341	23.21
6	9.7	7.91	0.36	297	55.00	348	25.05
7	9.3	7.95	0.37	277	51.53	342	23.27
8	9.5	8.01	0.33	283	52.13	345	24.11
9	9.7	8.08	0.32	287	50.90	341	22.17
10	9.7	8.06	0.34	273	53.97	348	25.11
Mean	9.5	8.00	0.35	284.8	53.48	344.4	23.18
Range	(9.1-9.7)	(7.91-8.08)	(0.32-0.37)	(273-297)	(50.90-56.01)	(341-348)	(20.11-25.11)

### 4.1.3 Soil under existing mango land use and management

Soils under existing mango land use system revealed (Table 14) that organic carbon content ranges from 9.1 to 10.2 g kg<sup>-1</sup> with a mean value of 9.6 g kg<sup>-1</sup> indicating its higher status in soil, while pH<sub>2.5</sub> ranges from 7.71 to 7.85 with a mean value of 7.76 indicating mildly alkaline in reaction. The soil EC<sub>2.5</sub> varies from 0.22 to 0.34 dSm<sup>-1</sup> with mean of 0.27 dSm<sup>-1</sup>.

Available nitrogen, phosphorus, potassium and sulphur are found to range from 301 to 335, 51.11 to 58.11, 315 to 331 kg ha<sup>-1</sup> and 21.01 to 24.11 mg kg<sup>-1</sup> respectively, exhibiting medium, medium to high, high and marginally high status with respect to available nitrogen, phosphorus, potassium and sulphur, respectively with mean value of 313.4, 55.30, 321.3 kg ha<sup>-1</sup> and 21.7 mg kg<sup>-1</sup> in chronological order.

**Table 14: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub>, and available nutrients of soils samples from mango land use and management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		mg kg <sup>-1</sup>
1	9.1	7.76	0.26	312	55.13	317	21.12
2	9.3	7.71	0.23	301	55.11	321	21.01
3	9.2	7.73	0.25	305	54.12	318	21.11
4	9.3	7.72	0.22	311	57.12	320	22.06
5	9.6	7.83	0.33	305	58.11	315	21.06
6	9.9	7.85	0.34	311	57.22	319	21.11
7	10.2	7.81	0.34	319	55.13	321	21.11
8	9.8	7.72	0.24	313	56.78	324	23.23
9	9.5	7.76	0.23	335	53.12	327	21.11
10	9.8	7.75	0.27	322	51.11	331	24.11
<b>Mean</b>	<b>9.6</b>	<b>7.76</b>	<b>0.27</b>	<b>313.4</b>	<b>55.30</b>	<b>321.3</b>	<b>21.70</b>
<b>Range</b>	<b>(9.1-10.2)</b>	<b>(7.71-7.85)</b>	<b>(0.22-0.34)</b>	<b>(301-335)</b>	<b>(51.11-58.11)</b>	<b>(315-331)</b>	<b>(21.01-24.11)</b>

#### 4.1.4 Soil under existing sugarcane land use and management

So far as sugarcane land use system is concerned, it is noticed (Table 15) that soil organic carbon varies from 7.5 to 8.5 g kg<sup>-1</sup> with a mean value of 8.0 g kg<sup>-1</sup> indicating its high status, while soil pH<sub>2.5</sub> ranged from 7.81 to 7.95 with mean value of 7.88 indicating moderately alkaline in soil reaction. The soil EC<sub>2.5</sub> exhibiting a mean value of 0.51 dSm<sup>-1</sup> has been noted to range from 0.41 to 0.58 dSm<sup>-1</sup>.

The mean value for soil available nitrogen, phosphorus, potassium and sulphur are recorded 276.4, 60.30, 421.3 kg ha<sup>-1</sup> and 15.31 mg kg<sup>-1</sup> respectively, indicating medium, high, high and medium status respectively. However, amongst sample, available nitrogen, phosphorus, potassium and sulphur have been observed to vary from 271 to 288, 56.23 to 64.10, 410 to 435 kg ha<sup>-1</sup> and 14.09 to 17.21 mg kg<sup>-1</sup> in soils, respectively.

**Table 15: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available nutrients of soils samples from sugarcane land use & management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		mg kg <sup>-1</sup>
1	7.7	7.95	0.41	271	57.20	411	14.31
2	7.5	7.91	0.45	273	56.23	411	15.11
3	7.8	7.94	0.46	273	59.23	417	14.09
4	7.5	7.93	0.47	271	58.11	418	14.21
5	7.6	7.92	0.48	273	57.29	410	14.31
6	8.3	7.84	0.56	272	63.31	423	15.21
7	8.4	7.81	0.55	277	63.21	426	16.33
8	8.5	7.83	0.58	281	62.11	430	16.12
9	8.2	7.85	0.57	285	62.23	432	16.23
10	8.4	7.85	0.58	288	64.10	435	17.21
<b>Mean</b>	<b>8.0</b>	<b>7.88</b>	<b>0.51</b>	<b>276.4</b>	<b>60.30</b>	<b>421.3</b>	<b>15.31</b>
<b>Range</b>	<b>(7.5-8.5)</b>	<b>(7.81-7.95)</b>	<b>(0.41-0.58)</b>	<b>(271-288)</b>	<b>(56.23-64.10)</b>	<b>(410-435)</b>	<b>(14.09-17.21)</b>

#### 4.1.5 Soil under existing rice land use and management

The results (Table 16) revealed that soils under the existing rice land use come under the category of highly medium to marginally high with respect to organic carbon varying from 7.1 to 7.9 g kg<sup>-1</sup> with a mean value of 7.5 g kg<sup>-1</sup>. The pH<sub>2.5</sub> of soils ranged from 5.71 to 5.97 with mean value of 5.82 indicating medium acidic in soil reaction. Soil EC<sub>2.5</sub> value are 0.42 to 0.59 dSm<sup>-1</sup> with a mean value 0.52 dSm<sup>-1</sup> respectively.

Soil available nitrogen, phosphorus, potassium and sulphur are found to vary from 248 to 256, 34.19 to 47.26, 140 to 147 kg ha<sup>-1</sup> and 16.23 to 17.54 mg kg<sup>-1</sup> indicating low to slightly medium, medium, marginally medium and medium status, respectively with corresponding mean value of 251.7, 41.45, 143.2 kg ha<sup>-1</sup> and 16.90 mg kg<sup>-1</sup> chronologically.

**Table 16: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available nutrients of soil samples from rice land use & management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		mg kg <sup>-1</sup>
1	7.9	5.71	0.59	256	46.75	146	16.43
2	7.3	5.72	0.57	248	41.33	142	17.42
3	7.1	5.91	0.56	251	47.26	147	16.32
4	7.2	5.83	0.58	253	45.11	141	17.42
5	7.1	5.97	0.57	250	43.78	140	16.56
6	7.4	5.93	0.49	251	34.19	145	17.21
7	7.5	5.77	0.47	255	38.24	144	17.54
8	7.7	5.83	0.48	253	35.32	142	17.23
9	7.6	5.81	0.42	249	42.14	145	16.23
10	7.7	5.73	0.44	251	40.39	140	16.67
Mean	7.5	5.82	0.52	251.7	41.45	143.2	16.90
Range	(7.1-7.9)	(5.71-5.97)	(0.42-0.59)	(248-256)	(34.19-47.26)	(140-147)	(16.23-17.54)

#### 4.1.6 Soil under existing pulses and oilseed land use and management

The results (Table 17) revealed that soils under pulses and oil seed crop are medium to marginally high in organic carbon status with a range from 7.5 to 8.4 g kg<sup>-1</sup> and a mean value of 7.9 g kg<sup>-1</sup>. While pH<sub>2.5</sub> of soils are found to range from 7.11 to 7.59 with a mean value of 7.31 indicating neutral in soil reaction, soil EC<sub>2.5</sub> varies from 0.31 to 0.39 dS m<sup>-1</sup> with a mean value of 0.35 dS m<sup>-1</sup>.

Soils can be rated highly medium, medium and high with respect to available nitrogen, phosphorus and potassium respectively as evidenced (Table.17) by their range values of 490 to 498, 49.29 to 52.76 and 320 to 326, respectively. However, mean of available nitrogen, phosphorus and potassium of soils of this system are noted to be 494, 50.76 and 322.9 kg ha<sup>-1</sup>, respectively. Available sulphur ranges from 21.01 to 23.23 mg kg<sup>-1</sup> with a mean value of 22.11 mg kg<sup>-1</sup> indicating marginally high status.

**Table 17: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available nutrients of soil samples from pulses and oilseed land use and management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		mg kg <sup>-1</sup>
1	7.7	7.31	0.33	495	49.72	322	22.23
2	8.1	7.12	0.31	496	50.23	320	22.25
3	7.6	7.23	0.33	490	49.29	321	23.21
4	8.1	7.51	0.39	492	51.35	321	21.21
5	7.7	7.33	0.38	495	49.97	325	22.03
6	7.8	7.54	0.36	497	50.26	326	23.23
7	7.5	7.12	0.33	490	52.13	321	22.11
8	8.3	7.59	0.31	490	50.21	322	21.01
9	8.4	7.25	0.33	497	51.64	325	21.90
10	8.1	7.11	0.39	498	52.76	326	21.90
<b>Mean</b>	<b>7.9</b>	<b>7.31</b>	<b>0.35</b>	<b>494</b>	<b>50.76</b>	<b>322.9</b>	<b>22.11</b>
<b>Range</b>	<b>(7.5-8.4)</b>	<b>(7.11-7.59)</b>	<b>(0.31-0.39)</b>	<b>(490-498)</b>	<b>(49.29-52.76)</b>	<b>(320-326)</b>	<b>(21.01-23.23)</b>

#### 4.1.7 Soil under existing banana land use and management

Soil sample collected from banana plantation revealed (Table 18) that organic carbon ranges from 7.1 to 7.8 g kg<sup>-1</sup> with a mean value of 7.5 g kg<sup>-1</sup> indicating its medium to marginally high status. While the pH<sub>2.5</sub> of soils range from 7.41 to 7.81 with a mean value of 7.61 indicating mildly alkaline in reaction, the soil EC<sub>2.5</sub> varies from 0.41 to 0.55 dSm<sup>-1</sup> exhibiting a mean value of 0.47 dS m<sup>-1</sup> respectively.

Soil available nitrogen, phosphorus and potassium have been found to range from 251 to 260, 40.93 to 48.23 and 323 to 380 respectively in this system, indicating marginally medium, medium and high status of these nutrients, respectively. The mean value of available nitrogen, phosphorus and potassium of these soils are 255.4, 45.51 and 350.5 kg ha<sup>-1</sup>, respectively. Available sulphur ranges from 21.03 to 24.98 mg kg<sup>-1</sup> indicating its slightly high status, with a mean value of 23.25 mg kg<sup>-1</sup>.

**Table 18: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available nutrients of soil samples from banana land use and management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>				
1	7.1	7.61	0.42	257	45.23	323	21.03
2	7.2	7.67	0.43	259	42.71	325	22.23
3	7.3	7.51	0.41	258	40.93	338	22.23
4	7.4	7.56	0.41	260	47.11	337	22.16
5	7.5	7.43	0.42	256	48.23	341	23.16
6	7.4	7.41	0.43	255	47.21	347	23.17
7	7.7	7.63	0.53	251	45.13	363	24.18
8	7.5	7.77	0.54	253	47.29	372	24.98
9	7.8	7.81	0.55	251	46.17	379	24.71
10	7.8	7.71	0.55	254	45.11	380	24.63
Mean	7.5	7.61	0.47	255.4	45.51	350.5	23.25
Range	(7.1-7.8)	(7.41-7.81)	(0.41-0.55)	(251-260)	(40.93-48.23)	(323-380)	(21.03-24.98)

#### 4.1.8 Soil under existing vegetable land use and management

The soil data (Table 19) under existing vegetable system revealed that organic carbon content ranges from 5.1 to 5.8 g kg<sup>-1</sup> with a mean value of 5.4 g kg<sup>-1</sup> indicating its medium status. While the range and mean values for soil pH<sub>2.5</sub> are 7.43 to 7.53 and 7.48 respectively indicating mildly alkaline in reaction, the corresponding values for soil EC<sub>2.5</sub> are recorded to be 0.32 to 0.38 dS m<sup>-1</sup> and 0.35 dS m<sup>-1</sup> respectively.

So far as available nutrients are concerned, data revealed that nitrogen, phosphorus and potassium vary from 201 to 219, 43.01 to 48.19 and 251 to 260 kg ha<sup>-1</sup> indicating low, medium and medium status of these nutrients, respectively. While the mean of available nitrogen is observed 211 kg ha<sup>-1</sup>, the mean values for available phosphorus and potassium are 46.14 and 255.3 kg ha<sup>-1</sup>, respectively. Available sulphur in soils of this system ranges from 14.92 to 16.71 mg kg<sup>-1</sup> indicating its medium status with a mean value of 15.63.

**Table 19: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available nutrients of soil samples from vegetable land use and management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		
1	5.8	7.43	0.38	209	46.01	251	15.31
2	5.3	7.53	0.33	219	47.00	255	15.01
3	5.7	7.49	0.37	205	47.33	259	15.61
4	5.3	7.46	0.35	219	45.12	258	16.23
5	5.4	7.47	0.37	201	48.19	253	15.27
6	5.1	7.51	0.35	203	46.31	255	15.71
7	5.2	7.47	0.32	216	45.13	257	16.33
8	5.5	7.53	0.33	203	47.23	252	15.23
9	5.7	7.45	0.37	218	43.01	260	14.92
10	5.1	7.46	0.37	217	46.11	253	16.71
Mean	5.4	7.48	0.35	211	46.14	255.3	15.63
Range	(5.1-5.8)	(7.43-7.53)	(0.32-0.38)	(201-219)	(43.01-48.19)	(251-260)	(14.92-16.71)

#### 4.1.9 Soil under existing floriculture land use and management

Organic carbon content has been found to vary from 4.3 to 4.9 g kg<sup>-1</sup> with a mean value of 4.6 g kg<sup>-1</sup> (Table 20) in soils under existing floriculture land use, indicating low status of this parameter. pH<sub>2.5</sub> of soils vary from 7.59 to 7.82 with mean value of 7.69 indicating mildly alkaline in reaction, while the soil EC<sub>2.5</sub> ranges from 0.37 to 0.48 dS m<sup>-1</sup> with a mean value of 0.42 dS m<sup>-1</sup>.

**Table 20: Organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub>, and available nutrients of soil samples from floriculture land use and management**

Sample	OC	pH <sub>2.5</sub>	EC <sub>2.5</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
	g kg <sup>-1</sup>		dS m <sup>-1</sup>		Kg ha <sup>-1</sup>		mg kg <sup>-1</sup>
1	4.6	7.73	0.46	249	42.13	293	16.31
2	4.3	7.75	0.41	240	41.33	295	14.11
3	4.7	7.74	0.43	254	40.17	297	15.12
4	4.3	7.59	0.48	245	42.33	291	14.30
5	4.6	7.73	0.42	259	41.37	298	14.23
6	4.3	7.63	0.39	245	43.17	296	15.23
7	4.8	7.82	0.43	263	39.90	292	16.01
8	4.9	7.61	0.38	267	42.33	300	14.31
9	4.3	7.62	0.37	238	43.78	294	16.31
10	4.7	7.63	0.39	254	44.11	300	14.37
<b>Mean</b>	4.6	7.69	0.42	251.4	42.06	295.6	15.03
<b>Range</b>	(4.3-4.9)	(7.59-7.82)	(0.37-0.48)	(238-267)	(39.90-44.11)	(291-300)	(14.11-16.31)

Available nitrogen, phosphorus and potassium have been observed to register low to medium, medium and marginally high status of these nutrients, respectively, showing their variation from 238 to 267, 39.90 to 44.11 and 291 to 300 kg ha<sup>-1</sup>, respectively. When mean values of these nutrients are considered, the status of available nitrogen, phosphorus and potassium are found to be marginally medium (251.4 kg ha<sup>-1</sup>), medium (42.06 kg ha<sup>-1</sup>) and marginally high (295.6 kg ha<sup>-1</sup>), respectively. The mean value of available

sulphur is noticed to be  $15.03 \text{ mg kg}^{-1}$  showing a range from 14.11 to  $16.31 \text{ mg kg}^{-1}$ , indicating its medium status in soils under this system.

#### 4.1.10 Soil under existing barren land and management

The data on various soil parameters under barren land (Table 21) revealed that organic carbon content ranges from 2.1 to  $2.8 \text{ g kg}^{-1}$  with a mean value of  $2.4 \text{ g kg}^{-1}$  indicating its very low status. While,  $\text{pH}_{2.5}$  of these soils ranges from 7.57 to 7.77 with mean value of 7.69 mildly alkaline reaction, the soil  $\text{EC}_{2.5}$  values vary from 0.31 to  $0.39 \text{ dS m}^{-1}$  with a mean of  $0.34 \text{ dS m}^{-1}$  respectively.

Data further revealed that soil available nitrogen, phosphorus and potassium vary from 225 to 248, 31.11 to 35.18 and 280 to  $321 \text{ kg ha}^{-1}$ , respectively, with corresponding mean value of 235.7, 33.29 and  $302.7 \text{ kg ha}^{-1}$ , respectively indicating low, medium and high status, respectively. Available sulphur is found to range from 16.31 to  $17.91 \text{ mg kg}^{-1}$  with a mean value of  $17.00 \text{ mg kg}^{-1}$  indicating its medium status.

**Table 21: Organic carbon  $\text{pH}_{2.5}$ ,  $\text{EC}_{2.5}$  and available nutrients of soil samples from barren land and management**

Sample	OC	$\text{pH}_{2.5}$	$\text{EC}_{2.5}$	N	$\text{P}_2\text{O}_5$	$\text{K}_2\text{O}$	S
	$\text{g kg}^{-1}$		$\text{dS m}^{-1}$				
1	2.3	7.69	0.35	230	32.12	320	16.31
2	2.6	7.77	0.37	225	33.47	315	17.47
3	2.4	7.73	0.38	231	35.17	321	16.33
4	2.1	7.57	0.39	246	33.12	311	17.91
5	2.2	7.74	0.31	241	31.11	309	17.37
6	2.5	7.61	0.33	233	32.16	280	16.42
7	2.3	7.59	0.31	227	34.17	287	16.74
8	2.6	7.77	0.35	229	35.18	291	16.99
9	2.8	7.71	0.31	247	34.27	296	17.17
10	2.1	7.67	0.33	248	32.17	297	17.31
Mean	2.4	7.69	0.34	235.7	33.29	302.7	17.00
Range	(2.1-2.8)	(7.57-7.77)	(0.31-0.39)	(225-248)	(31.11-35.18)	(280-321)	(16.31-17.91)

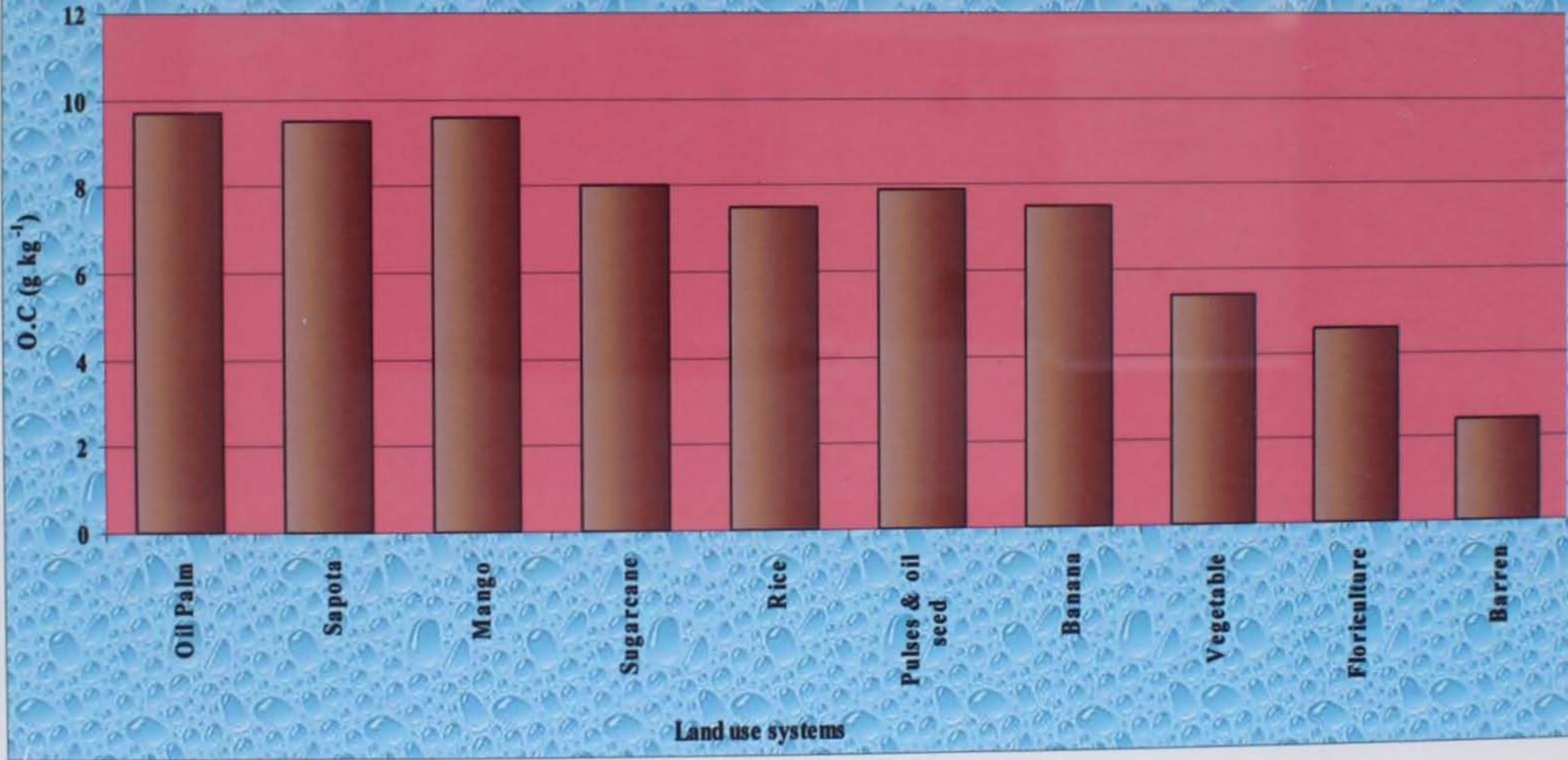
## 4.2 Effect of different existing land use and management on organic carbon, pH<sub>2.5</sub>, EC<sub>2.5</sub> and available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S of soils.

### 4.2.1 Effect of different land use and management on soil organic carbon

Mean soil organic carbon content associated with each land use system are expressed in the form of a graphical presentation (Fig. 1). The results revealed that soil under oil palm contained the highest organic carbon followed by mango, sapota, sugarcane, pulses & oilseed, banana, rice, vegetables, floriculture and barren land. No appreciable difference has been observed in the content of organic carbon in soils under oil palm, sapota and mango land use system *i.e.*, within 'Tree/Plantation land use group', where organic carbon are more or less, same. Similarly, under sugarcane, rice and pulses and oil seed system *i.e.*, within 'Agricultural land use group' the content of soil organic carbon are more or less same. Though banana plant can be considered under 'Horticultural land use group', yet it shows almost equivalent content of soil organic carbon as that under 'Agricultural land use group'. Within 'Horticultural land use group' soil under floriculture shows inferior in organic carbon content. Barren land depicts the least content of organic carbon.

The reasons for higher content of organic carbon in soil under oil palm, sapota and mango or 'Tree/Plantation land use group' might be ascribed to higher addition of organic biomass through litter fall as well as due to least disturbance of these soils. On the contrary, least addition of organic biomass, high rate of decomposition, oxidation of native organic matter and less canopy coverage are major reasons for the least organic carbon content under barren

**Fig-1: Effect of different land use and management on soil Organic carbon**



land. The lowest content of organic carbon in uncultivated land was reported by Sharma and Bali (2000). Variation of inputs (inorganic fertilizers and organic manures including bio-compost *etc.*) crop uptake, crop- root- biomass and their decomposition and canopy coverage are some of the major possible factors responsible for variation in organic carbon in other land use systems of NAU, campus. Results were in good agreement as obtained by Sharma *et al.* (2001), Kumar *et al.* (2006), Singh *et al.* (2006), Zhang *et al.* (2006) and Dhaliwal *et al.* (2008), wherein they found higher content of soil organic carbon under tree plantation in forest or plantation land use system as compared to agricultural land use and waste land use system. Poor carbon status in barren land of the campus suggests that land should not be kept barren, rather it should be kept under green cover through plantation or further efforts must be on for improving soil organic carbon particularly in soil under floriculture and vegetable through addition of more organic manures/biomass for possible increase in crop yield and for sustenance of soil health as well.

#### 4.2.2 Effect of different land use and management on soil pH<sub>2.5</sub>

Mean soil pH<sub>2.5</sub> associated with each of all land use systems are graphically presented in (Fig. 2). Soil pH<sub>2.5</sub> varies from 5.82 to 8.00 indicating soils are acidic to slightly alkaline in reaction. When soil pH<sub>2.5</sub> under different land use system are compared, no appreciable difference in soil pH<sub>2.5</sub> are observed as to different land use system, except rice soil which exhibits medium acidic pH<sub>2.5</sub> with a value of 5.82. Application of higher quantum of water, acid producing fertilizers and removal of basic cations through leaching under waterlogged condition are the major possible contributing factors for low soil pH<sub>2.5</sub> in rice soil. This result highly corroborates with the findings of Bouman *et al.* (1995), Wakene Negassa and Heluf Gebrekidan (2003).

Fig-2 :Effect of different land use and management on soil pH<sub>2.5</sub>



Soil under sapota exhibits the highest  $pH_{2.5}$  in comparison to soils under other land uses. Similar result was obtained by Singh *et al.* (2006), wherein higher soil  $pH_{2.5}$  was reported under orchard land use system. Results are in agreement with the findings of Dhaliwal *et al.* (2008) wherein they mentioned comparatively higher  $pH_{2.5}$  in undisturbed soil as compared to cultivated land.

#### 4.2.3 Effect of different land use and management on soil $EC_{2.5}$

Mean soil electrical conductivity value associated with each land use system are expressed graphically and presented in (Fig. 3) which revealed that soil under all the system are normal though the rice recorded the highest soil  $EC_{2.5}$  followed by sugarcane, banana, floriculture, oil palm, vegetable, pulses and oilseed, sapota, barren and mango land use system. The higher  $EC_{2.5}$  or the higher salt accumulation in surface soil of rice, sugarcane as well as banana might have arisen from soluble salts accumulated from higher quantum or frequency of applied irrigation water coupled with higher tillage practices. Similar result was obtained by Somasundaram *et al.* (2008).

Minimum salt accumulation under mango plantation might be due to less surface evaporation as a result of higher canopy coverage coupled with comparatively less watering/irrigation. There is no marked difference in soil  $EC_{2.5}$  in rest of the land use system. However, relative difference in  $EC_{2.5}$  under different crops/vegetations/barren systems may be attributable to varying degree of irrigation, canopy coverage and salt absorption capacity of plants/vegetations/trees.

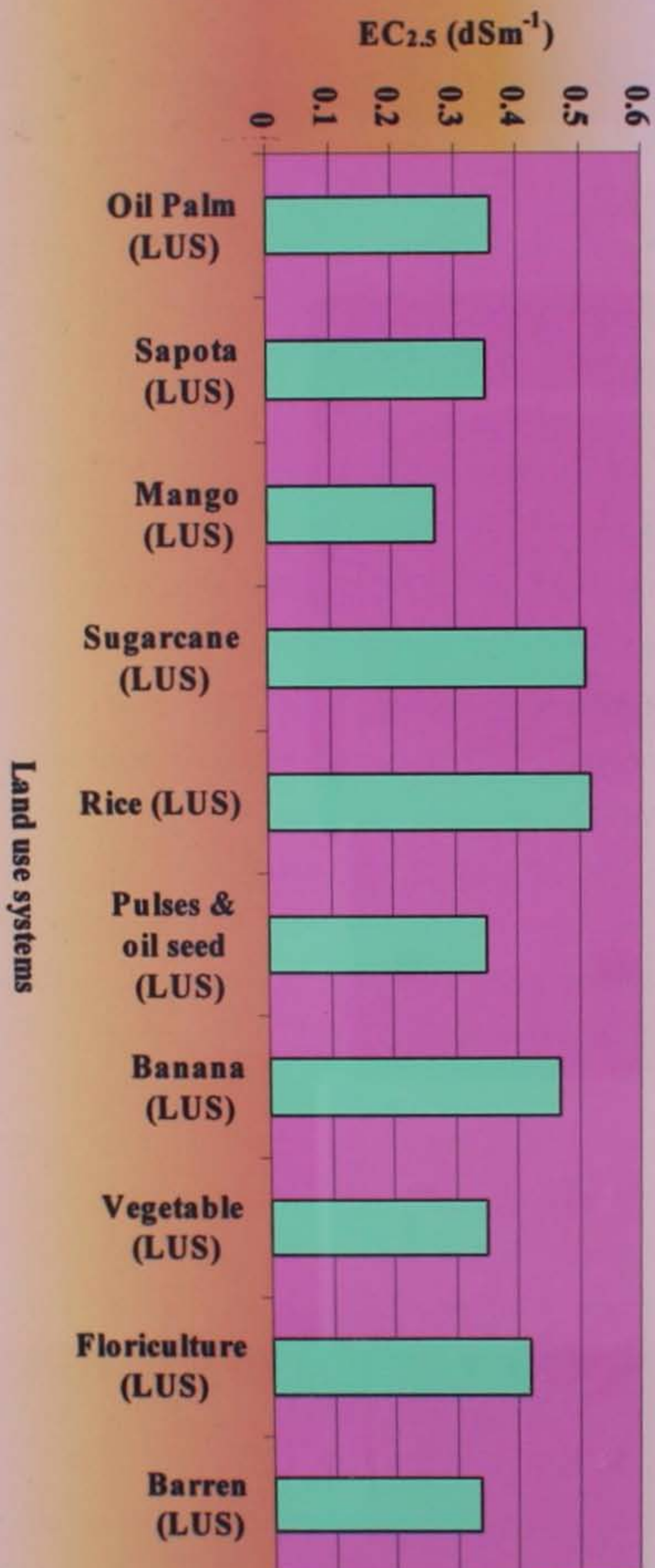


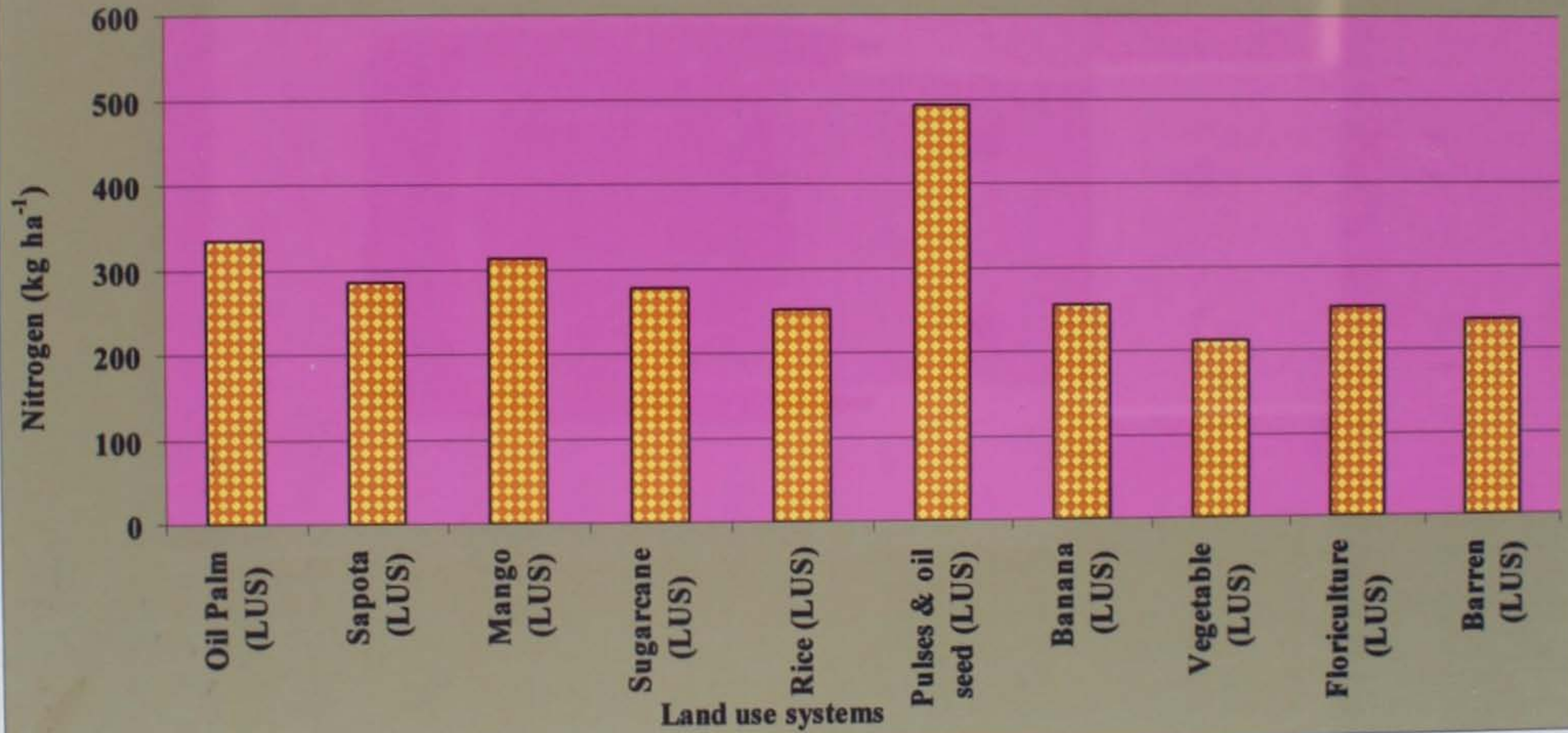
Fig-3: Effect of different land use and management on soil Electrical conductivity

#### 4.2.4 Effect of different land use and management on soil available nitrogen

Mean soil available nitrogen content associated with each land use system are expressed in the form of a graph and presented in (Fig. 4) which revealed that the available nitrogen in soils under all the land use systems are either low or marginally medium, except that has been found to record the highest available soil nitrogen under pulses and oilseed (494 kg ha<sup>1</sup>). Next to this ranking of available nitrogen are oil palm > mango > sapota > sugarcane > banana > rice > floriculture > barren land > vegetable land use system. The possible reason for higher soil available nitrogen in soils under pulses and oilseed crop might be the supplemental addition of nitrogen in soil over the years through symbiotic atmospheric nitrogen fixation by bacteria as well as decomposition of their root biomass. Barring pulses and oilseed, oil palm, sapota and mango plantation *i.e.*, “Tree/Plantation land use group” have shown their ability to exhibit higher available soil nitrogen as compared to rest of the land use systems.

One reason for low content of nitrogen in soil under vegetables might be due to its higher uptake of native as well as applied nitrogen because of higher crop productivity. Another reason for low nitrogen status in soils under vegetables, floriculture and barren land might be due to their low content of soil organic carbon which plays a pivotal role in the mineralization of nitrogen in soil. Comparatively higher status of available nitrogen under oil palm, mango, sapota, sugarcane, banana and rice system over others might be due to higher content of native soil organic carbon coupled with application of quite a good amount of bio-compost in these soils during last two years. These result in confirmative of the findings of Kumar *et al.* (2006). Except soil under vegetable crops, other cultivated soils under different land uses show slightly

Fig-4 : Effect of different land use and management on soil available Nitrogen

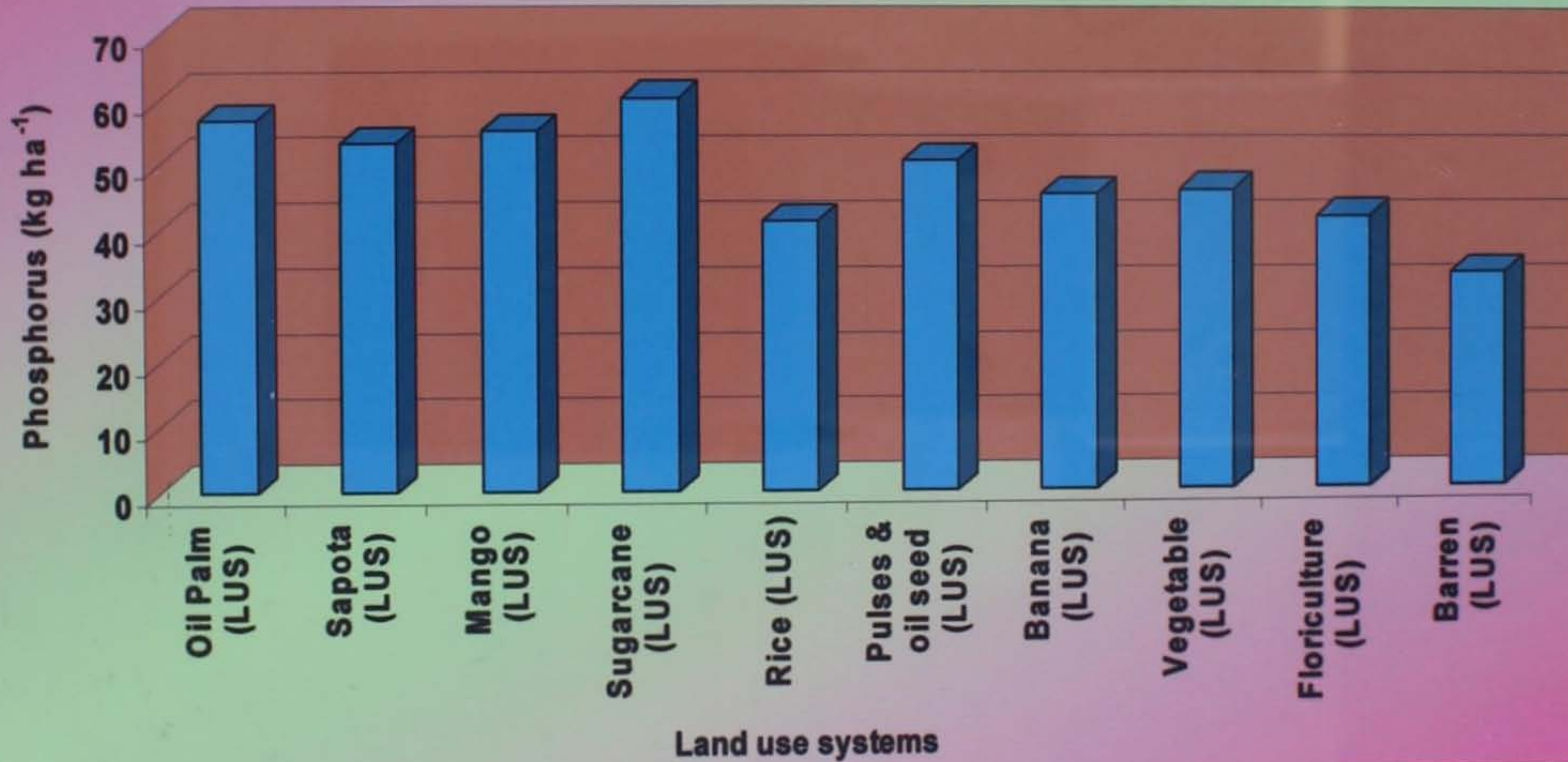


higher available nitrogen over barren land. These findings are in good agreement with the observation of Dhaliwal *et al.* (2008). The overall result calls for special measures for improving status of available nitrogen, particularly in soils of low available nitrogen through pulse crop/leguminous crops rotation as well as through addition of organic manures/compost/biomass and plots should not be kept barren.

#### **4.2.5 Effect of different existing land use and management on soil available phosphorus**

Mean value of soil available phosphorus obtained from all the existing land use systems are graphically presented in (Fig. 5). Irrespective of land use systems the mean available soil phosphorus is found to range from 33.29 to 60.30 kg ha<sup>-1</sup> *i.e.*, from medium to high status. The highest value of available phosphorus is recorded under sugarcane land use system while, the lowest one is registered under barren land. Available phosphorus under oil palm, sapota and mango plantation *i.e.*, 'Tree/Plantation land use group' and sugarcane are found to be higher as compared to that under rest of the land use systems. The higher content of available phosphorus under 'Tree/Plantation land use group' and sugarcane might have arisen from higher organic biomass with their subsequent decomposition under these plantation and partially due to build up phosphorus as a result of continuous application of organic and inorganic phosphatic fertilizer in case of sugarcane system. Type of vegetation/crop, application of fertilizer/manures and variation in uptake of phosphorus are some of the major factor as are responsible for variation of available soil phosphorus under rest of the systems. In general, all cultivated soils including soils under Tree/Plantation exhibit higher available phosphorus over that under barren land or undisturbed soil. These results are fully

Fig.-5 : Effect of different land use and management on soil available Phosphorus



supported by the findings of Dhaliwal *et al.* (2008) and partially by Kumar *et al.* (2006).

#### **4.2.6 Effect of different existing land use and management on soil available potassium**

Mean value of soil available potassium obtained from all the existing land use systems are graphically presented in (Fig. 6). Soils of NAU campus, being either *Vertisols* or *Inceptisols* in order, contain generally high available potassium. Mean available soil potassium in different land use systems range from 143.2 to 421.3 K<sub>2</sub>O kg ha<sup>-1</sup> *i.e.*, from marginally medium to high status. The highest value is recorded under sugarcane land use system, while the lowest one is registered under rice land use system. Except soils under rice and floriculture which exhibit marginally medium and highly medium, respectively, soils of all other systems have been found to contain high status of potassium. Leaching losses under puddled land/waterlogged condition coupled with uptake are main responsible factors for high depletion of available potassium in rice soils. The low status of available potassium in rice and floriculture soils call for special attention in respect to potassium management for balanced nutrition of crop and higher production. Cropping pattern/land use, management of crop and plant uptake may be considered as the key factors and are responsible for variation of mean available potassium in soils under different land use systems. Similar results have been reported by Ganeshamurthy and Srinivasarao (2009).

#### **4.2.7 Effect of different existing land use and management on soil available sulphur**

Mean value of soil available sulphur obtained from all the existing land use systems are graphically presented in (Fig. 7). Mean soil

Fig.-6 : Effect of different land use and management on soil available Potassium.

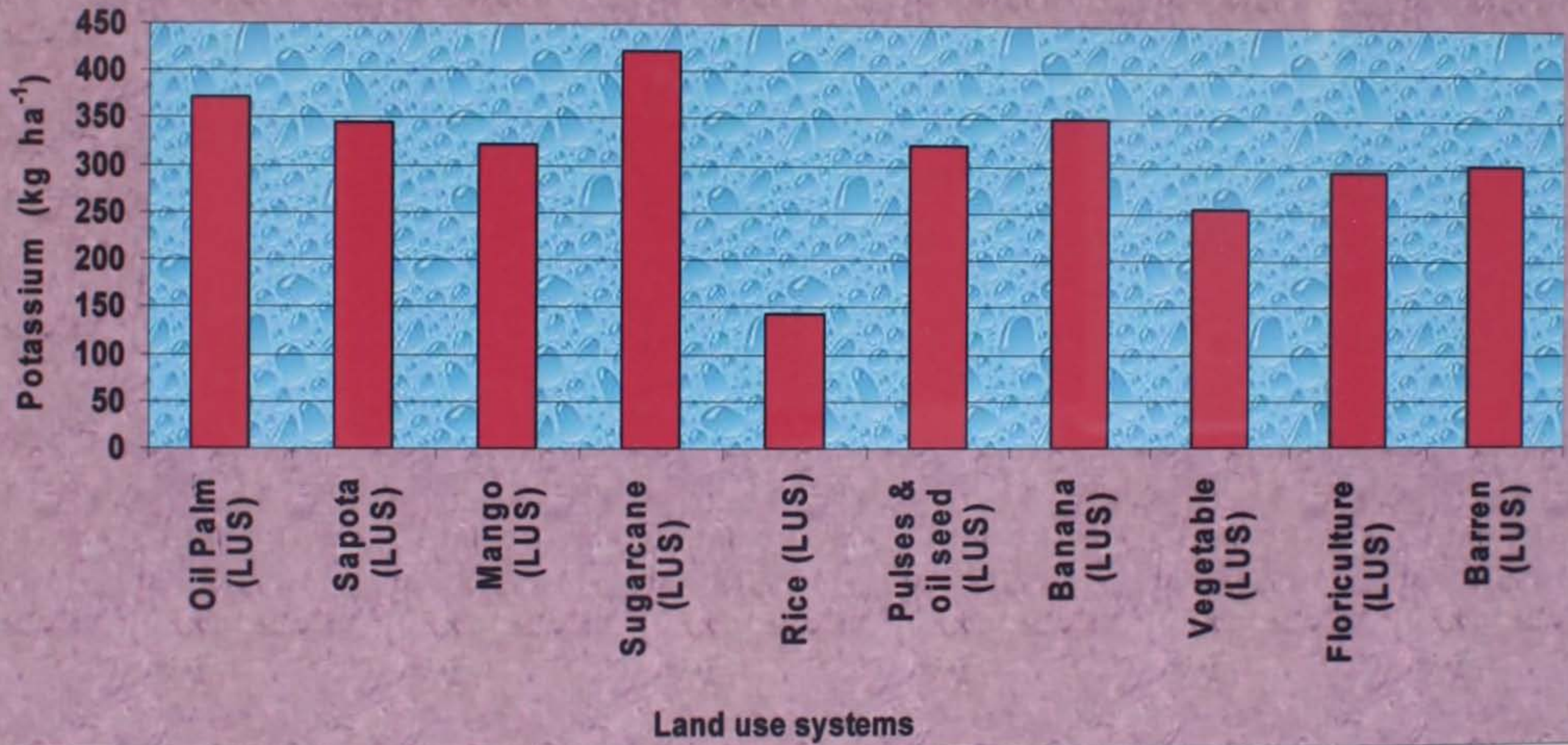
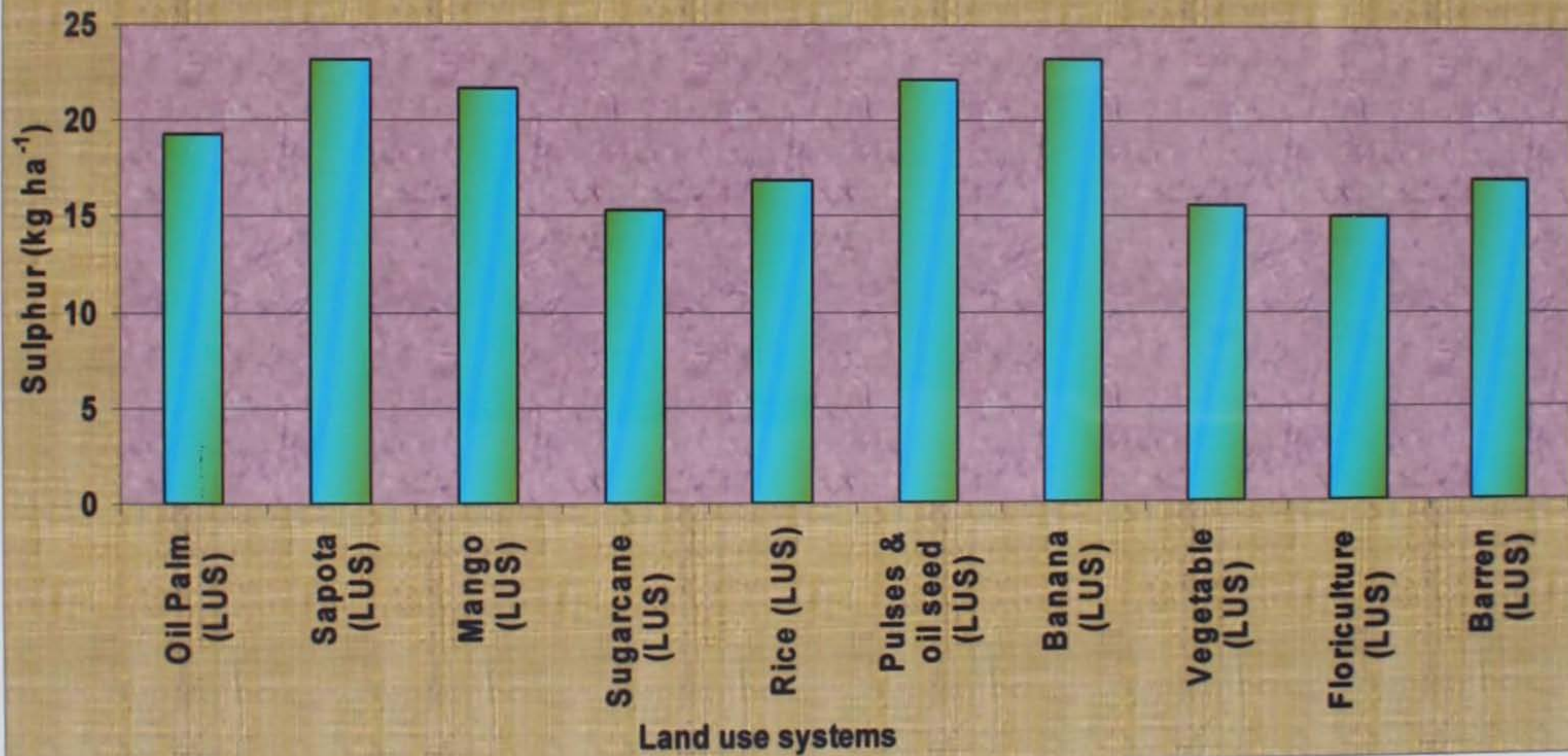


Fig.-7 : Effect of different land use and management on soil available Sulphur



available sulphur irrespective of different land use system varies from 15.03 to 23.25 mg kg<sup>-1</sup> *i.e.*, from medium to high status. The highest value of 23.25 mg kg<sup>-1</sup> is associated with banana land use system followed by sapota, pulses and oilseed, mango, oil palm, barren, rice, sugarcane and vegetable land use system and the lowest value (15.03 mg kg<sup>-1</sup>) is found to be associated with floriculture land use system. As organic matter plays a major role in generating available sulphur in soil, the higher status of sulphur or its comparatively higher content in soils of sapota, mango, banana, pulses and oilseed and oil palm might be due to higher content of soil organic carbon or higher addition of organic matter in these soils. Desai *et al.* (2009) obtained similar result, wherein they found higher status of available sulphur in soils receiving organics or crop residue as compared to soils which receive only inorganic inputs. The addition of sulphur through different sources in pulses and oilseed crops might be another reason of higher content of sulphur in these soils. However, the variation in the content of available sulphur might be attributed to the interaction effect among release of sulphur from soil organic matter, application of manure and fertilizer crop uptake.

### **4.3 Status of available micronutrients and physical properties of soil under different land use and management**

#### **4.3.1 Soil under existing oil palm land use and management**

The available micronutrient status under oil palm land use system revealed (Table 22) that Zn, Fe, Mn and Cu range from 0.41 to 0.59, 5.56 to 7.54, 7.75 to 9.25 and 0.15 to 0.90 mg kg<sup>-1</sup> respectively with chronological mean value of 0.51 (*marginally medium*), 6.64 (*medium*), 8.28 (*medium*) and 0.28 (*medium*) mg kg<sup>-1</sup> respectively.

So far as soil physical parameters are concerned, bulk density ranges from 1.47 to 1.52 Mg m<sup>-3</sup> with a mean of 1.49 Mg m<sup>-3</sup>, while water stable aggregates of size > 0.5 mm varies from 46.88 to 63.95 per cent with mean value of 59.85 per cent respectively.

**Table 22: Status of available micronutrients and physical properties of soil samples from oil palm land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.55	6.56	7.75	0.11	1.49	62.12
2	0.58	7.24	7.96	0.90	1.51	62.39
3	0.51	6.25	7.88	0.11	1.48	63.95
4	0.59	7.45	9.25	0.12	1.48	63.07
5	0.41	5.91	8.74	0.14	1.48	46.88
6	0.43	5.88	8.00	0.15	1.47	56.61
7	0.48	7.54	9.11	0.90	1.52	62.75
8	0.47	7.16	7.81	0.15	1.47	61.5
9	0.51	5.56	8.56	0.10	1.51	56.64
10	0.53	6.89	7.77	0.13	1.49	62.55
Mean	0.51	6.64	8.28	0.28	1.49	59.85
Range	(0.41-0.59)	(5.56-7.54)	(7.75-9.25)	(0.15-0.90)	(1.47-1.52)	(46.88-63.95)

#### 4.3.2 Soil under existing sapota land use and management

Under sapota land use system available Zn status is found to be low with a range from 0.40 to 0.48 mg kg<sup>-1</sup> in soil (Table 23). Available Fe shows low status having a range from 4.56 to 4.95 mg kg<sup>-1</sup>. Available Mn exhibits low to medium status showing a variation from 4.46 to 5.32 mg kg<sup>-1</sup>, while Cu shows marginally medium status with a range from 0.25 to 0.28 mg kg<sup>-1</sup>. Mean value of available Zn, Fe, Mn and Cu are observed to be 0.44, 4.77, 4.95 and 0.26 mg kg<sup>-1</sup> respectively.

Bulk density of soils under this land use ranges from 1.45 to 1.48 Mg m<sup>-3</sup> with a mean of 1.47 Mg m<sup>-3</sup>, while water stable aggregates of size >

0.5 mm range from 62.51 to 68.34 per cent respectively with mean value 66.53 per cent.

**Table 23: Status of available micronutrients and physical properties of soil samples from sapota land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.41	4.95	5.32	0.27	1.48	67.12
2	0.47	4.86	4.96	0.26	1.47	67.1
3	0.48	4.74	5.12	0.27	1.46	67.88
4	0.45	4.56	4.78	0.26	1.46	62.51
5	0.41	4.65	4.87	0.25	1.47	67.4
6	0.45	4.78	5.23	0.25	1.46	66.4
7	0.42	4.84	4.46	0.25	1.48	64.73
8	0.45	4.69	4.74	0.26	1.46	67.2
9	0.40	4.75	4.98	0.28	1.45	66.63
10	0.41	4.91	4.99	0.28	1.46	68.34
Mean	0.44	4.77	4.95	0.26	1.47	66.53
Range	(0.40-0.48)	(4.56-4.95)	(4.46-5.32)	(0.25-0.28)	(1.45-1.48)	(62.51-68.34)

#### 4.3.3 Soil under existing mango land use and management

Under mango land use system (Table 24) the available Zn ranges from 0.42 to 0.50 mg kg<sup>-1</sup> indicating low to medium status, Fe ranges from 9.10 to 10.13 mg kg<sup>-1</sup> indicating medium to high status, Mn varies 5.33 to 6.19 mg kg<sup>-1</sup> indicating its marginally medium value and Cu ranges from 0.21 to 0.25 mg kg<sup>-1</sup> indicating its slightly medium status with mean value of 0.45, 9.62, 5.68 and 0.23 mg kg<sup>-1</sup> respectively for Zn, Fe, Mn, and Cu in chronological order.

Bulk density of soils is observed to vary from 1.43 to 1.48 Mg m<sup>-3</sup> with a mean of 1.45 Mg m<sup>-3</sup>. Water stable aggregates of size > 0.5 mm range from 60.40 to 68.14 per cent, respectively with a mean value of 63.32 per cent.

**Table 24: Status of available micronutrients and physical properties of soil samples from mango land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.42	9.33	5.33	0.24	1.48	60.40
2	0.50	10.00	5.46	0.21	1.46	62.85
3	0.45	9.10	6.15	0.22	1.45	60.50
4	0.44	9.41	5.96	0.21	1.44	62.50
5	0.45	9.44	5.78	0.24	1.46	61.95
6	0.42	9.80	5.62	0.25	1.45	68.14
7	0.46	9.12	5.51	0.24	1.43	66.40
8	0.47	10.12	6.19	0.21	1.45	63.30
9	0.42	9.75	5.39	0.23	1.46	63.12
10	0.48	10.13	5.41	0.23	1.45	64.00
<b>Mean</b>	<b>0.45</b>	<b>9.62</b>	<b>5.68</b>	<b>0.23</b>	<b>1.45</b>	<b>63.32</b>
<b>Range</b>	<b>(0.42- 0.50)</b>	<b>(9.10- 10.13)</b>	<b>(5.33- 6.19)</b>	<b>(0.21- 0.25)</b>	<b>(1.43- 1.48)</b>	<b>(60.40- 68.14)</b>

#### 4.3.4 Soil under existing sugarcane land use and management.

The available micronutrient status under sugarcane land use system revealed (Table 25) that the mean values of Zn, Fe, Mn and Cu are 0.29, 6.23, 6.11 and 0.20 mg kg<sup>-1</sup> respectively. Available Zn varies from 0.21 to 0.38 indicating its low to medium status, Fe varies from 5.63 to 6.81 mg kg<sup>-1</sup> indicating its slightly medium status while Mn and Cu ranges from 5.51 to 6.68 mg kg<sup>-1</sup> and 0.18 to 0.22 mg kg<sup>-1</sup>, respectively indicating its slightly medium status and low to medium status, respectively.

In case of physical parameters, bulk density of soil under sugarcane land use ranges from 1.49 to 1.55  $\text{Mg m}^{-3}$  with a mean value of 1.52  $\text{Mg m}^{-3}$ , while water stable aggregates of size  $> 0.5$  mm range 50.52 to 65.66 per cent with a mean value of 58.18 per cent.

**Table 25: Status of available micronutrients and physical properties of soil samples from under sugarcane land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	$\text{mg kg}^{-1}$				$\text{Mg m}^{-3}$	$>0.5\text{mm}$
1	0.23	5.96	6.68	0.22	1.53	50.78
2	0.31	5.71	5.51	0.21	1.55	50.52
3	0.24	6.63	6.23	0.22	1.53	60.63
4	0.23	6.21	6.14	0.21	1.55	50.59
5	0.21	5.89	5.63	0.21	1.54	51.08
6	0.31	5.63	5.74	0.20	1.50	65.54
7	0.33	6.52	6.34	0.18	1.50	62.24
8	0.35	6.73	6.46	0.19	1.49	65.66
9	0.38	6.25	5.85	0.20	1.51	62.39
10	0.35	6.81	6.51	0.20	1.49	62.34
Mean	0.29	6.23	6.11	0.20	1.52	58.18
Range	(0.21-0.38)	(5.63-6.81)	(5.51-6.68)	(0.18-0.22)	(1.49-1.55)	(50.52-65.66)

#### 4.3.5 Soil under existing rice land use and management

The mean of available Zn, Fe, Mn and Cu status under rice land use system (Table 26) are 0.63, 20.48, 19.24 and 0.14  $\text{mg kg}^{-1}$  respectively. Available Zn varies from 0.60 to 0.65  $\text{mg kg}^{-1}$  indicating medium status. Fe ranges from 16.20 to 24.60  $\text{mg kg}^{-1}$  and Mn is observed to vary from 18.20 to 20.90  $\text{mg kg}^{-1}$  indicating their high status. Cu is observed to vary from 0.09 to 0.18  $\text{mg kg}^{-1}$  exhibiting low status.

Bulk density of soil under rice land use ranges from 1.59 to 1.64  $\text{Mg m}^{-3}$ , with a mean value of 1.62  $\text{Mg m}^{-3}$ , while water stable aggregates of

size > 0.5 mm showed variation from 22.36 to 26.61 per cent with a mean value of 24.19 per cent.

**Table.26: Status of available micronutrients and physical properties of soil samples from rice land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.64	21.8	18.2	0.09	1.60	25.42
2	0.61	22.1	19.8	0.10	1.63	24.72
3	0.63	23.3	20.3	0.16	1.64	22.57
4	0.62	24.6	20.9	0.15	1.64	24.67
5	0.64	22.8	19.2	0.18	1.64	25.36
6	0.63	19.7	19.1	0.17	1.61	22.42
7	0.61	18.2	18.2	0.12	1.61	26.61
8	0.6	19.8	19.7	0.14	1.59	24.36
9	0.63	16.2	18.3	0.13	1.59	23.42
10	0.65	16.3	18.7	0.11	1.60	22.36
<b>Mean</b>	<b>0.63</b>	<b>20.48</b>	<b>19.24</b>	<b>0.14</b>	<b>1.62</b>	<b>24.19</b>
<b>Range</b>	<b>(0.60-0.65)</b>	<b>(16.20-24.60)</b>	<b>(18.20-20.90)</b>	<b>(0.09-0.18)</b>	<b>(1.59-1.64)</b>	<b>(22.36-26.61)</b>

#### 4.3.6 Soil under existing pulses and oil seed land use and management

The available micronutrient status under pulses and oilseed land use system revealed (Table 27) that the lower and upper limits of Zn are 0.30 and 0.39 mg kg<sup>-1</sup> indicating its medium status, Fe and Mn varies from 6.51 to 7.77 mg kg<sup>-1</sup> and 6.21 to 7.98 mg kg<sup>-1</sup> indicating their medium status, while Cu is observed to vary from 0.12 to 0.18 mg kg<sup>-1</sup> indicating low status. The mean value of available Zn, Fe, Mn and Cu are 0.35, 7.15, 7.11 and 0.15 mg kg<sup>-1</sup> respectively.

Bulk density of soil under this land use ranges from 1.56 to 1.60 Mg m<sup>-3</sup> with a mean value of 1.58 Mg m<sup>-3</sup> while water stable aggregates of size

> 0.5 mm ranged from 52.81 to 63.86 per cent with a mean value of 58.73 per cent.

**Table 27: Status of available micronutrients and physical properties of soil samples from pulses & oilseed land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.33	6.78	7.73	0.15	1.58	52.81
2	0.32	7.71	6.23	0.12	1.57	55.91
3	0.39	6.68	6.21	0.13	1.59	53.11
4	0.37	7.63	7.78	0.17	1.57	54.11
5	0.39	6.51	6.78	0.16	1.59	55.01
6	0.33	6.55	6.71	0.17	1.59	63.26
7	0.35	7.77	6.21	0.12	1.60	62.62
8	0.30	6.89	7.71	0.18	1.56	63.86
9	0.35	7.25	7.98	0.14	1.56	63.36
10	0.39	7.76	7.78	0.12	1.57	63.26
<b>Mean</b>	<b>0.35</b>	<b>7.15</b>	<b>7.11</b>	<b>0.15</b>	<b>1.58</b>	<b>58.73</b>
<b>Range</b>	<b>(0.30-0.39)</b>	<b>(6.51-7.77)</b>	<b>(6.21-7.98)</b>	<b>(0.12-0.18)</b>	<b>(1.56-1.60)</b>	<b>(52.81-63.86)</b>

#### 4.3.7 Soil under existing banana land use and management

The available micronutrient status under banana land use system revealed (Table 28) that Zn ranges from 0.31 to 0.49 mg kg<sup>-1</sup> indicating its low status, Fe varies from 6.11 to 7.35 mg kg<sup>-1</sup> indicating its medium value, Mn show its limit from 6.45 to 7.56 mg kg<sup>-1</sup> indicating its medium value, while Cu varies from 0.15 to 0.18 mg kg<sup>-1</sup> indicating its slightly low status with chronological mean value of 0.38, 6.70, 6.92 and 0.17 mg kg<sup>-1</sup> respectively.

Bulk density of soil under banana land use ranges from 1.54 to 1.63 Mg m<sup>-3</sup> with a mean value of 1.59 Mg m<sup>-3</sup>, while water stable aggregates of size > 0.5 mm range from 41.31 to 51.22 per cent with a mean of 45.67 per cent respectively.

**Table 28: Status of available micronutrients and physical properties of soil samples from banana land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.31	6.23	6.91	0.17	1.63	41.92
2	0.32	6.11	6.98	0.18	1.63	46.75
3	0.31	6.35	6.87	0.16	1.63	51.22
4	0.34	7.12	6.81	0.16	1.62	46.20
5	0.32	7.35	7.56	0.15	1.60	47.39
6	0.35	6.51	7.35	0.15	1.61	45.25
7	0.47	7.19	6.75	0.17	1.55	47.00
8	0.48	6.41	6.56	0.19	1.58	46.31
9	0.49	6.51	6.45	0.20	1.54	41.31
10	0.43	7.22	6.95	0.19	1.54	43.35
Mean	0.38	6.70	6.92	0.17	1.59	45.67
Range	(0.31-0.49)	(6.11-7.35)	(6.45-7.56)	(0.15-0.18)	(1.54-1.63)	(41.31-51.22)

#### 4.3.8 Soil under existing vegetable land use and management

The available micronutrient status under vegetable land use system revealed (Table 29) that Zn, Fe, Mn and Cu varies from 0.20 to 0.35, 3.45 to 4.91, 4.21 to 5.81 and 0.11 to 0.14 mg kg<sup>-1</sup> indicating low, low, low to medium and low status with respect to available Zn, Fe, Mn and Cu respectively. The mean of available Zn, Fe, Mn and Cu are found to be 0.30, 4.19, 4.99 and 0.12 mg kg<sup>-1</sup> respectively.

Bulk density of soil under vegetable land use ranges from 1.69 to 1.72 Mg m<sup>-3</sup> with a mean value of 1.70 Mg m<sup>-3</sup> while water stable aggregates of size > 0.5 mm ranges from 36.92 to 50.08 per cent with a mean value of 44.15 per cent.

**Table 29: Status of available micronutrients and physical properties of soil samples from vegetable land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.22	4.91	5.81	0.11	1.69	45.28
2	0.35	3.45	4.21	0.13	1.71	40.10
3	0.24	3.65	4.55	0.12	1.69	44.75
4	0.31	4.73	5.51	0.11	1.71	36.92
5	0.20	3.81	4.81	0.12	1.71	44.85
6	0.33	4.51	5.11	0.13	1.71	47.10
7	0.35	3.72	4.61	0.12	1.70	50.08
8	0.32	3.55	4.35	0.14	1.69	42.40
9	0.31	4.87	5.62	0.11	1.69	45.80
10	0.33	4.65	5.31	0.11	1.72	44.18
<b>Mean</b>	<b>0.30</b>	<b>4.19</b>	<b>4.99</b>	<b>0.12</b>	<b>1.70</b>	<b>44.15</b>
<b>Range</b>	<b>(0.20-0.35)</b>	<b>(3.45-4.91)</b>	<b>(4.21-5.81)</b>	<b>(0.11-0.14)</b>	<b>(1.69-1.72-)</b>	<b>(36.92-50.08)</b>

#### 4.3.9 Soil under existing floriculture land use and management

The available micronutrient status under floriculture land use system revealed (Table 30) that Zn ranges from 0.18 to 0.24 mg kg<sup>-1</sup> indicating its low status, Fe varies from 5.13 to 6.72 mg kg<sup>-1</sup> indicating its medium status, Mn varies from 6.23 to 7.89 mg kg<sup>-1</sup> indicating its medium status, while Cu ranges from 0.14 to 0.19 mg kg<sup>-1</sup> indicating its low status with chronological mean value of 0.21, 5.82, 7.05 and 0.16 mg kg<sup>-1</sup> respectively.

So far as soil physical parameter are concerned, bulk density of soil under floriculture land use ranges from 1.68 to 1.73 Mg m<sup>-3</sup> with a mean value of 1.71 Mg m<sup>-3</sup>, while water stable aggregates of size > 0.5 mm ranges from 40.19 to 46.25 per cent with a mean value of 42.96 per cent.

**Table 30: Status of available micronutrients and physical properties of soil samples from floriculture land use and management**

Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.23	5.23	6.51	0.16	1.72	40.68
2	0.21	5.13	6.75	0.18	1.71	40.19
3	0.20	5.61	6.66	0.17	1.68	42.2
4	0.18	5.20	7.89	0.14	1.69	45.25
5	0.21	5.63	7.45	0.16	1.72	46.25
6	0.24	6.21	7.56	0.15	1.69	41.62
7	0.20	5.45	6.23	0.19	1.70	43.25
8	0.22	6.71	7.41	0.14	1.72	44.58
9	0.21	6.72	6.32	0.14	1.73	41.85
10	0.19	6.27	7.71	0.15	1.73	43.76
<b>Mean</b>	<b>0.21</b>	<b>5.82</b>	<b>7.05</b>	<b>0.16</b>	<b>1.71</b>	<b>42.96</b>
<b>Range</b>	<b>(0.18-0.24)</b>	<b>(5.13-6.72)</b>	<b>(6.23-7.89)</b>	<b>(0.14-0.18)</b>	<b>(1.68-1.73)</b>	<b>(40.19-46.25)</b>

#### 4.3.10 Soil under existing barren land and management.

The available micronutrient status under existing barren land revealed (Table 31) that available Zn ranges from 0.30 to 0.39 mg kg<sup>-1</sup> indicating its low value, Fe varies from 4.11 to 5.65 mg kg<sup>-1</sup> indicating its low to medium value, Mn varies from 5.09 to 6.71 mg kg<sup>-1</sup> indicating its medium status and Cu varies from 0.10 to 0.13 mg kg<sup>-1</sup> indicating its low status respectively with chronological mean value of 0.34, 4.90, 6.03 and 0.11 mg kg<sup>-1</sup> respectively.

Bulk density of soil under barren land ranges from 1.80 to 1.88 Mg m<sup>-3</sup> with a mean value of 1.83 Mg m<sup>-3</sup>, while water stable aggregates of size > 0.5 mm ranges from 28.62 to 35.94 per cent with a mean value of 31.59 per cent.

**Table 31: Status of available micronutrients and physical properties of soil samples from barren land and management**

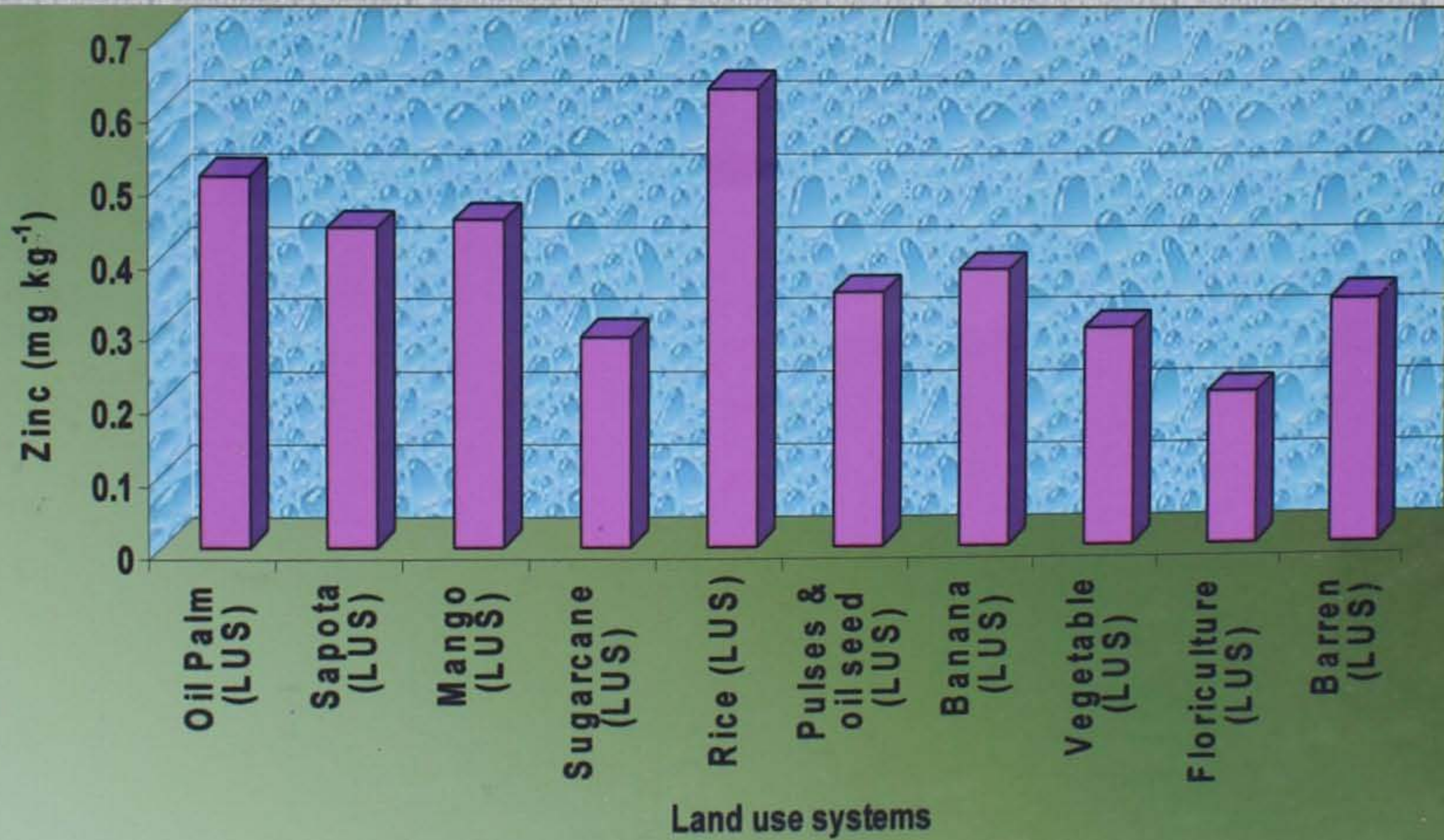
Sample	Zn	Fe	Mn	Cu	BD	WSA
	mg kg <sup>-1</sup>				Mg m <sup>-3</sup>	>0.5mm
1	0.33	5.11	6.11	0.11	1.82	33.32
2	0.31	4.29	6.21	0.12	1.88	30.18
3	0.32	4.57	5.61	0.12	1.82	31.93
4	0.39	5.65	6.71	0.10	1.83	28.62
5	0.31	4.38	5.56	0.10	1.83	29.00
6	0.37	5.41	6.45	0.12	1.81	34.92
7	0.39	5.53	6.53	0.11	1.83	31.02
8	0.30	4.11	5.09	0.12	1.80	32.09
9	0.33	4.75	5.75	0.13	1.80	35.94
10	0.35	5.23	6.23	0.11	1.83	28.85
Mean	0.34	4.90	6.03	0.11	1.83	31.59
Range	(0.30-0.39)	(4.11-5.65)	(5.09-6.71)	(0.10-0.13)	(1.80-1.88)	(28.62-35.94)

#### 4.4 Effect of different existing land use and management on micronutrients and physical properties of soil.

##### 4.4.1 Effect of different land use and management on soil available zinc

Mean value of soil available zinc obtained from all the existing land use system graphically presented in (Fig. 8). When all the land use systems are considered together, it is observed that, Zn ranges from 0.21 to 0.63 mg kg<sup>-1</sup>. The highest and the lowest value of available Zn are found to be associated with rice and floriculture land use systems. The addition of recommended dose of Zn might be reason for reflecting comparatively high available Zn in rice soil. The results further indicate that except soils under rice and oil palm system, other land use systems have been found to exhibit deficient status of available Zn, calling for adoption of corrective measures as to avoid Zn deficiency in the near future. Almost similar observations have

**Fig.-8 : Effect of different land use and management on available Zinc**

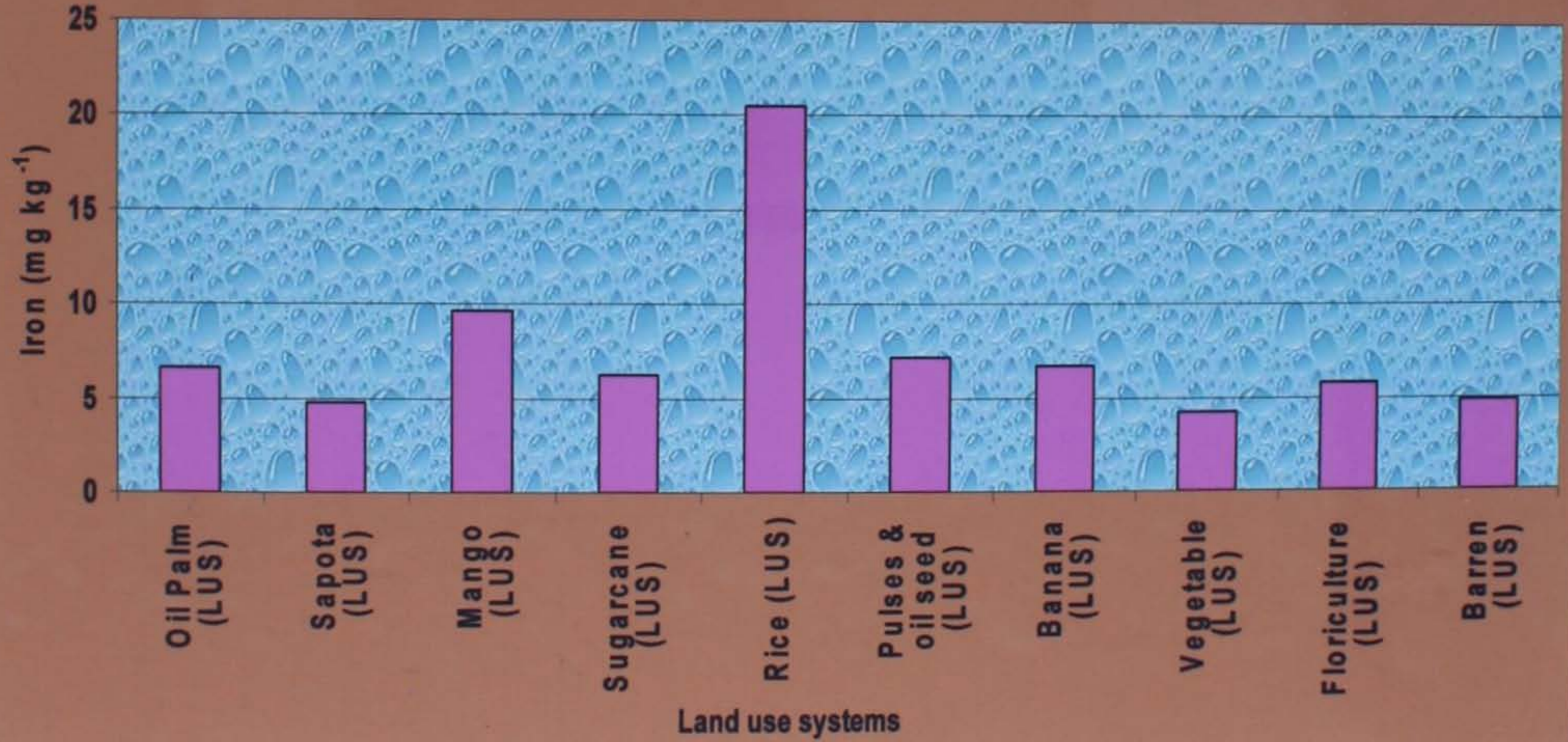


been made by Kathyal and Datta (2004) and Somasundaram *et al.* (2008). Application of Zn as per recommendation in rice as a part of management practices might be the reason for higher level of available Zn in rice soil.

#### 4.4.2 Effect of different land use and management on soil available iron

Mean value of soil available iron obtained from all the existing land use systems are graphically presented in (Fig. 9). When all land use systems of NAU, campus under study are considered it is observed that available Fe varies widely from 4.19 to 20.48 mg kg<sup>-1</sup>, exhibiting its low to high available status. The highest value of available Fe is found to be associated with rice soil and the lowest value with vegetable system. This fact indicates that different land use systems have impacted differently on available Fe content of soil. Soils under vegetables crop, barren land and sapota exhibit low to marginal status of available Fe, while in other systems (except rice) status of available Fe has been found to be medium. Exceptionally high available Fe under rice soil might have arisen due to lower pH of soils and reduced environment under water logged condition. The differences in available Fe content under other systems might be ascribed to the accelerated nutrient removal by crop under varying land use system and intensification. The available Fe below sufficiency range (6 to 8 mg kg<sup>-1</sup>) particularly in sapota, vegetable and floriculture systems suggest that Fe deficiency symptoms may develop in near future unless it is replenished through addition of organic matter or some other means. Similar findings in relation to critical limits of iron were reported by Sharma *et al.* (2001).

Fig.-9 : Effect of different land use and management on soil available Iron



#### 4.4.3 Effect of different land use and management on soil available manganese

Mean value of soil available Mn obtained from all the existing land use systems are graphically presented in (Fig. 10). Available Mn has shown wide variation in its available status having range from 4.95 to 19.24 mg kg<sup>-1</sup>, with the highest value associated with rice soil and the lowest one with sapota land use system. Soil available Mn has been found to follow, more or less, similar trend as that of available iron under different land use systems. This fact indicates that like available iron, land use systems imparted varying impact on available Mn content of soil. Soils under vegetable crops and sapota are observed to be exhibit low to marginal status of available Mn, while in other systems (except rice) status of the Mn has been found to be medium. The reason for exceptionally high available Mn under rice soil is almost the same as that is observed for iron. Comparatively higher pH transforms divalent form of Mn into tri or tetravalent forms of Mn which are water insoluble and not available to crop plants. The reasons for differences in available Mn under other systems are same as described in case of available iron. The available Mn below sufficiency range (6 to 8 mg kg<sup>-1</sup>) particularly in sapota and vegetable system suggest that Mn deficiency is required to be corrected to avoid possible adverse effect on crop yield under these land use systems. Sharma *et al.* (2001) described similar findings and results in relation to critical limits of Mn.

#### 4.4.4 Effect of different land use and management on soil available copper

Mean value of soil available Cu obtained from all the existing land use systems are plotted in the form of bar diagram (Fig. 11). The mean available Cu under varying land use system has been found to vary from 0.11

**Fig.-10 : Effect of different land use and management on soil available Manganese**

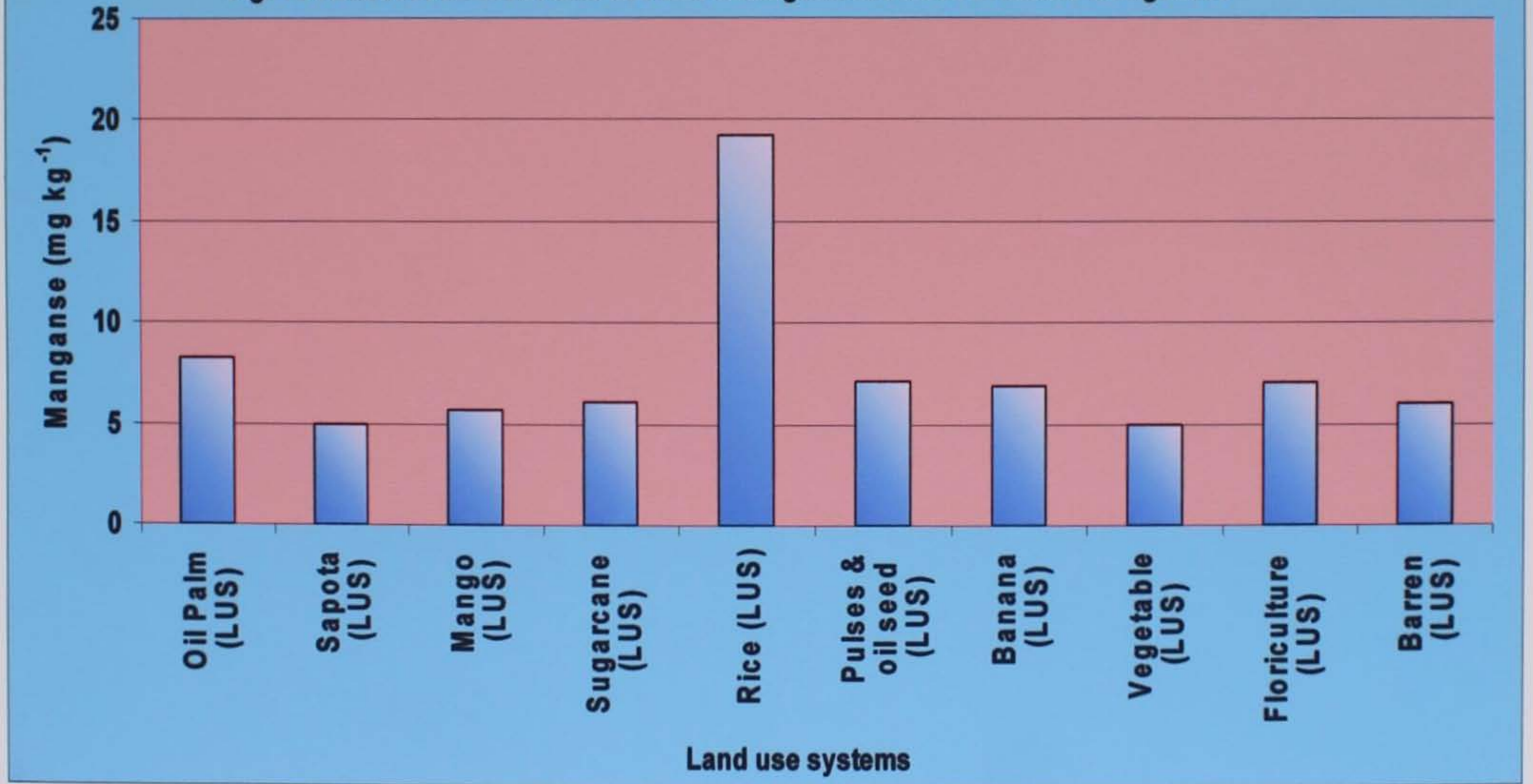
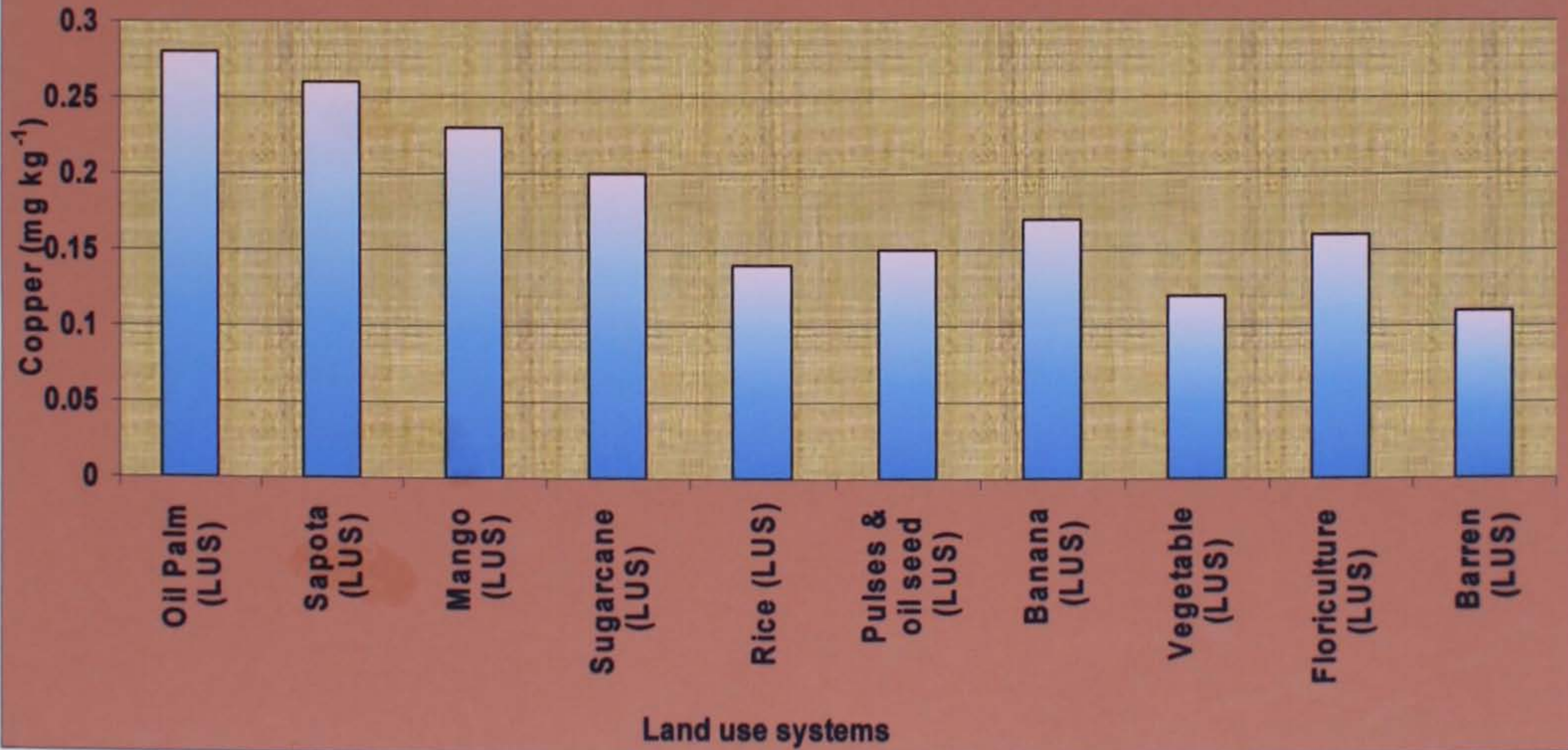


Fig.-11 : Effect of different land use and management on soil available Copper

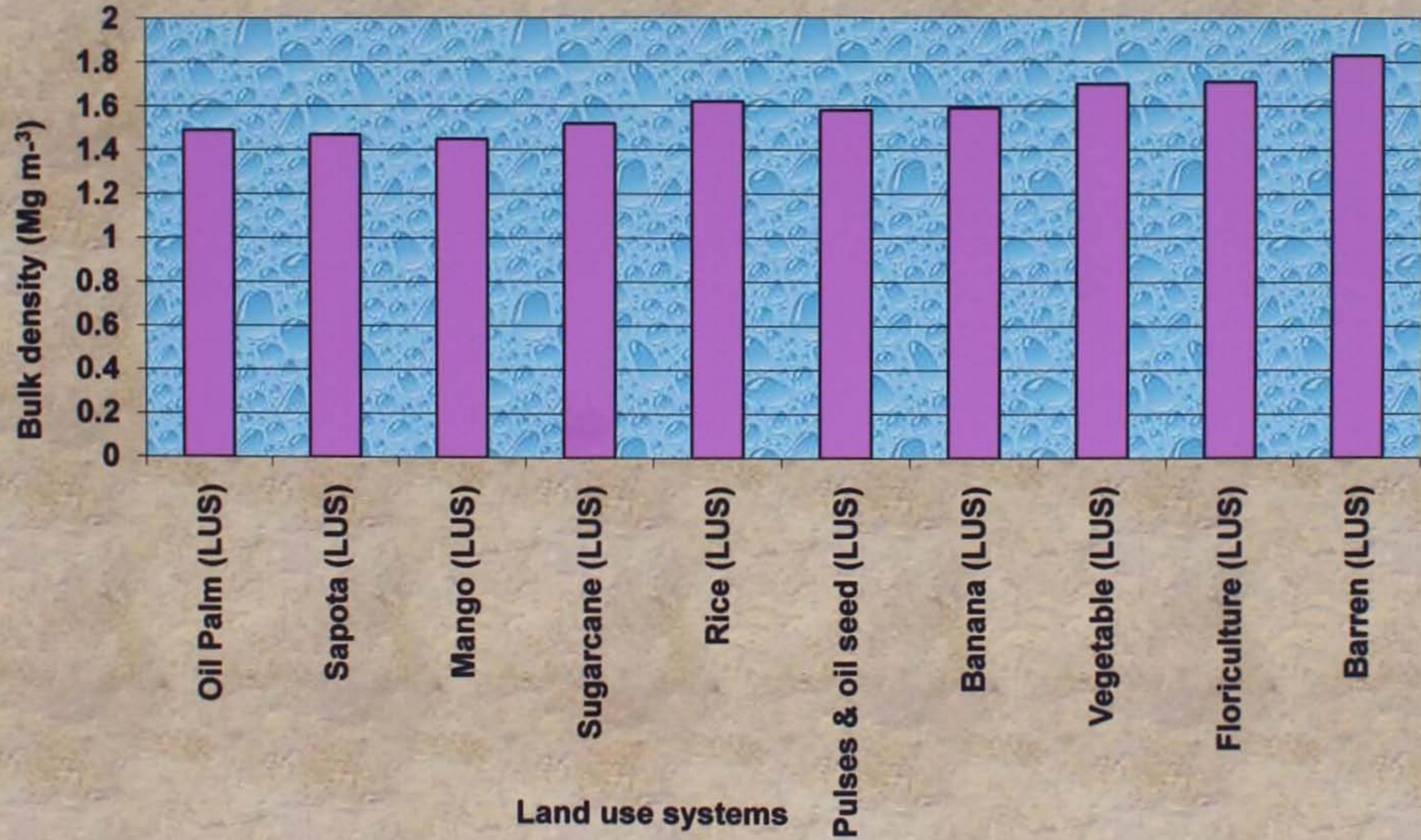


to  $0.28 \text{ mg kg}^{-1}$  indicating deficient to marginal status. Oil palm, sapota, mango and sugarcane land use system have exhibited marginal level of Cu while in rest of the system the same are found to be deficient as per Lindsay and Norvell (1978). However, Katyal and Sharma (1991) identified the critical limit of Cu and according to them soils of pulses and oil seed, sugarcane, banana, vegetable and barren land use system come below the critical limit wherein rest of the system are medium, might be due to the higher content of organic carbon. So far oil palm is concerned, slightly higher available Cu as other land uses might have arisen from continues addition of fertilizer containing Cu as a filler material. Similar results were also mentioned by Somasundaram (2006).

#### **4.4.5 Effect of different land use and management on soil bulk density (B.D)**

Mean value of soil bulk density obtained from different existing land use systems are graphically presented in (Fig. 12). When all the land use system of NAU, campus under study are considered, it is observed that the bulk density of soils under mango, sapota and oil palm *i.e.*, under “Tree/Plantation land use group” are lower value ( $1.45$  to  $1.49 \text{ Mg m}^{-3}$ ) as compared to those under other land uses. The reason might be due to the higher content of carbon or organic matter through addition of higher leaf- litter and twigs *etc.* to this soil as organic matter influences aggregate formation resulting in decrease in bulk density (Mathan and Kannan, 1993). On the other hand, barren land has exhibited the highest bulk density of  $1.83 \text{ Mg m}^{-3}$  possibly for no ploughing/tillage operation, less organic matter addition coupled with high rate of decomposition/oxidation under minimum canopy coverage. The highest bulk density in uncultivated land was reported by Sharma and Bali (2000). Soils under other land uses have shown intermediate values of bulk density

**Fig-12 : Effect of different land use and management on soil Bulk Density**

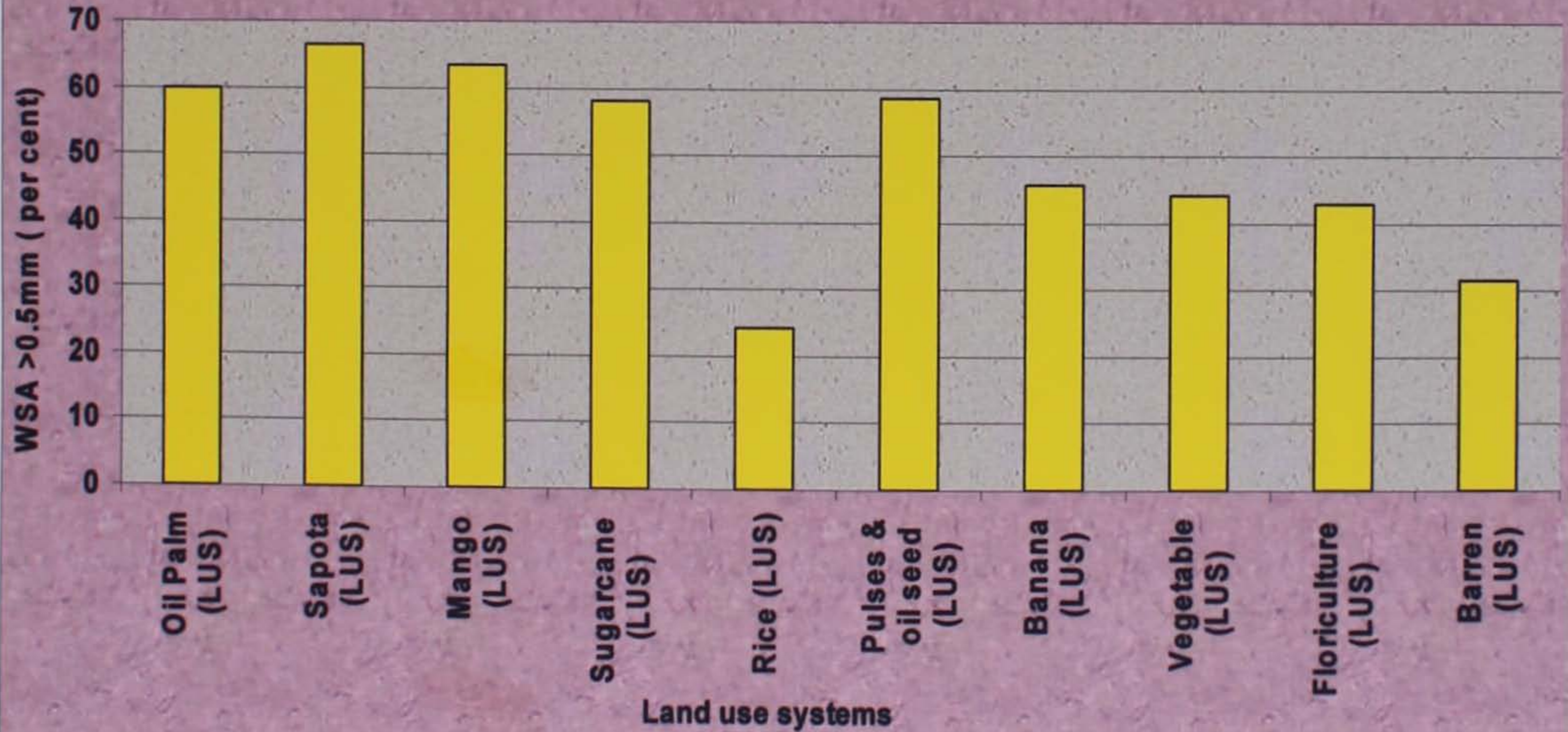


depending upon crops/vegetations, their management including tillage practices. However, soils under floriculture and vegetable land use depicted comparatively higher bulk density as compared to others which might be due to low organic carbon *i.e.*, organic matter content as discussed earlier results corroborates with the findings of Dhaliwal *et al.* (2008).

#### 4.4.6 Effect of different land use and management on soil Water Stable Aggregates (>0.5mm)

Irrespective of land use system when water stable aggregates >0.5 mm which are also considered as 'macro aggregates' varied widely (24.19 to 66.53 per cent) from system to system (Fig. 13), the highest and the lowest value were associated with sapota and rice land use system respectively. Comparatively higher per cent of macro aggregates are observed under sapota, mango and oil palm land use system *i.e.*, "Tree/Plantation land use group" followed by pulses and oil seed and sugarcane land use system *i.e.*, "Agricultural land use group" (excluding rice), followed by vegetable, floriculture and banana land use system *i.e.*, "Horticultural land use group". Similar result was reported by Kahlon *et al.* (2006), where in higher per cent of water stable aggregates was observed under forest plants followed by arable cultivated land and barren land. The higher per cent of water stable aggregates under "Tree/Plantation land use group" might be attributed to relatively higher organic carbon or organic matter content of these soils as well as relatively low tillage operation. Similar reason was also put forwarded by Mathon and Kannan (1993). The lowest per cent of aggregate under rice soil might have arisen because of puddling operations as a result of higher disintegration of aggregates/structures. Results indicate that cultivation practices, particularly in soils under "Agricultural land use group" and "Horticultural land use group", rate of organic matter loss has been faster by accelerated microbial

Fig.-13 : Effect of different land use and management on soil WSA > 0.5 mm



decomposition and reduced the proportion of water stable macro-aggregates, which hint us to adopt conservation agriculture to certain extent in order to expand minimum energy for ecological stability. These findings corroborates with the findings of Monreal and Kodama (1997). The barren land though contains the lowest per cent of carbon and as a result has exhibited second lowest per cent of aggregates after rice. Similar results were contributed by Zhang *et al.* (2008).

**Table 32: Simple Correlation between Organic carbon and other soil parameters of representative soils under different land use systems**

Land use Parameter	Oil Palm	Sapota	Mango	Sugarcane	Rice	Pulses and Oil Seed	Banana	Vegetable	Floriculture	Barren
pH <sub>2.5</sub>	0.16	0.16	0.55	-0.90**	-0.66*	0.23	0.41	-0.32	0.30	0.48
EC <sub>2.5</sub>	0.48	-0.35	0.67*	0.90**	-0.43	-0.07	0.82**	0.48	-0.07	-0.14
Avail.N	0.84**	0.42	0.34	0.70*	0.47	0.31	-0.77**	-0.19	0.93**	-0.30
Avail.P	0.00	0.33	0.03	0.95**	-0.25	0.30	0.32	-0.10	-0.36	0.53
Avail.K	0.38	0.37	0.33	0.87**	0.14	0.17	0.92**	0.09	0.47	-0.23
Avail.S	0.26	0.69*	0.27	0.82**	-0.12	-0.60	0.88**	-0.63*	-0.01	-0.21
Avail.Zn	-0.53	0.10	0.15	0.78**	0.08	-0.32	0.81**	-0.62	-0.07	-0.44
Avail.Fe	-0.24	-0.40	0.20	0.53	-0.61	0.29	0.60	0.11	0.17	-0.51
Avail.Cu	-0.69*	0.29	0.39	0.79**	0.52	0.22	0.46	-0.21	0.22	0.91**
Avail.Mn	-0.19	0.05	-0.07	0.37	-0.66*	0.66*	-0.28	0.22	-0.10	-0.42
B.D	-0.91**	-0.91**	-0.64*	-0.99**	-0.91**	-0.96**	-0.96**	-0.85**	0.15	-0.20
WSA (> 0.5mm)	-0.31	0.00	0.84**	0.93**	0.05	0.40	-0.27	0.00	0.34	0.75**

\* =Significant at 5 %

\*\* =Significant at 1%

#### 4.5 Simple correlation (r) of organic carbon with pH<sub>2.5</sub>, EC<sub>2.5</sub>, available N, P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O and S under different land use system

##### 4.5.1 Oil palm land use system

The data on correlation coefficients (r) between organic carbon and other soil parameters show (Table 32) that available nitrogen has shown a highly significant positive correlation with organic carbon ( $r=0.84^{**}$ ) which indicates that with the increase in soil organic carbon under this system available nitrogen increases. Bulk density of soil has highly significant but negative correlation ( $r=-0.91^{**}$ ) with organic carbon which means that with the increase in soil organic carbon bulk density of soil decreases. The available Cu show significant negative correlation ( $r=-0.69^*$ ) with organic carbon.

##### 4.5.2 Sapota land use system:

In sapota land use system available sulphur has shown a significant positive correlation with organic carbon ( $r=0.69^*$ ) and bulk density has formed a highly significant and negative correlation with organic carbon ( $r=-0.91^{**}$ ).

##### 4.5.3 Mango land use system

In mango land use system, a significant positive correlation is observed between electrical conductivity and organic carbon ( $r=0.67^*$ ) of soil while, a significant negative correlation is noticed between bulk density and organic carbon ( $r=-0.64^*$ ). The water stable aggregates of size > 0.5 mm has shown a highly significant and positive correlation ( $r=0.84^{**}$ ) with organic carbon.

##### 4.5.4 Sugarcane land use system:

In case of sugarcane land use system, highly significant positive correlations of organic carbon have been found with soil EC ( $r=0.90^{**}$ ), available P ( $r=0.95^{**}$ ), available K ( $r=0.87^{**}$ ), available S ( $r=0.82^{**}$ ), available Zn ( $r=0.78^{**}$ ), available Cu ( $r=0.79^{**}$ ) and water stable aggregates > 0.5 mm ( $r=0.93^{**}$ ), while a significant positive correlation ( $r=0.70^*$ ) of organic carbon was observed with available N. On the contrary, organic carbon is highly significant

but negatively correlated with soil  $\text{pH}_{2.5}$  ( $r=-0.90^{**}$ ) and with bulk density ( $r=-0.99^{**}$ ).

#### 4.5.5 Rice land use system

In soils under rice land use system, pH ( $r=-0.66^*$ ) and available Mn ( $r=-0.66^*$ ) have shown significant negative correlation with organic carbon, while bulk density has exhibited highly significant negative correlation ( $r=-0.91^{**}$ ) with organic carbon.

#### 4.5.6 Pulses & oilseed land use system

Available Mn in soil under pulses and oilseed is observed to be correlated significant and positively with organic carbon ( $r=0.66^{**}$ ), while soil bulk density is found to exhibit a highly significant negative correlation ( $r=-0.96^{**}$ ) with organic carbon.

#### 4.5.7 Banana land use system

So far as banana land use is concerned, soil organic carbon has been found to correlate highly positively and significantly with EC ( $r=0.82^{**}$ ), available K ( $r=0.92^{**}$ ), available S ( $r=0.88^{**}$ ) and available Zn ( $r=0.81^{**}$ ). On the contrary, organic carbon has shown highly significant negative correlation with available N ( $r=-0.77^{**}$ ) and with bulk density ( $r=-0.96^{**}$ ).

#### 4.5.8 Vegetable land use system

In case of vegetable land use system, available S ( $r=-0.63^*$ ) has shown significant negative correlation with organic carbon, while the correlation of bulk density is highly significant and negative ( $r=-0.85^{**}$ ) with organic carbon.

#### 4.5.9 Floriculture land use system

In floriculture land use system, a highly significant positive correlation is observed between available N ( $r=0.93^{**}$ ) and soil organic carbon.

#### 4.5.10 Barren land

In barren land, water stable aggregates of size  $> 0.5\text{mm}$  has come out with a highly significant positive correlation ( $r=0.75^{**}$ ) with organic carbon as well as available Cu shows highly significant positive correlation ( $r=0.91^{**}$ ) with organic carbon.

#### 4.6. Correlation between organic carbon and other soil parameters under different land use systems

Soil organic carbon is considered as a good indicator of soil productivity potential it has large bearing on soil physical, chemical and biological properties of soil and plays a pivotal role in sustaining soil quality, agricultural production and environmental quality. So, considering the importance of SOC correlations of organic carbon worked out with other soil parameters for varying existing land uses and management and discussed here.

Soil  $\text{pH}_{2.5}$  has been found to correlate negatively with SOC under sugarcane, rice and vegetable land use and positively with rest of the land use systems. Which is conforming to the findings of Dhaliwal *et al.* (2008). However, correlations under sugarcane ( $r= -0.90^{**}$ ) and rice system ( $r= -0.66^*$ ) only are observed to be highly significant and significant respectively. This finding is in conformity with Pal and Shrupali (2006). So far as soil  $\text{EC}_{2.5}$  is concerned, organic carbon is positively correlated in five land use systems except sapota, rice, pulses & oilseed, floriculture land use system and barren land. However, correlations with  $\text{EC}_{2.5}$  have been found significant or highly significant under mango ( $r=0.67^*$ ), sugarcane ( $r=0.90^{**}$ ) and banana system ( $r= 0.82^{**}$ ).

In case of available N except banana, vegetable land use and barren land, positive correlations have been observed in other land uses. But, positive correlations have reached to the level of high significance under oil palm ( $r= 0.84^{**}$ ), and floriculture system ( $r=0.93^{**}$ ) and to significant level only under sugarcane system ( $r=0.70^*$ ). Such positive correlation between organic carbon and

available N was also observed by Kumar *et al.* (2006) and Dhaliwal *et al.* (2008). In banana system, a highly significant negative correlation ( $r=-0.77^{**}$ ) exists between soil organic carbon and nitrogen. While available P has shown poor negative correlation in rice, floriculture and vegetable land use systems, it has expressed positive correlation with organic carbon in rest of the land uses. Negative correlation between organic carbon and P was also reported by Das *et al.* (1997). Only in soils of sugarcane system, a high significant positive correlation ( $r=0.95^{**}$ ) has been found between soil organic carbon and available P. Barring the barren land, in all other land use systems, organic carbon is positively correlated with available K. However, correlations have become highly significant only in sugarcane ( $r=0.87^{**}$ ) and banana system ( $r=0.92^{**}$ ). Correlation between organic carbon and sulphur is positive for oil palm, sapota, mango, sugarcane, banana land use systems and negative for rice, pulses & oil seed, floriculture, vegetable and barren land use system. While, the positive correlation have come out as significant or highly significant under sapota ( $r=0.69^*$ ), sugarcane ( $r=0.82^{**}$ ), and banana ( $r=0.88^{**}$ ) systems. The significant but negative correlation ( $r=-0.63^*$ ) has been observed only in vegetable land use system.

In oil palm, pulses and oil seed, floriculture, vegetable land use systems and barren land, available Zn is negatively correlated with organic carbon, while correlations are positive in other land use systems. However, only under sugarcane and banana land use, correlation have been observed highly significant ( $r=0.78^{**}$ ,  $r=0.81^{**}$ ) and positive. Such positive correlation was observed by Dhaliwal *et al.* (2008) and Venkatesh *et al.* (2003). In case of available Fe, no significant correlation exists. However, results of negative correlations observed in oil palm, sapota, rice land use and barren land are in conformity with the findings of Reddy and Agarwala (1972) and positive correlations in the rest of the land use systems are supported by results as were observed by Vadivelu and Bandhopadhyay (1995), Chattopadhyay *et al.* (1996) and Singh *et al.* (2006). Available Mn has shown significant positive correlation ( $r=0.66^*$ ) under pulse and

oil seed and a significant negative correlation under rice. In rest of the land uses correlations are either positive or negative, but could not reach to the level of significance.

So far as available Cu is concerned, positive correlations of organic carbon are observed in all land use systems except oil palm and vegetable. However, in sugarcane system and in barren land correlation are found to be highly significant and positive. Such positive correlation of available Cu with organic carbon was previously noted by Venkatesh *et al.* (2003). Only oil palm system has shown highly significant negative correlation which are in conformity with the findings of Das *et al.* (1997).

In case of bulk density, high negative and significant correlations of organic have been observed in almost all land systems, except floriculture and banana land. This fact indicates that soil organic carbon has a large bearing on the regulation of soil bulk density almost in all the land use system of NAU, campus. Similar observations were recorded by Mathan and Kannan (1993) and Bhattacharyya (2007).

As per as water stable aggregate of size  $> 0.5\text{mm}$  are concerned, highly positive and significant correlations have been observed with organic carbon in mango and sugarcane land use systems and in barren land. The results of positive correlations are in agreement with the findings of Zhang *et al.* (2008) that soil organic matters were related positively to water stable aggregates.



*SUMMARY  
AND  
CONCLUSION*



## **V. SUMMARY AND CONCLUSION**

The present investigation was carried out with an objective to study the organic carbon, available nutrients and physical properties of soils of Navsari Agricultural University campus as influenced by varying existing agricultural land use and management. For this purpose, ten different land use systems namely, 1) Oil palm plantation 2) Sapota plantation 3) Mango plantation 4) Sugarcane crop 5) Rice crop 6) Pulses and Oil seed crops 7) Banana plantation 8) Vegetable crops 9) Floriculture crops and 10) Barren land were identified in the NAU, campus and taken under study. Out of ten land uses No.1 to 3, No. 4 to 6, No.7 to 9 and No.10 are considered as "Tree/plantation land use group", "Agricultural land use group", "Horticultural land use group" and "Barren land" respectively. Hundred surface soil samples, of which ten from each land use system were collected and were subjected to laboratory analysis for organic carbon, available major (N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O), Secondary (S), micro nutrients (Zn, Fe, Mn and Cu) and physical properties (bulk density and water stable aggregates of size > 0.5 mm) of the soils. The results obtained were interpreted and discussed as to the effect of different land uses on the various soil parameters under study. The correlation coefficients of organic carbon with other soil parameters were worked out for all categories of land uses to study their interrelationship. Based on results, some suggestions were made for their better utilization, keeping in view the necessity of sustenance of soil health/quality as well as higher crop yield. The

results of the present investigation are summarized and conclusions have been made in the foregoing part.

### 5.1 Organic carbon and physico-chemical properties

The organic carbon under different land uses varied from 2.4 to 9.7 g kg<sup>-1</sup> and showed the following descending order: oil palm > mango > sapota > sugarcane > pulses & oil seed > banana > rice > vegetables > floriculture > barren land. "Tree/ Plantation land use group" showed higher soil organic carbon as compared to those under "Agricultural land use group" and "Horticultural land use group" and "Barren land".

The major reason for higher content of organic carbon in "Tree/ Plantation land use group" might be ascribed to higher addition of organic biomass through litter fall while, reverse is the true for the least organic carbon content under "Barren land". Poor carbon status in barren land of the campus suggests that land should not be kept barren, rather it should be kept under green cover through plantation. Further, efforts must be made for improving soil organic carbon, particularly in soils under floriculture and vegetable through addition of more organic manures/biomass *etc.* for possible improvement of soil health and crop yield as well.

Soils in all land use systems exhibited salinity below problematic limit. The order of different land uses with respect to EC<sub>2.5</sub> is as: rice > sugarcane > banana > floriculture > oil palm > sapota > pulses & oil Seed > vegetable > barren > mango. Comparatively higher salt in sugarcane and banana systems is due

to accumulated salt from higher quantum and / or frequency of applied irrigation water.

Soil  $\text{PH}_{2.5}$  under different land use systems varied from 5.82 to 8.0 with no appreciable difference amongst land uses, except for rice which showed acidic soil reaction. Application of higher quantum of water, acid producing fertilizers and removal of basic cations through leaching, are the some contributing factors for low soil  $\text{PH}_{2.5}$  in rice soil. Soils under sapota was slightly alkaline and in others were, more or less, normal in soil reaction.

## 5.2 Available major nutrients:

Pulses and oil seed land use system recorded higher available soil nitrogen ( $494 \text{ kg ha}^{-1}$ ) as compared to other land use systems, exhibiting either medium or marginally medium or low status of available N. The descending orders of land use with respect to available N are as below: Pulses & oil seed > oilpalm > mango > sapota > sugarcane > banana > rice > floriculture > barren > vegetable. Atmospheric nitrogen fixations by bacteria as well as decomposition of root biomass are possible reason for comparatively higher available N in pulses and oilseed soil. Low to marginally medium status of available nitrogen in major soils indicate that special care must be adopted for crop selection and nitrogen management in these soils to obtain sustained/higher crop yield. Further, pulse crops/leguminous crops should be taken in a rotation along with others crops.

Available soil phosphorus varying widely from 33.29 to 60.30 kg ha<sup>-1</sup> exhibited medium to high status under varying land use system. The descending orders of land use with respect to available P are as below: sugarcane > oil palm > mango > sapota > pulses & oil seed > vegetable > banana > floriculture > rice > barren. Tree/plantation land uses, in general analyzed higher available phosphorus over other cultivated soils and barren land perhaps due to higher organic biomass and their subsequent decomposition. The results suggests that application of phosphorus must be monitored as based on crop yield, plant P uptake and build up of P in soil.

Soil potassium in different land use systems varying from 143.2 to 421.3 K<sub>2</sub>O kg ha<sup>-1</sup> depicted marginally medium to high status. Except rice, all other land use systems showed high available potassium status. High leaching losses coupled with uptake might be major factors responsible for high depletion of available potassium in rice soils which calls for special attention in respect to K-management for balanced crop nutrition and higher production.

Available sulphur varying from 15.03 to 23.25 mg kg<sup>-1</sup> showed medium to high status. Under different land uses and the descending order of which in respect to available S is as follows: banana > sapota > pulses and oilseed > mango > oil palm > barren > rice > vegetable > sugarcane > floriculture. Presence of comparatively higher available S in some land uses might be due to higher content of soil organic carbon. As the demand for sulphur

is in the order of oil seeds > pulses > cereals, the selection of crop /land and management practices would play a crucial role in controlling the optimum production of crops in the campus soils.

### 5.3 Available micronutrients:

Available Zn ranged widely from 0.21 to 0.63 mg kg<sup>-1</sup> showing deficient status in most soils, except rice soil ranking the highest, in oil palm soil. Deficient status of available Zn in major land uses calls for adoption of corrective measures as to avoid Zn deficiency in the near future, particularly for Zn sensitive crops. Available Fe ranged from 4.19 to 20.48 mg kg<sup>-1</sup>, exhibiting its low to high available status with its highest and lowest value associated with rice soil and vegetable soil respectively. Exceptionally high available Fe in rice soil might be due to lower pH of soils. The available Fe below sufficiency range (6 to 8mg kg<sup>-1</sup>) particularly in sapota, vegetable and floriculture systems indicated that Fe deficiency symptoms may develop in near future unless, it is replenished through addition of organic matter or some other means.

Available Mn showed wide variation in available status (low to high) having range from 4.95 to 19.24 mg kg<sup>-1</sup> with the highest and the lowest value associated with rice and sapota soil respectively. The available Mn below sufficiency range (6 to 8mg kg<sup>-1</sup>), particularly in sapota and vegetable systems indicate that manganese deficiency is required to be corrected to avoid adverse effect on crop yield under these land use systems.

The mean available copper under varying land use system varied from 0.11 to 0.28 mg kg<sup>-1</sup> indicating deficient to marginal status. Oil palm, sapota, mango and sugarcane land use system exhibited marginal level of copper while in rest of the system the same were deficient. Available copper in soils of pulses & oilseed, rice, banana, vegetable land uses and barren land were just equal or below the critical limit. Soil organic carbon content and addition of inorganic fertilizer possibly played the major role in controlling soil available copper under different land use system.

#### 5.4 Physical properties

Bulk density of soils under mango, sapota and oil palm *i.e.*, under Tree/Plantation was lower (1.45 to 1.49 Mg m<sup>-3</sup>) as compared to those under other land uses. Barren land exhibited the highest bulk density of 1.83 Mg m<sup>-3</sup>. With respect to bulk density the descending order of various land use are as: Barren > floriculture > vegetable > rice > banana > pulses and oilseed > sugarcane > oil palm > sapota > mango. Bulk densities of comparatively higher magnitude might be due to low organic carbon *i.e.*, organic matter content in soils. For good and healthy plant growth, maintenance of optimum soil bulk density, which plays a major role in controlling important soil physical parameters, is must. So, the soils particularly under floriculture, vegetable and barren land should be subjected to the higher addition of organic manure/matter *etc.* to achieve higher status of

organic carbon and optimum bulk density for possible improvement in soil physical environment for crop growth.

Water stable aggregates of size  $> 0.5$  mm (also considered as macro aggregates) varied from 24.19 to 66.53 per cent, the highest and the lowest values being associated with sapota and rice land use system respectively. Comparatively higher per cent of macro aggregates were observed under "Tree/plantation land use group". The reason might be relatively high organic carbon or organic matter and low tillage operation. Puddling operations in rice soil carried higher disintegration of macro aggregates/structures and resulted in lower per cent of macro aggregates. Result indicated that cultivation practices, particularly in soils under 'Agricultural land use group' and 'Horticultural land use group', rate of organic matter loss was enhanced by accelerated microbial decomposition and reduced the proportion of water stable macro-aggregates. Soil macro-aggregates induces the formation of soil structure and good structure induces good growth of crop. Thus, results suggest that excessive cultivation practices which may lead to destroy soil structure/aggregate. Depletion of soil organic carbon and nutrients must be avoided for sustained crop yield and soil health.

### **5.5 Correlation studies:**

Correlation between organic carbon and other soil parameters of different land use system revealed that  $pH_{2.5}$  under sugarcane ( $r=-0.90^{**}$ ) and rice soils ( $r=-0.66^*$ ), available nitrogen under banana system ( $r=-0.77^{**}$ ), available sulphur under

vegetable system ( $r=-0.62^*$ ), available manganese under rice land use ( $r=-0.66^*$ ), available copper under oil palm soil ( $r=-0.69^{**}$ ) and bulk density under all systems excluding floriculture and banana system were negatively and significantly or highly significantly correlated with organic carbon. Similarly,  $EC_{2.5}$  under mango ( $r=0.67^*$ ), sugarcane ( $r=0.90^{**}$ ) and banana land use ( $r=0.82^{**}$ ), available nitrogen under oil palm ( $r=0.84^{**}$ ), floriculture ( $r=0.93^{**}$ ) and sugarcane ( $r=0.70^*$ ), available phosphorus under sugarcane system ( $r=0.95^{**}$ ), available potassium under sugarcane ( $r=0.87^{**}$ ) and banana soil ( $r=0.92^{**}$ ), available sulphur under sapota ( $r=0.69^*$ ), sugarcane ( $r=0.82^{**}$ ) and banana land use ( $r=0.88^*$ ), available zinc under sugarcane ( $r=0.78^{**}$ ) and banana ( $r=0.81^{**}$ ), available manganese under pulses and oil seed land use ( $r=0.66^*$ ), available copper under sugarcane soil ( $r=0.79^{**}$ ) and barren land ( $r=0.91^{**}$ ) and WSA under sugarcane ( $r=0.93^{**}$ ), mango soils ( $r=0.84^{**}$ ) and barren land ( $r=0.75^{**}$ ) were positively and significantly or highly significantly correlated with organic carbon.

## CONCLUSION

Based on the results of present study following conclusions are emerged.

- 1) No land should be kept barren and efforts should be made for improving soil organic carbon in systems having its low status through application of more organic manure or so.

- 2) For soils having low to marginally medium status of available nitrogen, special care should be taken for nitrogen management. Phosphatic fertilizer application must be monitored for all the soils. Rice soils call for special attention in respect to potassium management.
- 3) Corrective measures inclusive of organic manure application should be adopted to avoid Zn, Iron, Copper and Manganese deficiency in systems having low/deficient status of these micronutrients.
- 4) Bulk density should be maintained at optimum level through addition of organic manure/ matter and excessive cultivation practices may be avoided for higher per cent of water stable aggregate which helps to sustain crop yield and soil health.



*BIBLIOGRAPHY*



## REFERENCES

- Aggarwal, V. A.; Kumar, K. B. and Sidhu, P. S. (2005). Spatial changes in some soil properties under litchi and mango plantations. *Communication in Soil Science and Plant Analysis*. **36**:(17 & 18) : 2503-2511.
- \*Andrews, S. S.; Karlen, D. L. and Cambardella, C. A. (2004). The soil management assessment framework: a quantitative soil quality evaluation method. *Soil Sci. Soc. Amer. J.*, **68**:1945-1962.
- Ashoka, K. (1998). Studies on the properties of an alfisol under selected forest plantations. The M.Sc. (Agri) Thesis submitted to *Univ. Agric. Sci.*, Bangalore, Karnataka (India) (Unpublished).
- Bhattacharyya, T. (2007). Carbon sequestration in red and black soils.II. Influence of physical and chemical properties. *Agropedology* , **17**:16-25.
- Black, C. A. (1965). Methods of soil analysis. Amer. Soc. Agron., Univ. Wisconsin, USA.
- Bouman, O. T.; Curtin, D.; Campbell, C. A.; Bieberbeck, V. O. and Ukraintez, H. (1995). Soil acidification from long-term use of anhydrous ammonia and urea. *Soil Sci. Soc. Amer. J.*, **59**: 1488-1494.
- Chattopadhyay, T.; Sahoo, A. K.; Singh, R. S. and Shyampura, R. L. (1996). Available micronutrient status in the soils of

- Vindhyan scarplands of Rajasthan in relation to soil characteristics. *J. Indian Soc. Soil Sci.*, **44** (4): 678-681.
- Chandran, P.; Ray, S. K.; Durge, S. L.; Rajapandnimkar, A. M.; Bhattacharyya, T. and Pal, D. K. (2009). Scope of horticultural land use system in enhancing carbon sequestration in ferruginous soils of the semi-arid tropics, *Curr. Sci.*, **97** (7): 1039-1046.
- Chopra, C. L. and Kanwar, J. S. (1980). Analytical agricultural Chemistry, Kalyani Publishers, Ludhiana.
- Das, M.; Singh, B. P. and Khan, S. K. (1997). Effect of major land uses on soil characteristics of Alfisols in Meghalya. *J. Indian Soc. Soil Sci.*, **45** (3): 547-553.
- Datta, M.; Bhattacharria, B. K. and Saikh, H. (2001). Soil fertility- A case study of shifting cultivation sites in Tripura. *J. Indian Soc. Soil Sci.*, **49** (1): 104-109.
- Desai, R. M.; Patel G. G.; Patel T. D. and Das, A. (2009). Effect of integrated nutrient supply on yield, nutrient uptake and soil properties in rice-rice crop sequence on a Vertic Halusteps of south Gujarat. *J. Indian Soc. Soil Sci.*, **57** (2): 172-177.
- Dhaliwal, S. S.; Sharma, B. D.; Singh, B. and Khera, K. L. (2008). Profile distribution of chemical, physical and microbial characteristics in four land use systems of *Sadh Di Khad* watershed in submontaneous tract of Punjab. *An Asian Journal of Soil Science*, **3** (2): 316-322.

- Ganeshamurthy, A. N. and Srinivasarao, C. (2009). Assessment of field indicators of soil quality following long-term cultivation of pulses on entisols in Indo gangetic plain. *J. Indian Soc. Soil Sci.*, 57 (1): 76-80.
- Gupta, M. K. and Singh (1990). Studies on some physical properties of soil under different forest covers and land use in Himachal Pradesh. *Van Vigyan*, 28 (3): 86-93.
- Hanway, J. and Heidel, H. (1952). Soil analysis as used in Iowa State College Testing laboratory, Ames. Iowa. *Agric.*, 57: 131.
- Jackson, M. L. (1979). Soil Chemical Analysis. Prentice Hall of India (Pvt.) Ltd., New Delhi. pp. 2<sup>nd</sup>, Edn.
- Kahlon, M. S. (2006). Investigation on soil erodibility under different land use pattern of certain soils of sub-mountain Punjab India. *Indian Forester*. pp:1391- 1397.
- \*Karlen, D. L.; Gardner, J. C. and Rosek, M. J. (1998). A soil quality framework for evaluating the impact of CRP. *Journal of Production Agriculture* 11:56-60.
- Katyal, J. C. and Datta, S. P. (2004). Role of micronutrients in ensuring the optimum use of macronutrients. *IFA International Symposium on Micronutrients* held at New Delhi, India during February, pp: 23-25.
- Katyal, J. C. and Sharma, B. D. (1991). DTPA extractable and total Zn, Cu, Mn and Fe in Indian soils and their association with some soil properties. *Geoderma.*, 49: 165-179.

- Kenjale, R. Y.; Chavan, K. N. and Chavan, A. S. (1994). Recycling of nutrient elements by some forest tree species of Konkan in Maharashtra. *Van Vigyan*, **32** (1-2): 7-14.
- Kumar, P.; Verma, T. S. and Sharma, P. K. (2006). Effect of land uses on relationship between organic carbon and available nutrients in dry temperate zone of Himachal Pardesh. *J. Indian Soc. Soil Sci.*, **54** (4): 485-488.
- Lindsay, W. L. and Norvell, W. A. (1978). Development of a DTPA micronutrient soil test for Zn, Fe, Mn and Cu. *Soil Sci. Soc. Amer. J.*, **42**: 401-408.
- Mathan, K. K. and Kannan, N. (1993). Physico-chemical properties of pedons under the influence of different vegetation in kodaikanal hills of Tamil Nadu. *Madras Agric J.*, **80** (10): 581-585.
- Monreal, C. M. and Kodama, H. (1997). Influence of aggregate architecture and minerals on living habitats and soil organic matter. *Canadian J. of Soil Sci.*, **77** (3): 367-377.
- Moutusi, D. and Chattopadhyay, P. P. (2009). Assessment of soil nutrient in spice based cropping sequences. *Indian Agric.*, **53** (1-2): 39-45.
- Nitant , H. C.; Bhushan, L. S. and Pal, I. (1992) . Status of soil properties in Yamuna ravines under forest cover. *J. Trop. For.*, **8** (1): 31-37.

- Olsen, S. R.; Cole, C. V.; Watanabe, F. S. and Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bi-carbonate, U.S.D.A. Circ., 939.
- Osman, K. T.; Rahman, M. M. and Barua, P. (2001). Effect of forest species on soil properties in Chittagong University Campus, Bangladesh. *Indian Forester.*, **127** (4): 431-441.
- Pal, S. K and Modal, G. M. (2005). Impact of land use on forms and availability of P in terai soils of Eastern India. *G.A.U. Res. J.*, **30** (1-2): 43-46.
- Pal, S. S.; and Shurpali, N. J. (2006). Variation in soil organic carbon as influenced by climate under different cropping systems in India. *J. Indian Soc. Soil Sci.*, **54** (3): 294-299.
- Panse, V. G. and Sukhatme, P. V. (1967). "Statistical Methods for Agricultural Workers", ICAR publication, New Delhi, India, pp. 152-161.
- Parthiban, K. T. and Rai, V. (1994). Trees on farm lands-their effects on soil fertility. *Ann. For.*, **2** (1): 44-51.
- Piper, C. S. (1966). Soil and Plant analysis, Hans publ., Bombay.
- \*Reddy, C. J and Agarwala, H. P. (1972). Changes in physico-chemical properties of soil under intensive cropping systems. *J. Indian Soc. Soil Sci.*, **20**: 241.

- Rudramurthy, H. V.; Puttaiah, E. T and Vageesh, T. S. (2007). Chemical properties of soils under different land use systems in Shimoga district of Karnataka. *J. Indian Soc. Soil Sci.*, **55** (3): 259-264.
- Saha, R. and Mishra, V. K. (2007). Long-term effect of various land use system on physical properties of silt clay loam soil of N-E Hills. *J. Indian Soc. Soil Sci.*, **55** (2): 112-118.
- Seth, S. P. (1967). Indices for diagnosis of alkalinity and salinity in the soils of Rajasthan. *J. Indian Soc. Soil Sci.*, **15** : 93-95.
- Sharma I. P. (2001). Study on soil erosion behavior under different land uses in watershed. *J. Trop. For.*, **17**(3): 47-50.
- Sharma, B. D. and Gupta J. C. (1989). Effect of tree cover on soil fertility in Western Rajasthan. *Indian Forester*, **115** (5) : 348-353.
- Sharma, M. P. and Bali S. V (2000). Long- term effect of different cropping systems on physico-chemical properties and soil fertility. *J. Indian Soc. Soil Sci.*, **48** (8): 181-183
- Singh, K.; Narain, P.; Sharda, U. N. and Juyal, G. P. (1993) Soil characteristics under different land uses in Fakot watershed of Western Himalayas (U.P). *Indian J. Soil Conser.*, **21** (3): 14-24.

- Singh, R. D.; Kumar, S. and Pande, H. (2006). Micronutrient status of soils under different vegetation in Uttarakhand Hills. *J. Indian Soc. Soil Sci.*, **54** (1): 115-116.
- Singhal, R. M. and Panwar, B. P. (1991). A study of cropping pattern of poplar Based Agroforestry system in North-Western U.P. *Van Vigyan*, **29**(3):187-191.
- Somasundaram, J.; Singh, R. K.; Parandiyal, A. K. and Prasad, S. N. (2009). Micronutrient status of soils under different land use systems in Chambal ravines. *J. Indian Soc. Soil Sci.*, **57** (3): 307-312.
- Sreerangappa, K. G. (1998). Comparative assessment of resource degradation under identified land use systems in selected agro-climatic zones of Karnataka. The Ph. D. Thesis submitted to *Univ. Agric. Sci.*, Bangalore (India) (Unpublished).
- SSSA (1962). Committee Report, Glossary of Soil Science Terms. *Soil Sci. Soc. Amer. Proc.*, **26** : 306-317.
- Subbiah, B. V. and Asija, G. L. (1956). A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.*, **25** : 259-260.
- Vadivelu, S. and Bandhopadhyay, A. K. (1995). Distribution of DTPA extractable Fe, Mn, Cu and Zn in the soils of Minicoy island, Lakshadweep. *J. Indian Soc. Soil. Sci.*, **43**: 133-134.

- Venkatesh, M. S.; Majumdrar, B.; Kumar, K. and Patiram (2003). Status of micronutrient cation under various land use system of Meghalaya. *J. Indian Soc. Soil Sci.*, **57** (1): 60-64.
- Wakene Negassa and Heluf Gebrekidan (2003). Influence of land management on morphological, physical and chemical properties of some soils of Buko western Ethiopia, *Agropedology*, **13**:1-9.
- Walkley, A. J. and Black, I. A. (1934). Estimation of soil organic carbon by chromic acid titration method. *Soil Science*, **37**: 29-38.
- Wankhede, S. R. and Jagdish P. (2008). Characterization of soils in teak forests, grassland and agricultural lands of basaltic origin in central India. *Indian Forester*, pp-487-499.
- \*Yang, J. C.; Han, X. G. and Huang, J. H. (2003). The dynamics of soil organic matter in cropland responding to agricultural practices. *Acta Ecologica Sinica.*, **23** (4): 787-796.
- Yoder, R. E. (1936). A direct method of aggregate size analysis of soils and a study of the physical nature of erosion losses. *J. American Soc. Agron.*, **28** : 337-351.
- \*Zhang, H.; Zhang, G. L. and Qi, Z. P. (2003). Systematic assessment of soil quality at farm level in tropical area of China. *Acta Pedologica Sinica.*, **40** (2):186-193.

- \*Zhang, X.; Chen L.; Bojie, F.; Qin, L.; Xin, Q. and Yan, M. (2006). Soil organic carbon changes as influenced by agricultural land use and management: a case study in Yanhuai basin, Bieijing, China. *Acta Ecologica Sinica.*, 26 (10): 3198-3204.
- \*Zhang, Z.; Chaofu, W.; Deti, X.; Ming, G. and Xibai, Z. (2008). Effects of land use pattern on soil aggregate stability in Sichuan basin, China. (2008). *Particuology*, 6: 157-166.
- 

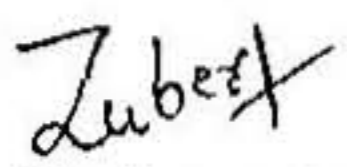
\* Original not seen

## C E R T I F I C A T E

This is to certify that I have no objection for supplying to any scientist any one copy or any part of this thesis at a time through reprographic process if necessary for rendering reference services in a library or documentation centre.

**Place:** Navsari

**Date :** 3<sup>rd</sup> May , 2010

  
(Md. Zuber Ansari)