Global Theme on Agroecosystems

Report no. 41

Influence of Different Landuse Management on Soil Biological Properties and other C Fractions under Semi-Arid Benchmark Soils of India

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

Science with a human face

Citation: Manna MC, Wani SP, Rego TJ, Sahrawat KL, Bhattacharyya Tapas, Ramesh V, Bandyopadhyay KK, Rupa TR, Singh Piara, Pathak P and Padmaja KV. Influence of Different Landuse Management on Soil Biological Properties and other C Fractions under Semi-Arid Benchmark Soils of India. Global Theme on Agroecosystems Report no. 41. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 60 pages.

Abstract

Fifty two pedons spread over 28 benchmark spots of Vertisols and Alfisols were studied for soil biological properties and other C fractions (soil microbial biomass c, soil respiration dehydrogenase activity, soil microbial biomass N, mineralizable N, water soluble C and soluble carbohydrates, water stable aggregates, water stable aggregates C, humic and fulvic acid C, etc.) in different systems viz., agricultural, horticultural, forest and wasteland. The agricultural system represents dominant crops namely cereals, soybean and cotton. The horticultural system represents mandarins. The forest systems represent teak and sal. The selections of benchmark spots were limited to a mean annual rainfall range from 1448 to 520 mm in semi-arid tropics. The present experiment was conducted under various bio-climatic condition such as sub-humid moist (>1200 mm), sub-humid dry (1200-100 mm), semiarid dry (1000-850mm), semi-arid moist (850-550 mm) and arid (<550 mm). The active pools of SMBC comprised 3.2 to 5.6 % of SOC in Vertisols and 1.2 to 5.7 % of SOC in Alfisols. WSC comprised 0.80 to14.1 % of SOC in Vertisols and 1.5 to 4.9 % of SOC in Alfisols. WSCarbohydrates comprised 15-40.3 % of SOC in Vertisols and 10.5 to 25 % of SOC in Alfisols. In sub-humid moist regions, the SMBC content followed the order: forest (teak)> soybean-wheat>paddy-wheat>cotton (HM). In sub-humid dry regions of Vertisols, the SMBC was maximum under horticultural system (citrus), followed by intercropping (cotton + pigeonpea) and mango-orchard. In semi-arid moist regions, SMBC and SR were higher under intercropping system (soybean+ pigeon pea) compared to soybean –gram system. The soil biological activity in terms of SMBC, SMBN can be improved with concomitant increase of water-soluble carbon and carbohydrates by better management practices. Among field crops, legume-based intercropping system (soybean + pigeonpea and greengram + pigeonpea) restored higher amount of SOC, SMBC compared to double crop in rotation (soybean-wheat/paddy-paddy cropping system). Among the horticultural-based cropping systems, citrus with high management has better SOC restoration compared to mango orchard. Cotton-based cropping system either as intercropping or sequential cropping registered least improvement of SOC storage. In Vertisols, the percentage of water stable aggregates and concentration of carbon in WSA was higher than Alfisols. Water stable aggregates, carbon concentration increased with decrease in size class. By and large, the maximum concentration of SOC in the water stable aggregates was observed in <0.1 mm size aggregates. In 0-30 cm soil depth, passive fraction of HA-C was relatively higher than FA-C in surface whereas FA-C increased with soil depth. The percent variations in passive fractions among different cropping systems were not pronounced as compared to active and slow pool of C.

This publication is part of the research project "*Identifying Systems for Carbon Sequestration and Increased Productivity in Semi-Arid Tropical Environments (RNPS-25)*" funded by the National Agricultural Technology Project (NATP) through Indian Council of Agricultural Research, New Delhi, India.

Global Theme on Agroecosystems
Report no. 41

Influence of Different Landuse Management on Soil Biological Properties and other C Fractions under Semi-Arid Benchmark Soils of India

MC Manna, SP Wani, TJ Rego, KL Sahrawat, Tapas Bhattacharyya, V Ramesh, KK Bandyopadhyay, TR Rupa, Piara Singh, P Pathak and KV Padmaja

ICRISAT
Science with a human face

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS
Patancheru 502 324, Andhra Pradesh, India

ICAR

Indian Institute of Soil Science (IISS)
Bhopal 462 038, Madhya Pradesh, India

National Bureau of Soil Survey & Landuse Planning (NBSS&LUP)
Nagpur 440 010, Maharashtra, India

Central Research Institute for Dryland Agriculture (CRIDA)
Hyderabad 500 059, Andhra Pradesh, India

2008

About the authors

MC Manna	Senior Scientist, Indian Institute of Soil Science (IISS), Bhopal 462 038, Madhya Pradesh, India.
SP Wani	Principal Scientist (Watersheds) and Regional Theme Coordinator (Asia), Global theme on Agroecosystems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.
TJ Rego	Former Principal Scientist (Soil Science), Global Theme on Agroecosystems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.
KL Sahrawat	Visiting Scientist, Global Theme on Agroecosystems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.
T Bhattacharyya	Principal Scientist, National Bureau of Soil Survey and Landuse Planning (NBSS&LUP), Nagpur 440 010, Maharashtra, India.
V Ramesh	Scientist, Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad 500 059, Andhra Pradesh, India.
KK Bandyopadhyay	Senior Scientist, Indian Institute of Soil Science (IISS), Bhopal 462 038, Madhya Pradesh, India.
TR Rupa	Senior Scientist, Indian Institute of Soil Science (IISS), Bhopal 462 038, Madhya Pradesh, India.
Piara Singh	Principal Scientist (Soil Science), Global Theme on Agroecosystems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.
P Pathak	Principal Scientist (Soil and Water Management), Global Theme on Agroecosystems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.
KV Padmaja	Visiting Scientist, formerly with Global Theme on Agroecosystems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

Acknowledgements

The authors are grateful to Dr JS Kanwar (SAP, Chairman, NATP), Dr NN Goswami (member of SAP committee, NATP) and Dr BVenkateswarlu, (PPSS, NATP, Hyderabad) for their untiring guidance and constructive criticism in overall improvement of this manuscript. We are thankful to Dr TK Ganguly, Head of Department, Soil Biology, Dr A K Misra, Head, Division of Soil Physics, Dr M Singh, Head, Division of Soil Chemistry and Fertility , IISS, Bhopal, for providing laboratory facilities. The assistance of Dr KV Padmaja of ICRISAT; Mr RS Sisodia, Mrs Seema Sahu; Mr Hukum Singh; Mr Bhoilal Uikey and Mr AK Mishra of IISS, Bhopal, are also duly acknowledged. Special thanks are due to Drs KL Sahrawat and Ch Srinivasa Rao for reviewing the manuscript and Ms Shalini N for editorial assistance. The financial support provided by National Agriculturla Technology Project (RNSP–25), Indian Council of Agricultural Research (ICAR), is gratefully acknowledged.

Contents

Team Members

International Crops Research Institute for the Semi- Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh

SP Wani - Principal Investigator
TJ Rego - CCPI
P Pathak
Piara Singh
KL Sahrawat
KPC Rao
KV Padmaja
LS Jangawad
C Vineela
B Padmaja (Research Scholar)
William D Dar

National Bureau of Soil Survey & Landuse Planning (NBSS& LUP), Nagpur, Maharashtra

T Bhattacharyya - CCPI
P Chandran
SK Ray
C Mandal
DK Pal
MV Venugopalan
P Srivastava
SL Durge
PN Dubey
GK Kamble
RP Sharma
M Velayutham
KS Gajbhiye

Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad, Andhra Pradesh

V Ramesh - CCPI (since March 2002)
KL Sharma
M Vanaja
D Gangadhara Rao - CCPI (till February 2002)
B Venkateshwarlu
K Srinivas
V Maruthi
HP Singh
YS Ramakrishna

Indian Institute of Soil Science (IISS), Bhopal, Madhya Pradesh

MC Manna - CCPI
TR Rupa
KK Bandhopadhyay
CL Acharya
DLN Rao/AK Misra

Introduction

Improved agricultural practices have great potential to increase the amount of carbon (C) sequestration in cropland soils. Adoption of recommended management practices (RMPs) in agriculture contributes not only to soil conservation but also helps in enhancing the amount of organic carbon (SOC) in soil through carbon sequestration and in mitigating adverse effects of excessive carbon dioxide (CO_2) emission on climate change. Climate change refers to long-term alterations in temperature, precipitation, wind, and other elements that cause fluctuations in climate (IPCC, 1996). In terrestrial ecosystems, SOC is the largest pool and globally contains over 1550 Pg C, followed by the soil inorganic carbon (SIC) pool that contains 750-950 Pg C (Batjes, 1996; Eswaran et al., 1993; Schiesinger, 1995). Terrestrial vegetation is reported to contain an additional 600 Pg C (Houghton, 1995; Schimel, 1995). Thus, the soil C pool (SOC plus SIC) is about four times larger than the terrestrial vegetation pool and three times larger than the atmospheric C pool. The location of the soil-C pools extends across the surface of the earth. The net annual increase in atmospheric CO_2-C is estimated to be about 3.3 Pg yr^{-1} (Sarminto and Wofsy, 1999). Consequently, even a small annual percent change in the amount of C storage or release from these large terrestrial C stock could affect the net change in atmospheric CO_2. About 20% of the earth's land area is used for growing crops (Allmaras et al., 1999) and thus farming practices have a major influence on C storage in soil and its release into the atmospheric as CO_2. Within a cropping/farming system, the equilibrium level of SOC can be related linearly to amount of crop residue applied to soil (Larson et al., 1972; Rasmussen et al., 1980). Paustain et al., (1992) identified that higher residue lignin content also positively influences the SOC content. The net rate of accumulation of SOC depends on the extent to which the soil is already filled by SOC i.e., the size and capacity of the reservoir. Surface residues generally decompose slowly than those incorporated by tillage because the former have less contact with soil microorganisms (Reicosky et al., 1995) and soil water (Grant, 1997). Further, observations by Reicosky et al. (1997) strongly indicated that mechanical disturbance of soil by tillage increases the decomposition of SOC. Practices that increase residue, and/or plant growth result in enhanced SOC sequestration (Lal et al., 1999; Bruce et al., 1999). Use of conservation tillage (i.e., no-till, ridge-till, and mulch-tillage), maintaining higher levels of residue cover on conventionally tilled crop-land, planting cropland to permanent cover, and improved fertility management can increase SOC sequestration (Lal et al., 1998). The potential to sequester more carbon (C) in soils by increasing cropping intensity and N fertilization in semi-arid, dryland areas could contribute in mitigating agricultural effect on atmospheric carbon dioxide (CO_2) levels and its effect on global climate change. The beneficial effect of SOC is more than improving soil quality and fertility. Its hidden value lies in its ability to help moderate the greenhouse effect on environment by reducing atmospheric enrichment of CO_2. Thus, we need to understand how management practices such as fertilization, tillage, and cropping systems can potentially enhance SOC storage and improve environmental quality.

An important objective of the sustainable management of resources is to increase soil organic carbon (SOC) pools i.e., active, passive and slow pools of C by soil management, soil water conservation and soil fertility regulation and these are all important aspects in improving carbon sequestration in soil (McGill et al., 1981; Parton et al., 1987; van Veen et al., 1984). Significant advances in both understanding and managing the behavior of soil organic matter (SOM) as a source or a sink of plant nutrients will only be achieved through carbon sequestration studies at conceptual level. Evaluation of the content and susceptibility to mineralization of organic

C, N, S, and P as a function of aggregate size have provided another approach to study the behavior of SOM. Elliott (1986) found that the contents of C, N, and P in aggregates decreased with aggregates size; however, C/N and C/P ratios narrowed with decreasing aggregates size. Keeping in view the above facts, an inter-institutional collaboration project involving ICRISAT (Hyderabad), IISS (Bhopal) NBSS & LUP (Nagpur) and CRIDA (Hyderabad) was initiated to identify systems for carbon sequestration under different agroecosystems with varying land management practices in the semi-arid tropics (SAT) region of India. This paper deals with the changes in soil biological properties in the selected benchmark sites of SAT as influenced by different landuse management options.

Materials and methods

The sites are located at the semi-arid tropic benchmark sites of India under sub-humid moist and dry regions, semi-arid dry and moist region, and arid regions. Soil samples were collected from different diagnostic horizons of selected profiles in this region with different landuse management practices. Annual average rainfall of the study area varies from 1100 to 1500 mm (sub-humid moist) to <500 mm (arid), of which 75 to 80 % precipitation takes place from June to September in a year. The soil of the study site includes Vertisols and Alfisols. Under each agroecosystem, the profile samples were collected from high, low and farmers' management systems. The study was initiated during 2001. For the present study, after harvest of different crops, soil samples were taken profile wise upto 0 to 150 cm depths. Two cores per depth increment were composited for each plot.

Aggregate separation and C distribution

To study the slow pools of C concentration in macro-aggregates and micro-aggregates, sub-samples (>2 mm) were used for aggregate separation by wet sieving method (Camberdella and Elliott, 1992; Elliott, 1986). 100-g sub-samples (capillary-rewetted) were wet sieved through double stage Yodder's apparatus through a series of five sieves to obtain six size fractions: (i) >2000 μm, (ii) 1000 to 2000 μm, (iii) 500 to 1000 μm (iv) 250 to 500 μm, and (v) 53-250 μm (vi) <53 μm.

To determine the percent of sand-free in the size classes, soil from each of the size classes was shaken overnight with 1% (W/V) of sodium hexametaphosphate by the method described by Elliott (1986), and sieved through a 53 μm screen. After rinsing several times with deionized water, the sand fraction retained on sieve was oven dried at 65^{0}C and weighed on dry weight basis. Sand-free total C concentration was calculated with the following formula:

$$\text{Sand free (C)}_{\text{fraction}} = \frac{(\text{C})_{\text{fraction}}}{1\text{-(Sand portion)}_{\text{fraction}}}$$

Characterization of Organic C Pools

Organic C content of whole soil and extract were determined from each treatment by digesting soil samples with $K_2Cr_2O_7$ and H_2SO_4 at 150^{0}C for 30 minutes in a block digester (Nelson and Sommers, 1975). Mineral-N: (2*M* KCl–extractable mineralizable N (NH_4-N and NO_3-N) was determined with steam distillation (Bremmer, 1965) from whole soil samples.

Active Pools of C

Hot-water soluble carbon (WSC) and carbohydrates were estimated by the method described by McGill et al., (1986). Microbial biomass C (SMBC) and microbial biomass nitrogen (SMBN) were determined by the ethanol-free chloroform-fumigation and incubation method (Jenkinson and Powlson, 1976).

Passive Fraction of C

The principal extraction procedure (Stevenson, 1994) was performed by seperation after extracting with freshly-prepared sodium hydroxide (0.5 *M* NaOH) at pH 13.0 with acid wash (0.1 *N* HCl). This principal extract was utilized to estimate humic acid (HA) and fulvic acid (HA).

Results and discussion

Effects of different landuse management on SMBC, SMBN, N_{min}, SR, WSCarbon, and WSCarbohydrates and Dehydrogenase activity

Various carbon fractions were estimated from different landuse management systems viz., cultivated arable crops, horticultural crops and forest lands in sub-humid moist and dry regions of Vertisols and Alfisols. The active pool of soil microbial biomass C (SMBC) comprised 3.2 to 5.6 % of total organic carbon (TOC) in Vertisols and 1.2 to 5.7 of TOC in Alfisols, water-soluble C (WSC) comprised 0.80 to 14.1% of TOC in Vertisols and 1.5 to 4.9% of TOC in Alfisols, and water-soluble carbohydrates comprised 15-40.3% of TOC in Vertisols and 10.1 to25 % of TOC in Alfisols. Overall, in Vertisols, SMBC was relatively higher (145-324 mg kg^{-1}) than Alfisols (122.5-213.6 mg kg^{-1}), irrespective of landuse management system (Fig.1 and 2). Other parameters such as soil respiration (SR), soil microbial biomass nitrogen (SMBN) and mineral nitrogen (Min-N) also followed the similar trend as SMBC in these two soils groups (Fig.3, 4,5,6,7 and 8). For WSC, it varied from 153 to 291 mg kg-1 in Vertisol and from 160 to 366 mg kg^{-1} in Alfisol (Fig 9 and 10). The content of WSCarbohydrates was relatively more in Vertisol than Alfisol (Fig.11 and 12). The activity of dehydrogenase (DHA) varied from 22 to 50 mg TPF g^{-1} in Vertisol and in Alfisol, it varied from 37.6 to 53 mg TPF g^{-1} (Fig. 13 and 14). There was no fixed trend of soil biological activity under both the soil groups when moisture regimes receded from sub-humid moist to arid regions.

Compared to sub-humid moist and sub-humid dry regions in Vertisols, the activity of SMBC, SMBN and SR values were relatively lower in sub-humid dry region than sub-humid moist region (Fig.1, 3 and 7). The similar trends of these parameters were also observed in semi-arid moist and semi-arid dry regions of Vertisol. The soil biological activity decreased substantially under arid regions in Vertisol as compared sub-humid moist and dry regions in the same soil

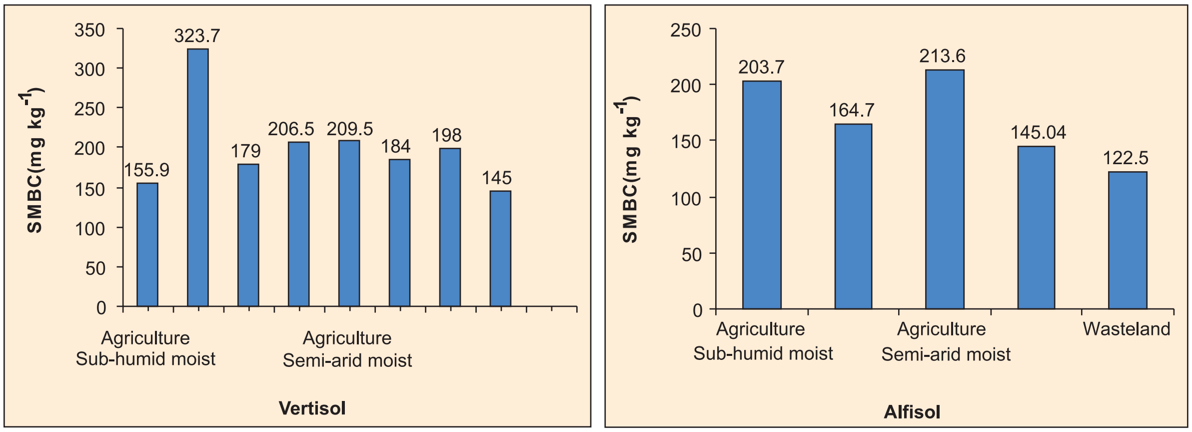

Fig. 1&2 Effects of landuse management pratices on SMBC under different moisture regimes in Vertisol and Alfisol.

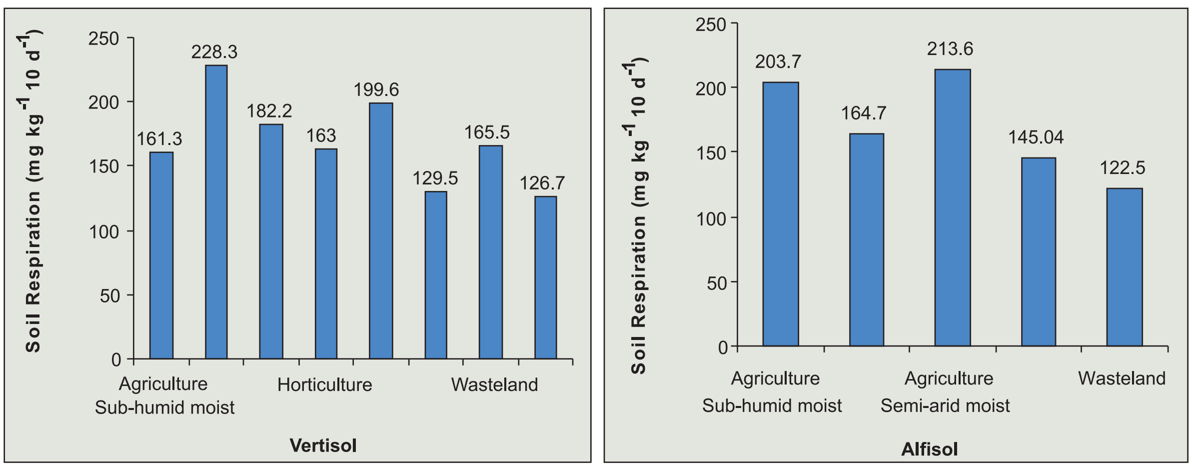

Fig. 3&4 Effects of landuse management pratices on soil respirations under different moisture regimes in Vertisol and Alfisol.

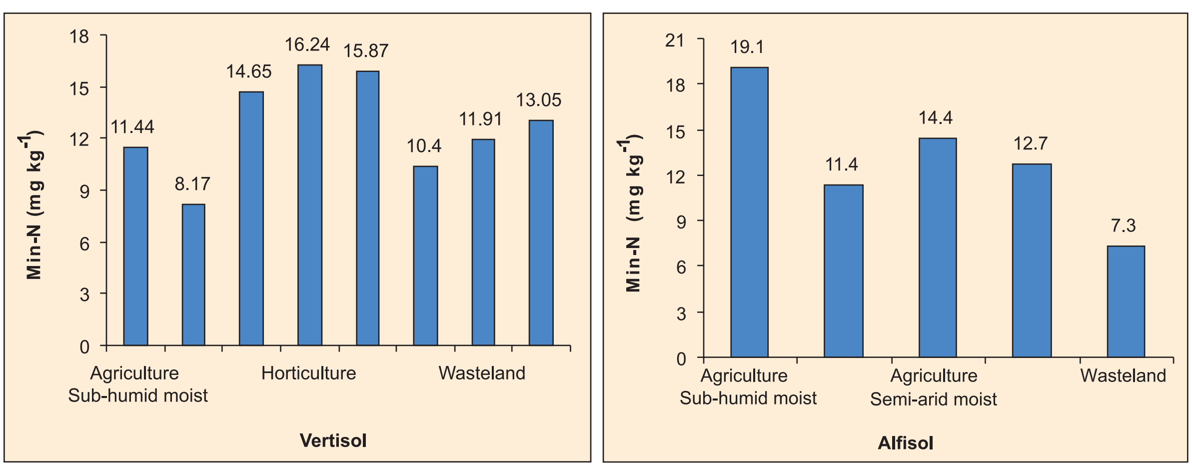

Fig. 5&6 Effects of landuse management pratices on Min-N under different moisture regimes in Vertisol and Alfisol.

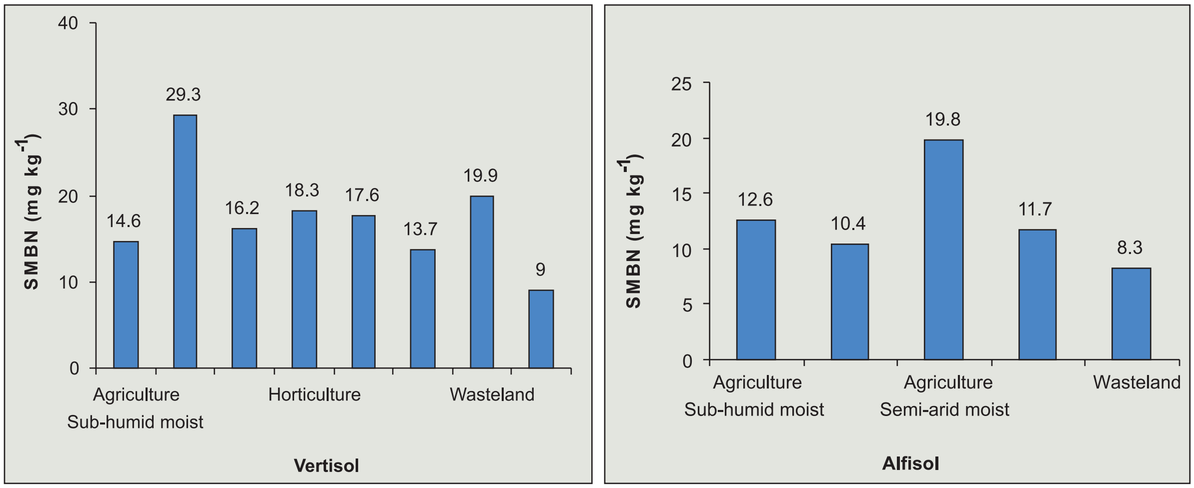

Fig. 7&8 Effects of landuse management pratices on SMBN under different moisture regimes in Vertisol and Alfisol.

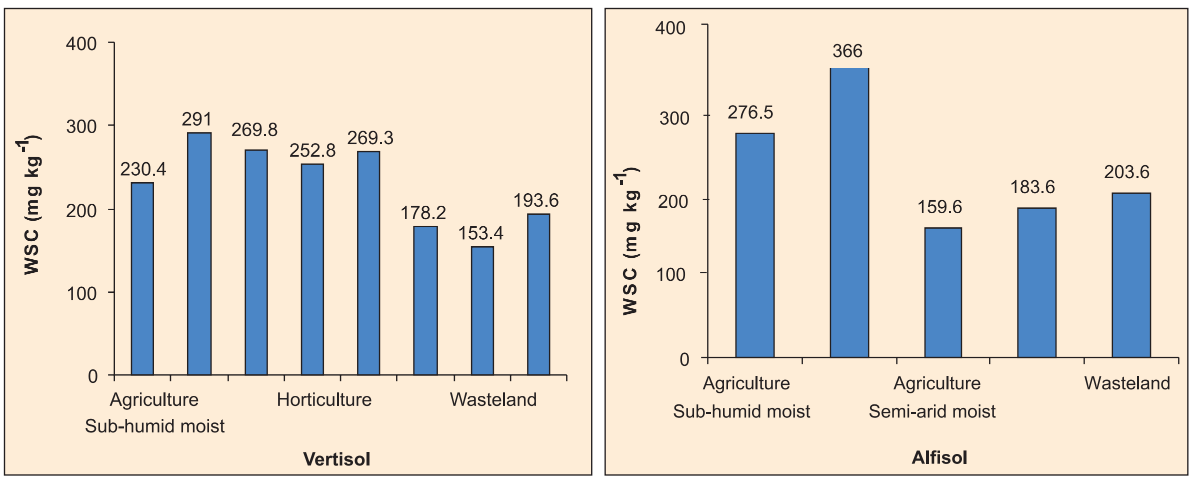

Fig. 9&10 Effects of landuse management pratices on WSC under different moisture regimes in Vertisol and Alfisol.

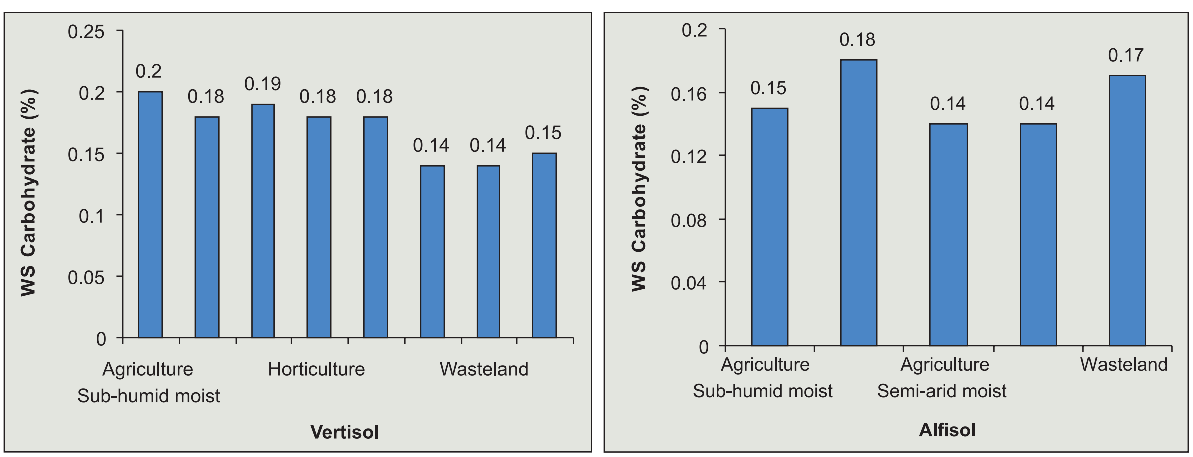

Fig. 11&12 Effects of landuse management pratices on WS Carbohydrate under different moisture regimes in Vertisol and Alfisol.

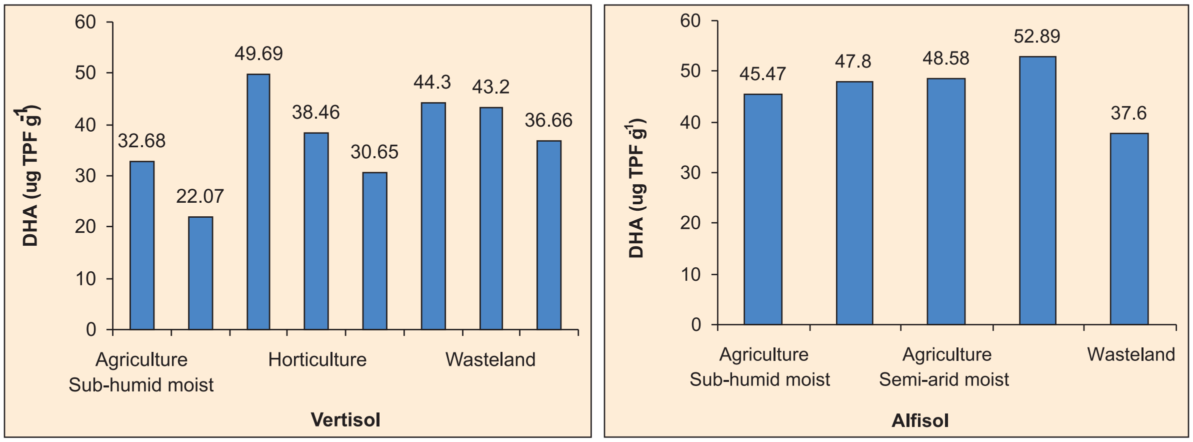

Fig. 13&14 Effects of landuse management pratices on DHA under different moisture regimes in Vertisol and Alfisol

group. In Alfisol, the activity of SMBC, SMBN and SR values followed the order: semi-arid moist>sub-humid moist> semi-arid dry (Figs. 2, 4 and 8). The DHA in Vertisol was maximum in sub-humid dry regions followed by semi-arid dry, arid, semi-arid moist and sub-humid moist (Fig.13). In case of Alfisol, the activity of DHA was higher in semi-arid moist, followed by semi-arid dry and sub-humid moist (Fig.14). On an average, the content of WSC and soluble carbohydrates in Vertisol were on par in the sub-humid moist, sub-humid dry and semi-arid moist ecosystems. These values decreased in semi-arid dry and arid regions (Figs.9 and 11). The content of WSC and carbohydrates were relatively higher in sub-humid regions of Alfisol, followed by semi-arid dry and semi-arid moist (Figs.10 and 12). The Min-N content in sub-humid dry region was maximum in Vertisol, followed by semi-arid dry, arid and sub-humid moist regions. In Alfisol, the content of Min-N followed the order: sub-humid moist> semi-arid moist>semi-arid dry (Fig.6).

In both the soil groups, the activity of SMBC, SMBN and SR values were maximum in forest soils, followed by horticulture and then agriculture system, irrespective of agronomic management practices. It was also observed that the activity of SMBC was higher under agriculture system in sub-humid moist, followed by semi-arid moist of Vertisol and Alfisol (Figs.1 and 2). The activity of SR and SMBN also followed the similar trend as SMBC in these cropping systems. The activity of dehydrogenase was higher under agriculture/or forestry system in sub-humid moist region of Alfisol, followed by agriculture system in semi-arid moist and agriculture system in semi-arid dry regions in Alfisols (Fig.14). In case of Vertisol, the DHA was higher in agriculture system, followed by horticulture and forestry system (Fig.13).

The soil biological activity and soluble fractions of C almost decreased with increased soil depths and thus in the present study our various biochemical attributes are confined to mostly to 0 to 30 cm depth. We have given depth-wise details of biological parameters in Annexure-I. Under sub-humid moist region in Vertisol, the SMBC and SR were maximum under forest (teak), followed by soybean-wheat (FM), paddy-wheat, (HM), cotton (HM) paddy-wheat (LM) (Fig. 19). In case of sub-humid dry regions in Vertisols, the SMBC followed the order: citrus (HM)> cotton intercropping with pigeonpea (FM) > mango-orchard (HM) > soybean-wheat or gram-wheat system (HM or FM) (Fig. 20). Basal respiration also followed the similar trend to that of SMBC in these systems (Fig.19 and 20). Among four cropping system in semi-arid moist regions

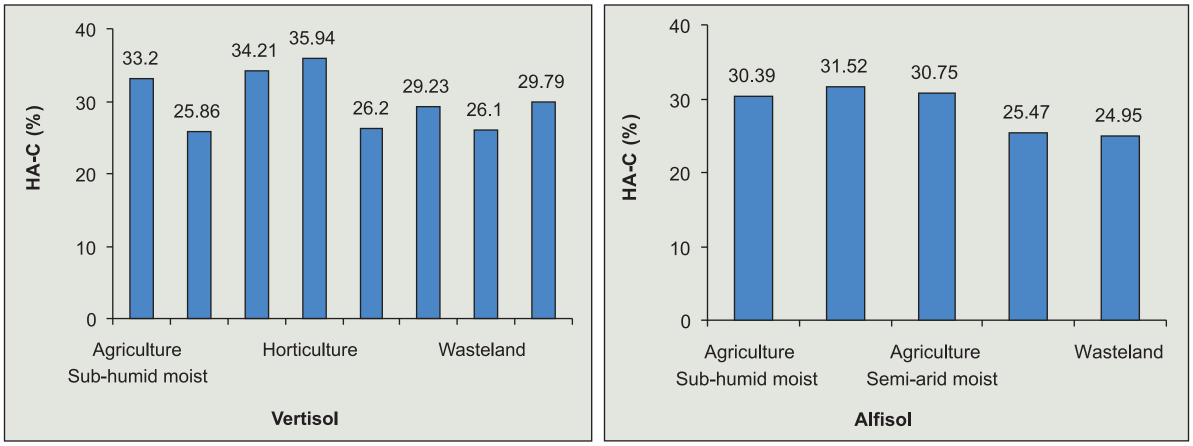

Fig. 15&16 Effects of landuse management pratices on HA-C under different moisture regimes in Vertisol and Alfisol.

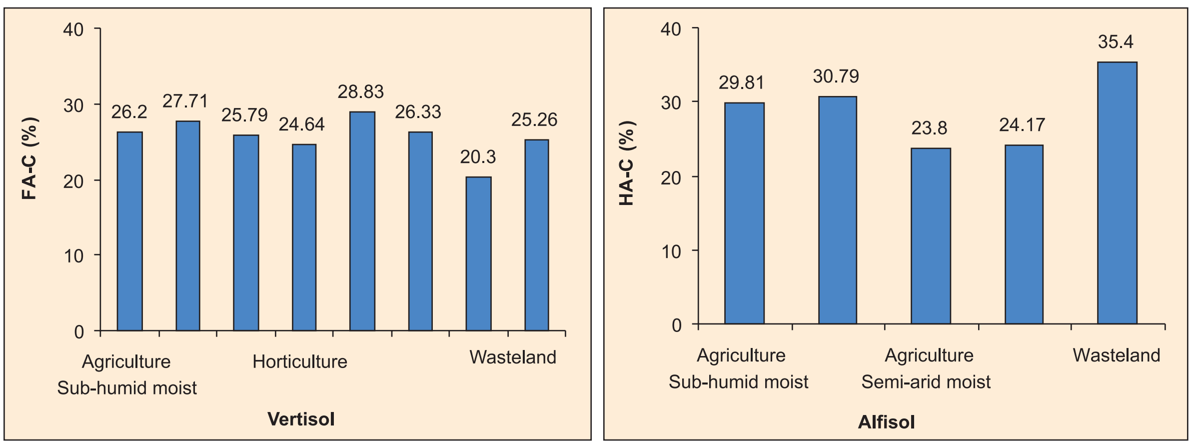

Fig. 17&18 Effects of landuse management pratices on FA-C under different moisture regimes in Vertisol and Alfisol.

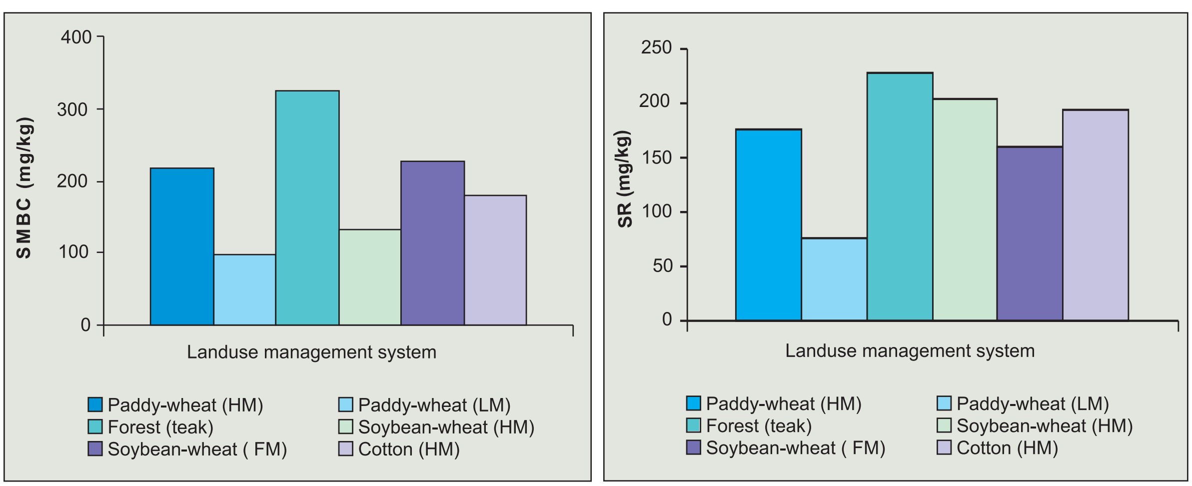

Fig. 19 Effects of different landuse management on SMBC and SR under different SAT benchmark Vertisols of sub-humid moist regions at 0-30 cm soil depth.

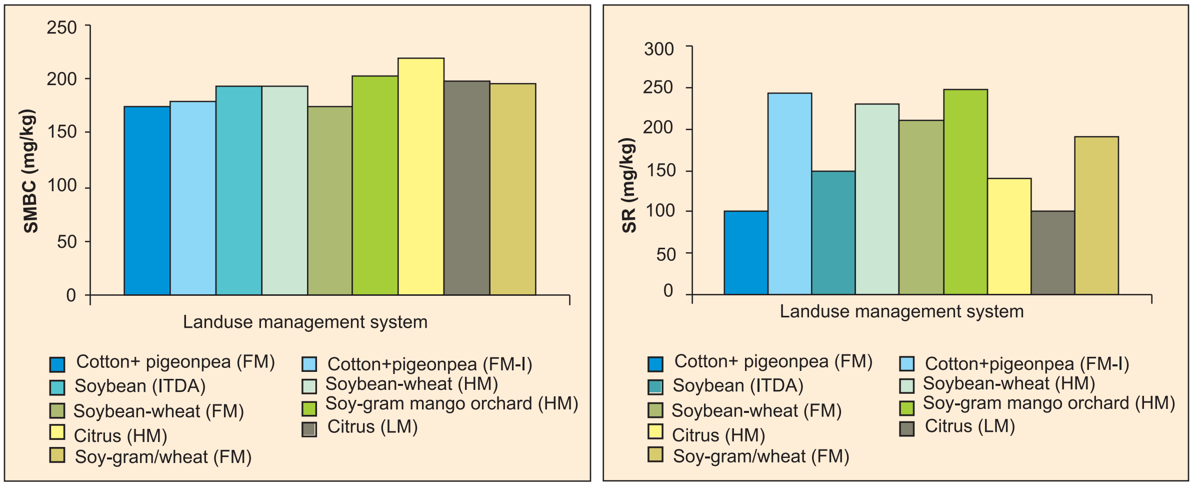

Fig. 20 Effects of different landuse management on SMBC and SR under different SAT benchmark Vertisols of sub-humid dry regions at 0-30 cm soil depth.

in Vertisol, SMBC and SR values were maximum in intercropping systems of cotton/green gram with pigeonpea (FM), followed by soybean + pigeonpea system (FM) and soybean-gram (HM) in rotation (Fig. 21). Whereas, in case of semi-arid dry regions legume-cereal (soybean-wheat, FM) cropping system was maximum in term of SMBC and SR, followed by soybean-pigeonpea (FM) and intercropping of cotton with pigeonpea/sorghum (FM). The least was observed in paddy-wheat system but the basal respiration (SR) was maximum in intercropping system (cotton + pigeonpea + sorghum (LM)) even after low management (Fig. 22). High intensive cropping such as triple-cropping system of sugarcane-wheat-gram (FM) in semi-arid dry region in Vertisols registered relatively more SMBC, followed by double cropping system (paddy-paddy, (HM)) and wasteland system (Fig.23). Overall, in arid regions, biological activities were comparatively lower than sub-humid and semi-arid region in Vertisols. It was observed that in arid regions of Vertisols, the SMBC and SR values were comparatively more in double cropping system of cotton-wheat or chickpea, followed by cotton-bajra system than soybean/wheat/chickpea system (FM) (Fig. 24).

The SMBC and SR values were almost similar in different cropping systems in Alfisols of sub-humid moist and semi-arid moist regions, (Figs. 25, 26) In case of semi-arid dry region in Alfisols, the activity of SMBC and SR were relatively higher in intercropping system (sorghum+ castor (LM)), followed by vegetable-based cropping system and the least was observed in castor–pigeonpea system (Fig.27). These results indicated that the soil biological activity depends upon year-round soil moisture regime, temperature, and precipitation, agronomic management practices and vegetations.

Mineral N (N_{min}) was relatively more in HM of cultivated soils under paddy-wheat system (22 mg kg^{-1}) in Vertisols of sub-humid moist, followed by soybean-wheat system in farmers' management and the least was observed under teak forest (Fig. 28). In case of SMBN, the values were maximum under teak forest (28 mg kg^{-1}), followed by soybean-wheat system and the least was observed under low management in paddy-wheat system (Fig.28). Higher values of N_{min} in cultivated soils may be attributed to regular addition of N through fertilizer and manure but the SMBN was relatively more in forest soils compared to cultivated soil, which indicates that inorganic fertilizer cannot help to improve substantial amount of SMBC and SMBN compared to forest system. Forest litter may help to improve WSC and WSCarbohydrates, which eventually acted as a bio-energy and therefore, it helps to improve the proliferation of SMBC and SMBN. Our earlier findings also concluded that there was no significant build up of biomass C, N, P and S due to inorganic fertilizer addition alone. Organic matter addition positively improved SMBC and associated nutrients of SMBC (Manna and Swarup, 2000). Mineral N (N_{min}) was maximum in intercropping system (cotton + pigeonpea (FM)), followed by horticultural- based cropping system, (citrus (HM)) and soybean-wheat system in Vertisols of sub-humid dry regions (Fig.29). In case of SMBN legume-based cropping system (soybean-wheat (FM)) registered maximum value, followed by intercropping system and horticultural-based cropping system (citrus/mango-orchard). The least was observed under cotton based cropping system under farmer's management (cotton+ pigeonpea (FM), Fig.29).

The N_{min} content in cotton/pigeonpea/soybean-gram with high management system in Vertisols of semi-arid moist (Fig. 30) was maximum, followed by intercropping system (sorghum + pigeonpea (FM)) and the least was observed under intercropping system (cotton/green gram + pigeonpea (FM)). In case of SMBN, the values were maximum under intercropping system (cotton/greengram + pigeonpea (FM)), followed by soybean + pigeonpea system (Fig.30). This study clearly brought out the fact that the improvement of N_{min} was relatively higher in intercropping system compared to crops in rotations. Further, it was observed that the content of N_{min} was relatively lower in legume-based cropping system (soybean-wheat, FM) than cereal-based cropping systems (paddy-paddy (FM), cotton + pigeonpea/sorghum (LM)) but SMBN was relatively higher in soybean-wheat system, followed by intercropping system and the least was observed under paddy-wheat system in Vertisols of semi-arid dry soils. (Fig.31). Out of nine cropping systems in Vertisols of semi-arid dry region, SMBN was maximum in wasteland, followed by sorghum/sunflower/cotton system and the least was observed in sunflower-sorghum system (Fig.31 and Fig.32). The SMBN was maximum in Vertisols of arid region under cotton based (cotton-wheat) cropping system, followed by cotton-*bajra* with low management system. (Fig.33). There were marked variations of mineral N in cultivated maize/mustard system compared to forest system (Fig.34) in Alfisols of sub-humid moist region. The SMBC content also followed the similar trend to that of mineral N in these system. Biomass N was relatively more in teak forest than sal forest (Fig.34). In cereal-based cropping system (finger millet, FM), the SMBN was relatively higher than finger miller /red gram/ groundnut in Alfisols of semi-arid moist (Fig.35). Compared to cropping systems (sorghum-castor (HM), fallow-system, castor + pigeonpea (FM) and vegetables) in Alfisols of semi-arid dry regions, the values of SMBN and mineral N were higher in vegetable-based cropping system, followed by sorghum-castor system. The least was observed in castor + pigeonpea system (Fig.36).

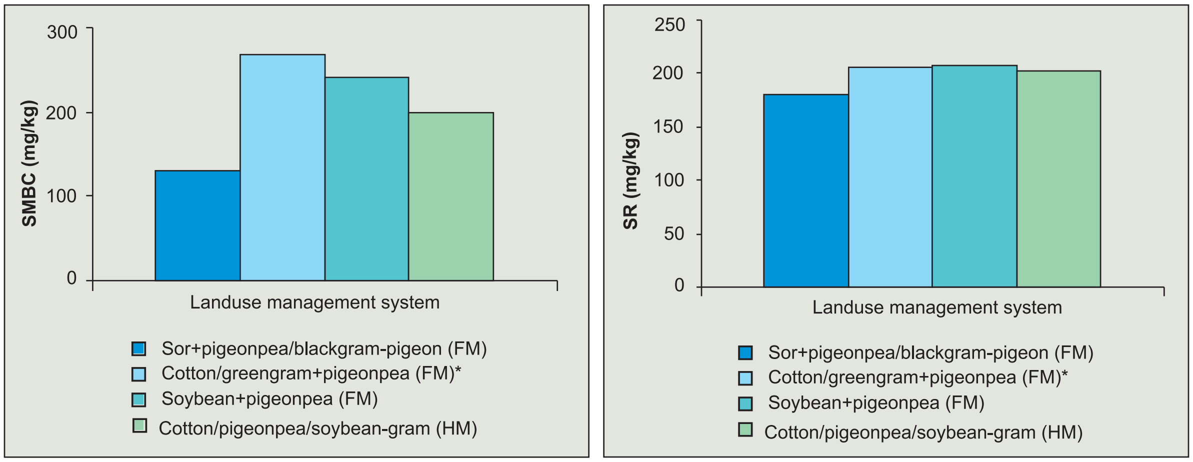

Fig. 21 Effects of different landuse management on SMBC and SR under different SAT benchmark Vertisols of semi-arid moist regions at 0-30 cm soil depth.

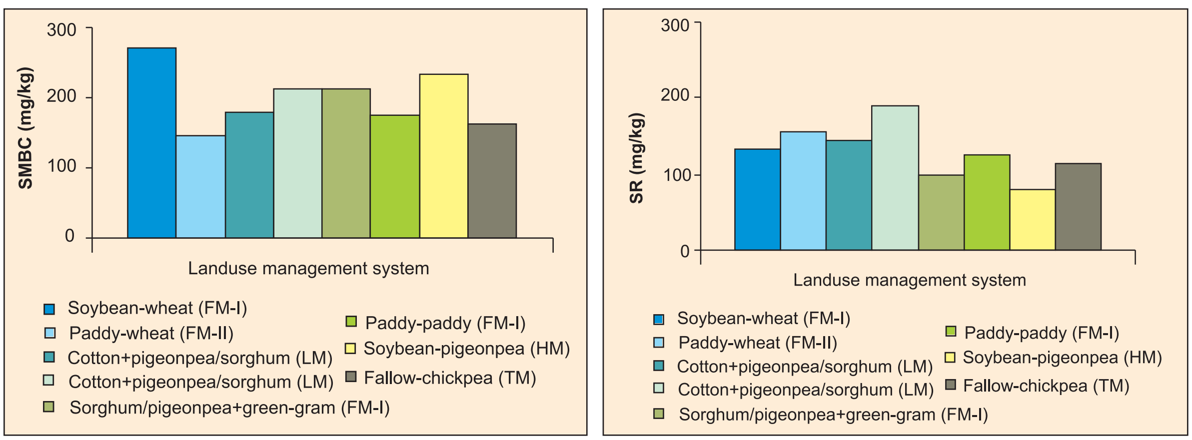

Fig. 22 Effect of different landuse management on SMBC and SR under different SAT benchmark Vertisols of semi-arid dry regions at 0-30 cm soil depth.

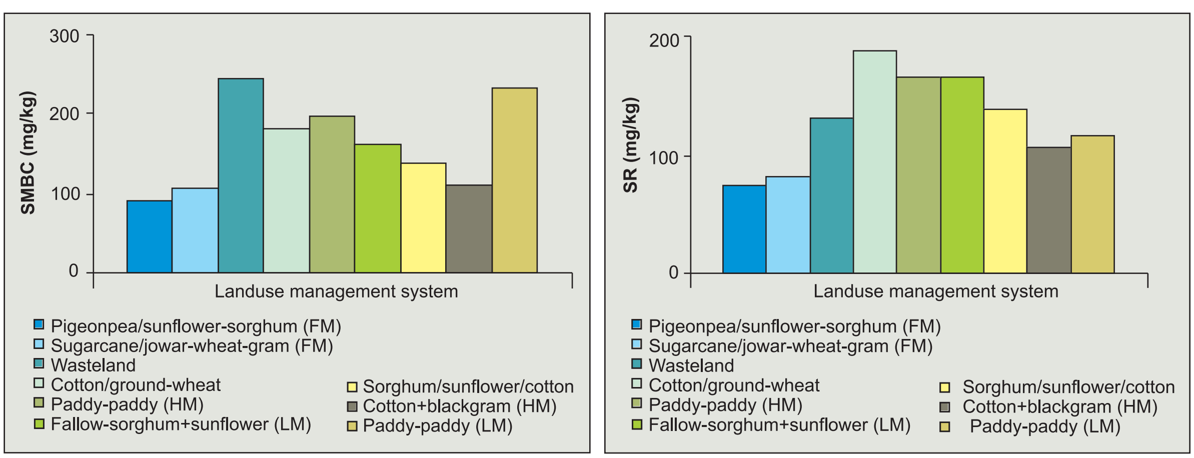

Fig. 23 Effects of different landuse management on SMBC and SR under different SAT benchmark Vertisols of Semi-arid dry regions at 0-30 cm soil depth.

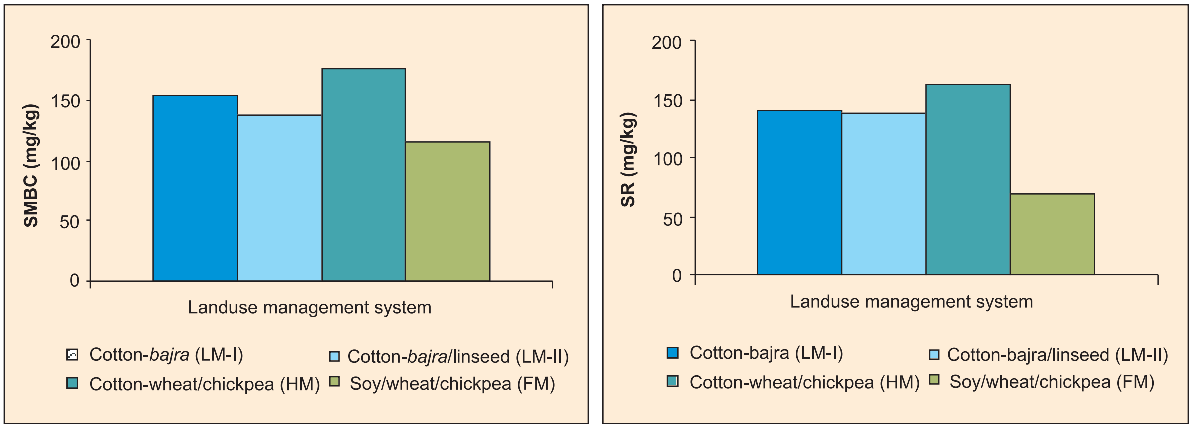

Fig. 24 Effects of different landuse management on SMBC and SR under different SAT benchmark Vertisols of arid regions at 0-30 cm soil depth.

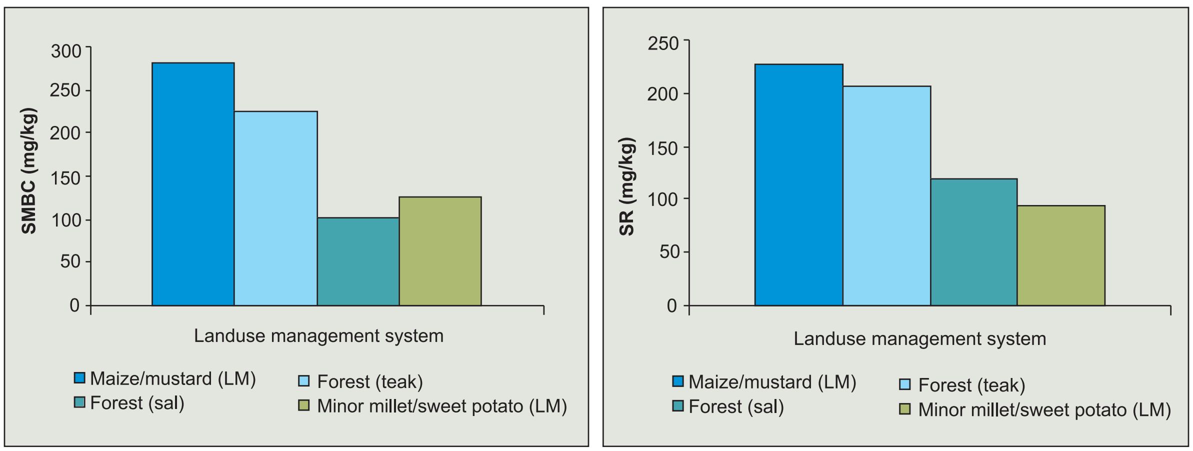

Fig. 25 Effects of different landuse management on SMBC and SR under different SAT benchmark Alfisols of sub-humid moist regions at 0-30 cm soil depth.

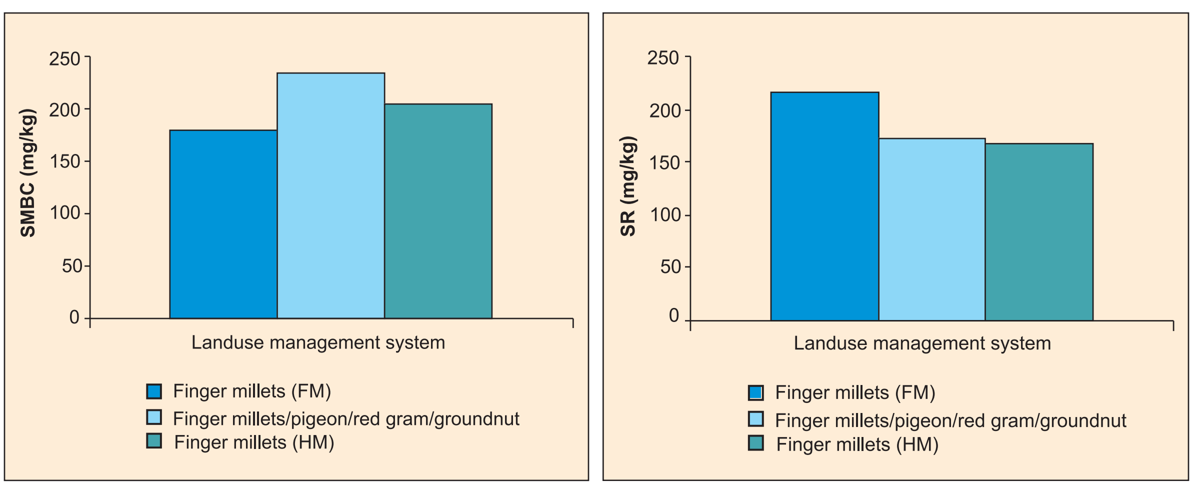

Fig. 26 Effects of different landuse management on SMBC and SR under different SAT benchmark Alfisols of semi-arid moist regios at 0-30 cm soil depth.

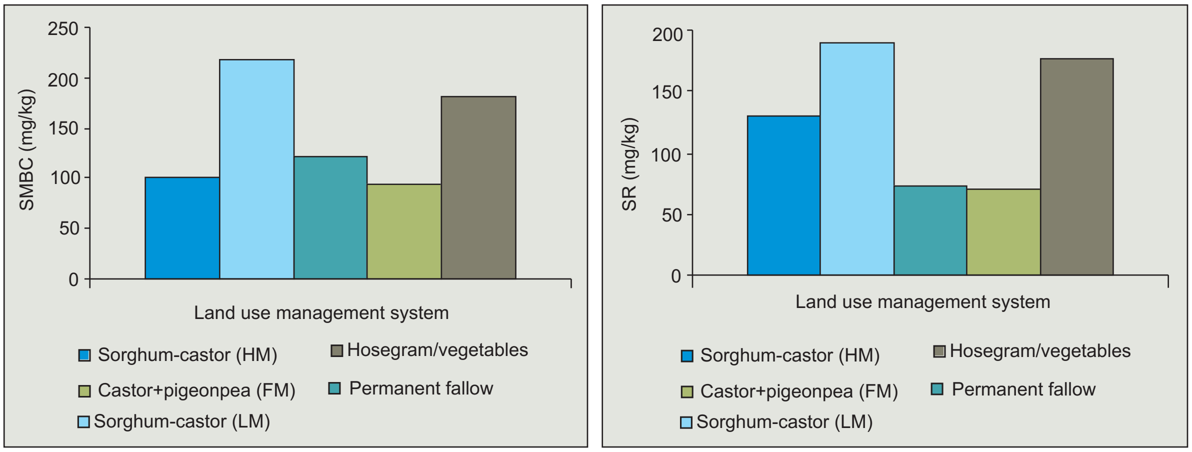

Fig. 27 Effects of different landuse management on SMBC and SR under different SAT benchmark Alfisols of semi-arid dry regions at 0-30 cm soil depth.

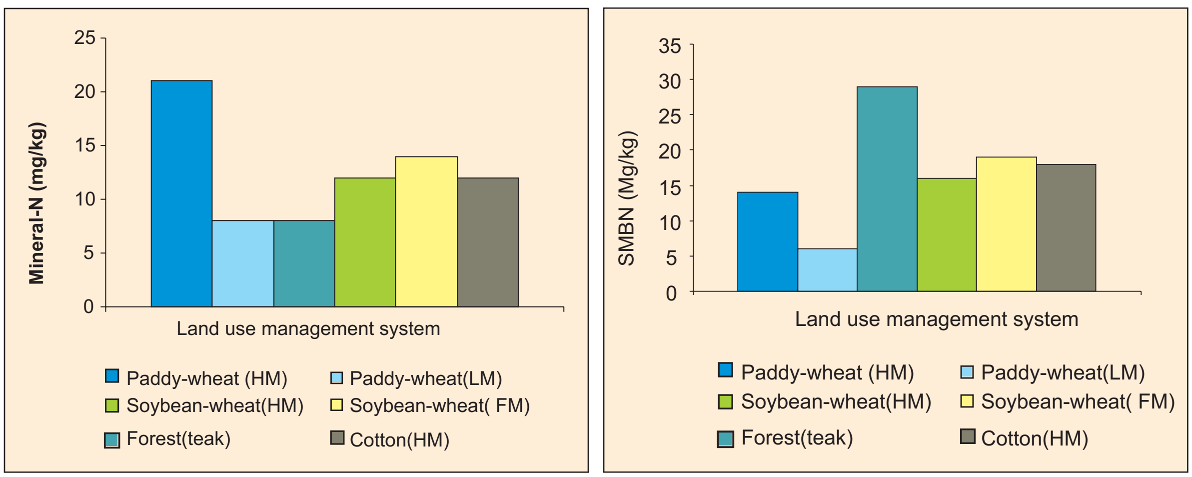

Fig. 28 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Vertisols of sub-humid moist regions at 0-30 cm soil depth.

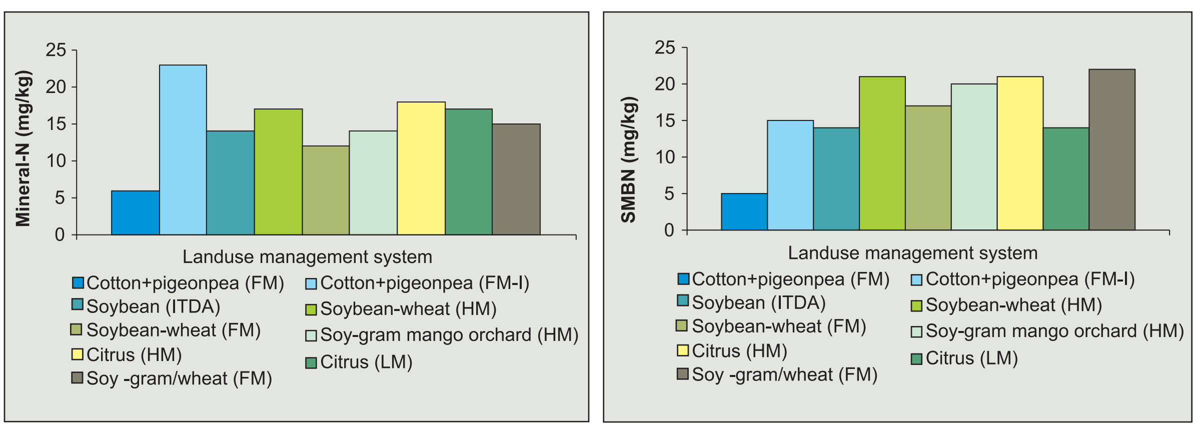

Fig. 29 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Vertisols of sub-humid dry regions at 0-30 cm soil depth.

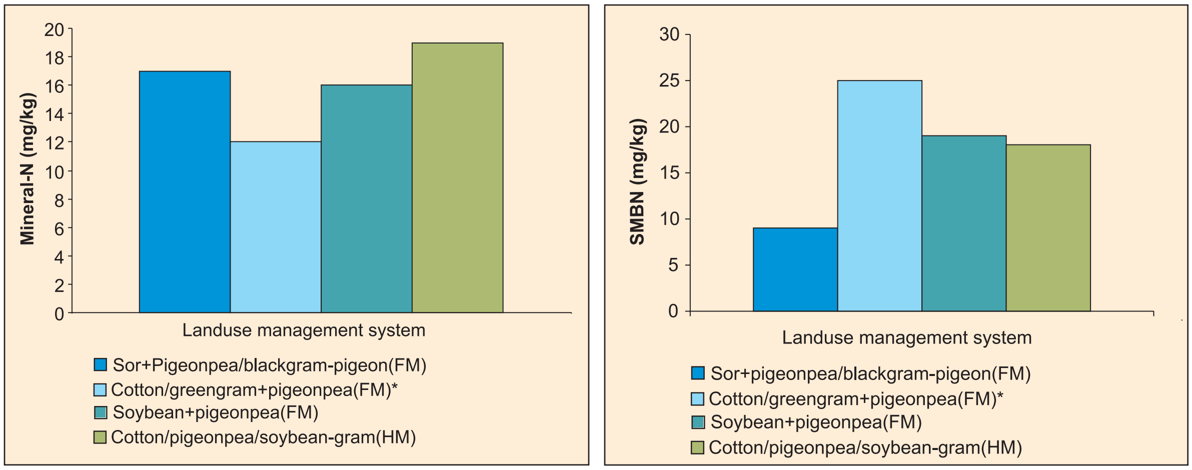

Fig. 30 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Vertisols of semi-arid moist regions at 0-30 cm soil depth.

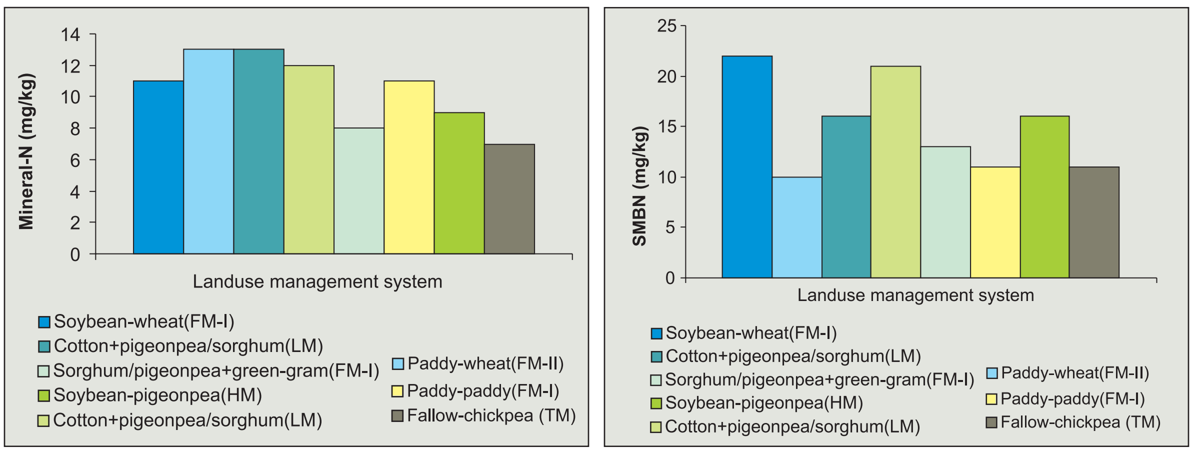

Fig. 31 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Vertisols of semi-arid dry regions at 0-30 cm soil depth.

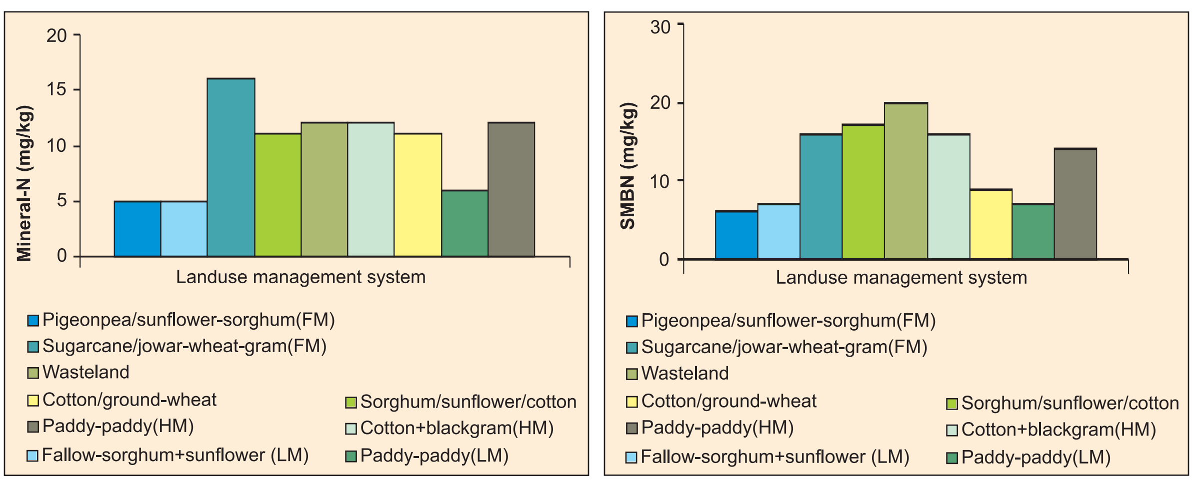

Fig. 32 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Vertisols of semi-arid dry regions at 0-30 cm soil depth.

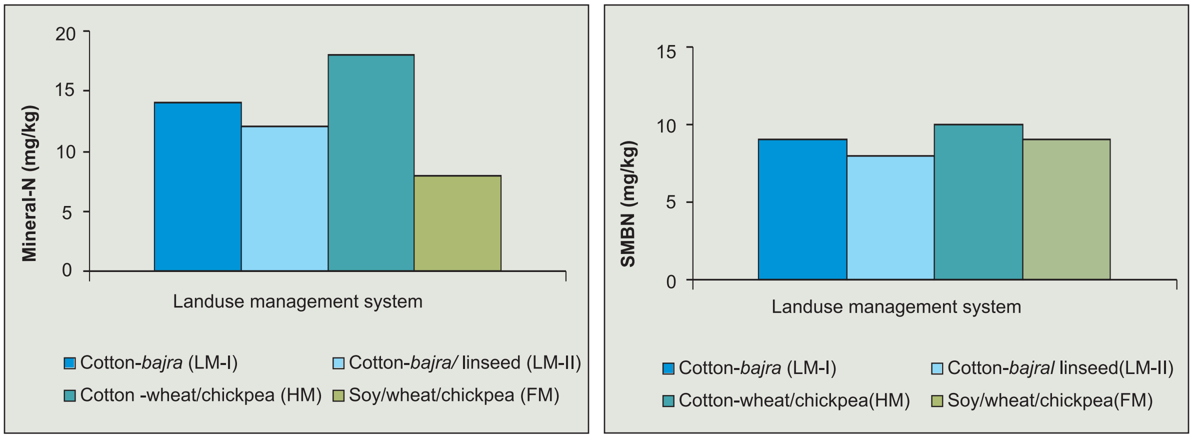

Fig. 33 Effects of different landuse management of Mineral-N, SMBN SAT benchmark Vertisols of arid dry regions at 0-30 cm soil depth.

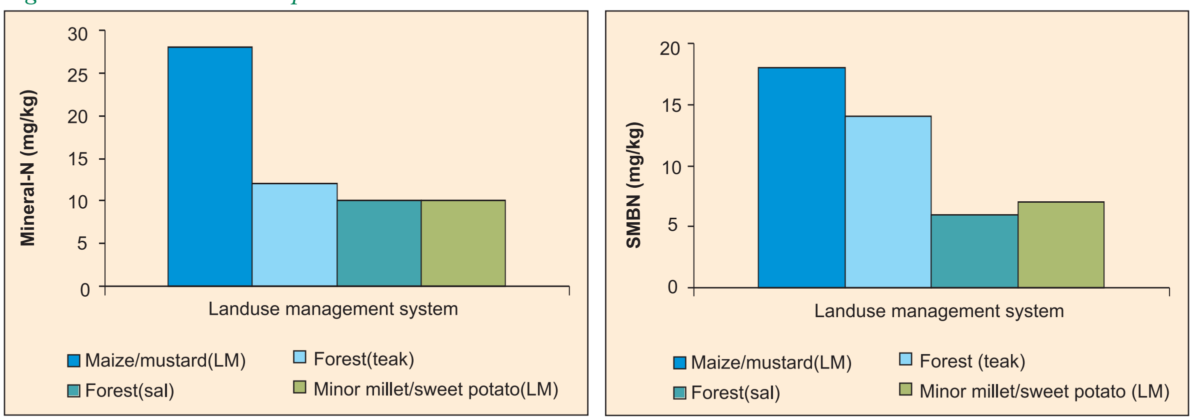

Fig. 34 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Alfisols of sub-humid moist regions at 0-30 cm soil depth.

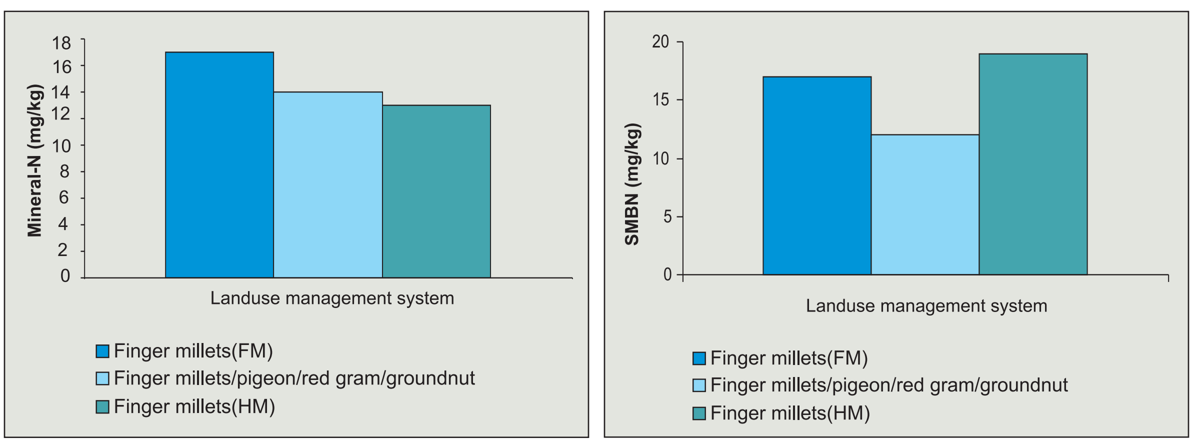

Fig. 35 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Alfisols of semi-arid moist regions at 0-30 cm soil depth.

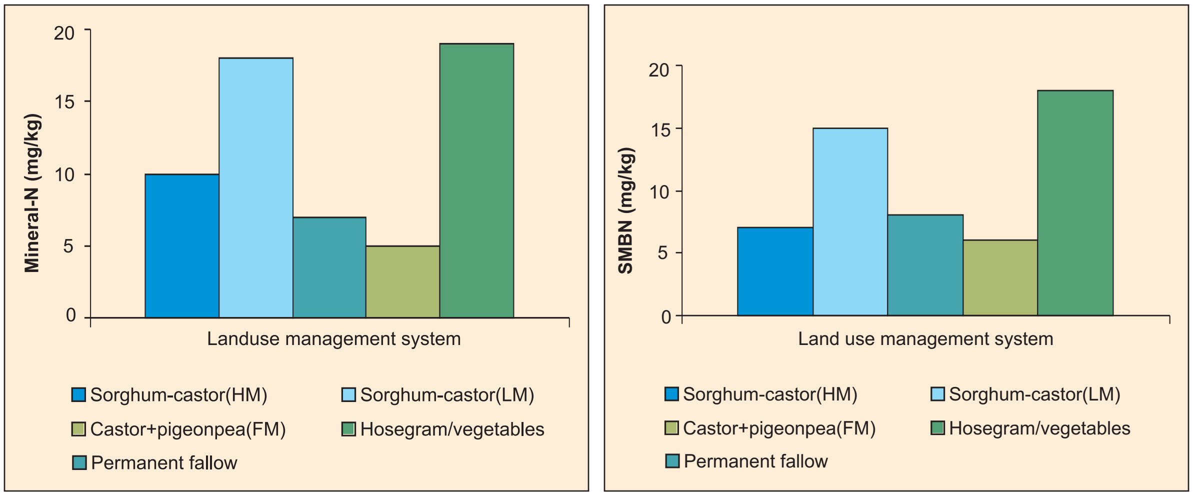

Fig. 36 Effects of different landuse management of Mineral-N, SMBN of SAT benchmark Alfisols of semi-arid dry regions at 0-30 cm soil depth.

Interrelationship between SMBC, SR, DHA, SMBN, N_{min}, WSC and WSCarbohydrates

It was observed that SOC was significantly correlated with SMBC (r=0.68) in Vertisols of sub-humid moist regions, (r=0.92) in Vertisols of semi-arid moist, (r=0.31) in Vertisols of semi-arid dry, and (r=0.73) in Alfisols of sub-humid moist region. Respiration rate (SR) was significantly correlated with the SOC (r=0.52) in Vertisols of sub-humid moist regions, (r=0.84) in Vertisols of semi-arid moist, and (r=0.80) in Alfisols of sub-humid moist. Relationship between WSC and DHA was also significant in Vertisols under sub-humid dry (r=0.75), semi-arid moist (r=0.88), semi-arid dry (r=0.67), and arid soil (r=0.77). WSCarbohydrates was significantly correlated with DHA in the Vertisols of sub-humid moist (r=0.76), sub-humid dry (r=0.63), semi-arid moist (r=0.54), semi-arid dry (r=0.78), and arid soils (r=0.66). In sub-humid moist and semi-arid dry regions of Alfisols significant correlation were observed between DHA vs. WSC and DHA vs. WSC and DHA vs. WSCarbohydrates. However, no significant correlation was observed under semi-arid dry regions in Alfisols. It was also observed that SMBC and DHA were significantly correlated with WSC and WSCarbohydrates under Vertisols and Alfisols. SMBN was significantly correlated with $N_{min.}$. It was (r=0.60) in Vertisols of sub-humid dry, (r=0.73) in semi-arid dry, (r=0.58) in arid regions, (r=0.88) in Alfisols of sub-humid and (r=0.96) in sub-humid dry regions.

Distribution of water stable aggregates and organic carbon distribution in aggregates under different agroecosystems as influenced by various landuse management systems

In the semi-arid tropical region of India, it was found that on an average the percentage of water stable aggregates under Vertisols (63.7%) was higher than that of Alfisols (59.4%) in the 0-30 cm soil depth. In Vertisols, the percentage of water stable aggregates was the highest under arid ecosystem (74.9%) whereas in Alfisols, the percentage of water stable aggregates was the highest under sub-humid moist ecosystem (72.4%). Under sub-humid moist and semi arid dry ecosystems the percentage of water stable aggregates were higher under Alfisols than

Vertisols. Whereas under semi-arid moist ecosystem the percentage of water stable aggregates under Vertisols was higher than that of Alfisols (Fig. 37). Both in Vertisols and Alfisols, the percentage of water stable aggregates under horticulture and forest based system was higher than the agriculture based system (Fig. 38). This may be attributed to intensive tillage operation under agriculture-based system than horticulture and forest system. In Alfisols, the percentage of water stable aggregates under agriculture and forest system was lower than Vertisols. The percentage of water stable aggregates under wasteland was the minimum among the systems.

In sub- humid moist ecosystem the percentage of water stable aggregates under Vertisols was less than that of the Alfisols, both under agriculture and forest systems. Among the agriculture systems, soybean/paddy-wheat cropping system recorded the highest percentage of water stable aggregates (79.5%) in Vertisol and minor millet based cropping system had the highest percentage of water stable aggregates in Alfisols (79.1%) (Figs. 39 and 40). In Vertisols the percentage of water stable aggregates under teak forest (71.3%) was lesser than Alfisols (77.9%).

In sub-humid dry ecosystem, the average percentage of water stable aggregates under Vertisols was 57%. In this ecosystem, the percentage of water stable aggregates under horticultural system (59.9%) was higher than the agriculture system (57.5%). The maximum percentage of water stable aggregates was observed under agri-horticultural system i.e. soybean/gram/mango orchard system (77.8%). Among the agricultural systems, the maximum percentage of water stable aggregates was recorded in cotton + pigeonpea intercropping system (69.3%) (Fig.41).

In semi-arid moist ecosystem the percentage of water stable aggregates under Vertisols (60.3%) was higher than Alfisols (31.2%). Among the agricultural systems soybean + pigeonpea intercropping system registered the highest percentage of water stable aggregates (71.3%) in Vertisols (Fig. 42). In Alfisol, the crop diversification from finger millets to pigeonpea and groundnut improved the percentage of water stable aggregates than sole crop of finger millet (Fig. 43).

In semi-arid dry ecosystem, the percentage of water stable aggregates under Vertisol (58.6%) was less than that of Alfisol (69.7%). In Vertisol, the percentage of water stable aggregates under wasteland of Kovilpatti was minimum (22.7%) among different management systems (Fig. 44). Among the agricultural systems, soybean + pigeonpea intercropping registered the highest percentage of water stable aggregates (85.5%). The percentage of water stable aggregates under paddy-wheat system (83.1%) was significantly higher than the continuous paddy-paddy system (55.9%). Continuous pudding of soil in paddy-paddy system might have resulted in breaking down of soil structure, resulting in lower percentage of water stable aggregates. Among the cropping systems, cotton-based cropping system registered the minimum percentage of water stable aggregates (43.2%). Keeping the soil fallow in the rainy season significantly improved the percentage of water stable aggregates (82.7%) in Vertisol. Among the fallow based systems, fallow-chickpea registered higher percentage of WSA than fallow -sorghum + sunflower system. The percentage of water stable aggregates under sorghum based cropping system was significantly higher in Alfisol (78.5%) than Vertisol (47.8%). Keeping the soil permanently fallow reduced the percentage of water stable aggregates (56.3%) than agricultural system (71.9%) in Alfisol (Fig. 45). The root biomass in agricultural system might have helped in soil aggregation in this soil.

In arid ecosystem, the percentage of water stable aggregates of Vertisol was the highest among different agroecosystems. Among different agricultural systems, cotton-based cropping systems registered higher percentage of water stable aggregate (76.0%) than soybean-wheat/chickpea system (71.6%) (Fig. 46).

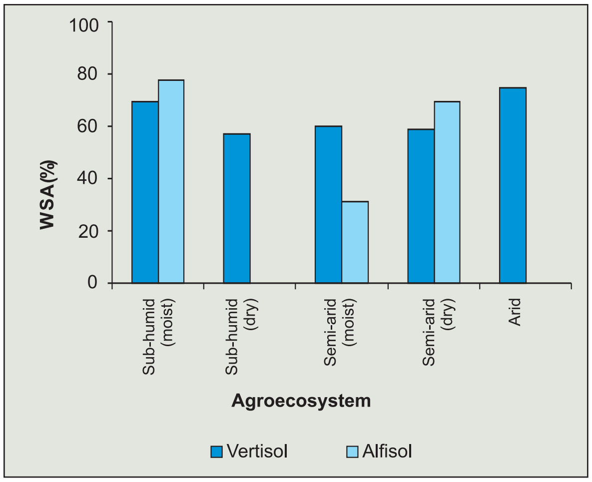

Fig. 37 Distribution of aggregates in different agroecosystems at first 30 cm soil depth.

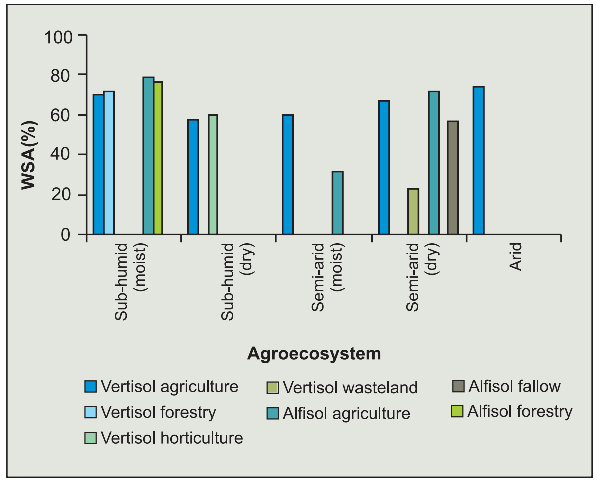

Fig. 38 Distribution of aggregates in different agroecosystems at first 30 cm soil depth under different landuse management practices.

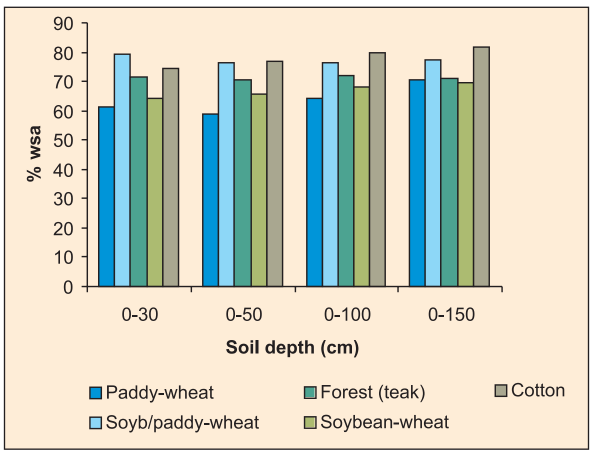

Fig. 39 Water stable aggregates of Vertisol under sub-humid moist ecosystem.

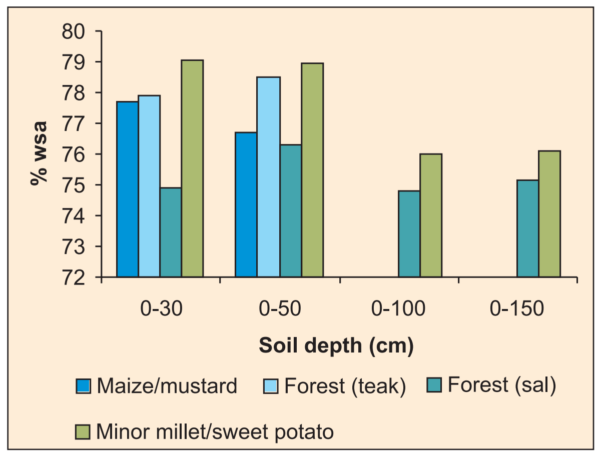

Fig. 40 Water stable aggregates of Alfisol under sub-humid moist ecosystem.

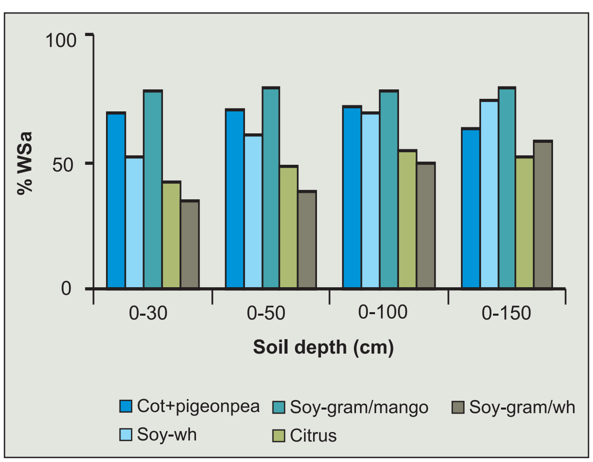

Fig. 41 Water stable aggregates of Vertisol in sub-humid dry ecosystem.

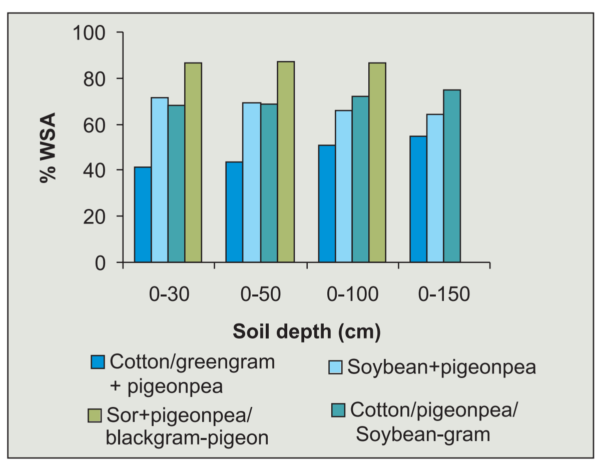

Fig. 42 Water stable aggregates of Vertisol under semi-arid moist ecosystem.

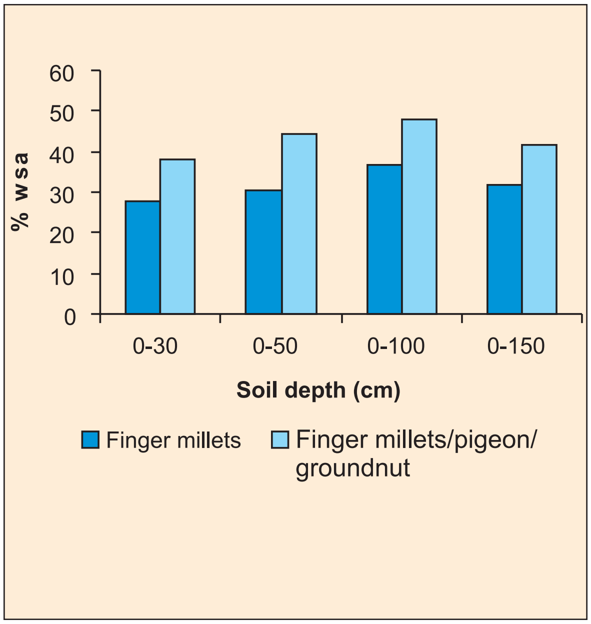

Fig. 43 Water stable aggregates of Alfisol under semi-arid moist ecosystem.

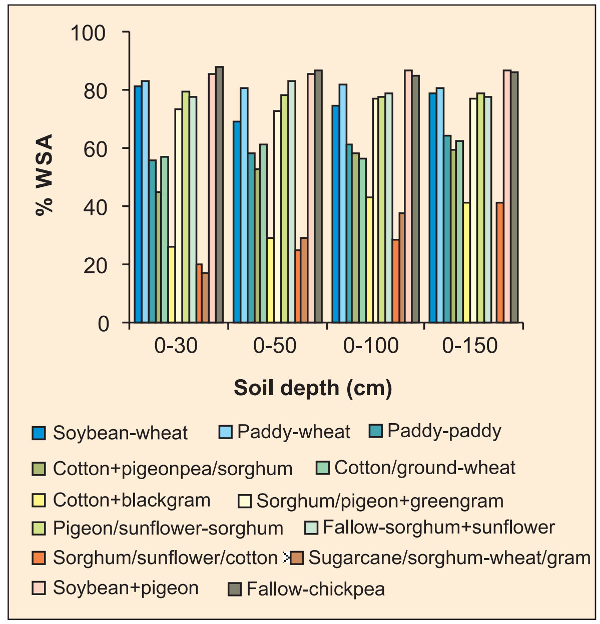

Fig. 44 Water stable aggregates of Vertisol in semi arid (dry) ecosystem.

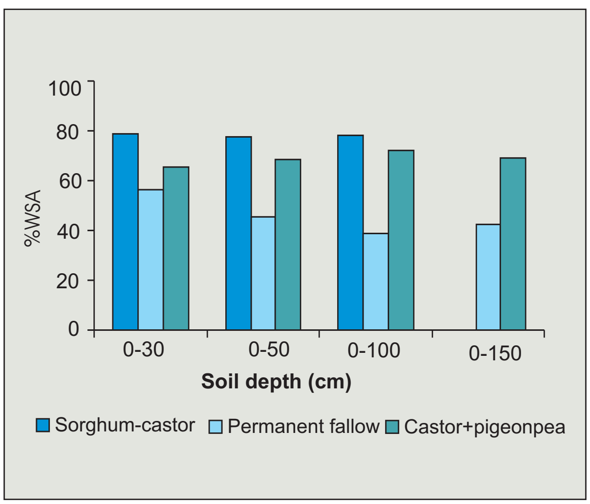

Fig. 45 Water stable aggregates of Alfisol under semi-arid dry ecosystem.

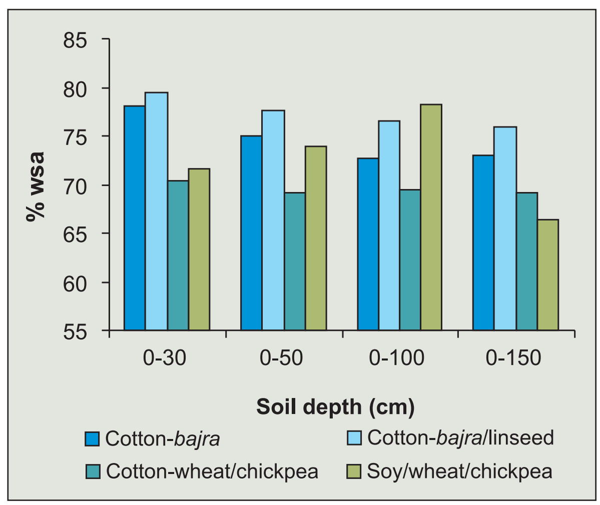

Fig. 46 Water stable aggregates of Vertisol under arid ecosystem.

In the semi-arid tropical region of India, the concentration of soil organic carbon (SOC) in different size classes of aggregates was higher in Vertisol than Alfisol (Fig. 47). Irrespective of soil type as the size of the aggregates decreases, the concentration of SOC increases. In Vertisol, agriculture system registered higher concentration of SOC in all the size classes than forest and horticultural systems, whereas in Alfisol forest system registered higher concentration of SOC in all the size classes than that of agriculture system (Fig. 48). However, keeping the soil permanently fallow registered lower SOC concentration in all the size classes than that of agricultural system in Alfisol. This may be attributed to lower microbial activity due to lower root biomass in permanent fallow than that of agricultural system. The minimum concentration of SOC in all the size classes of aggregates of Vertisol was recorded in wastelands.

In sub-humid moist ecosystem, the concentration of SOC in the WSA was higher in Vertisol than in Alfisol of all the size classes except 2-1 mm (Fig.48). Both in Vertisol and Alfisol, the concentration of SOC in WSA under agricultural system was higher than that of forest soil in all the size classes except 2-1 mm. Both under agricultural system and teak forest system, the concentration of SOC in WSA was higher in Vertisol than Alfisol in all the size classes. Among the agricultural systems, paddy-based system registered the highest concentration of SOC in all the size classes of WSA in Vertisol (Fig. 49). In Alfisol, maize-mustard cropping system registered higher concentration of SOC in WSA than minor millet system in all the size classes except 1-2 mm size aggregates (Fig. 50). Among the forest systems, sal forest recorded higher SOC concentration in all the size class of aggregates than teak forest system.

In sub-humid dry ecosystem the SOC concentration in WSA under agricultural system was higher than that of horticultural system in Vertisol. Among the agricultural systems, the highest SOC concentration in WSA was registered in cotton + pigeonpea intercropping system (Fig. 51).

In semi-arid moist ecosystem, the concentration of SOC in WSA was higher under Alfisol than Vertisol. In Vertisol, cotton + pigeonpea/soybean registered the highest SOC concentration in WSA in all the size classes expect 1-0.5 mm size (Fig. 52), whereas in Alfisol finger millet system under farmers management registered the highest SOC concentration in WSA (Fig. 53) up to first 30 cm soil depth.

In semi-arid dry ecosystem, the concentration of SOC in WSA was higher under Vertisol than Alfisol. Among the agricultural systems, soybean + pigeonpea registered the highest concentration of SOC in WSA. The SOC concentration in WSA under paddy-paddy system was lesser than paddy-wheat system. This may be attributed to the fact that under paddy-paddy system, due to intensive pudding operation the soil aggregates get broken down, exposing the organic carbon, which gets oxidized. This fact is supported by lower percentage of water stable aggregates under paddy-paddy stem than paddy-wheat system (Fig. 54). Among the cropping systems, sorghum based cropping systems registered the highest SOC concentration in WSA both in Vertisol and Alfisol. Among the fallow based cropping systems, the concentration of SOC in WSA was higher in fallow-chickpea system than fallow-sorghum system upto 0.5 mm size class but the trend was reverse above 0.5 mm size aggregates. However, in Alfisol, keeping the soil permanently fallow registered lower SOC concentration in WSA of 0.5-0.1 mm and 1-0.5 mm size classes than the agricultural system (Fig. 55). In Vertisol, the concentation of SOC in WSA was minimum under wastelands.

In arid ecosystem, the concentration of SOC in WSA of Vertisol was the highest under cotton-bajra intercropping system in all the size classes except 0.5-1 mm size aggregates where cotton-bajra/linseed recorded the highest SOC concentration. Cotton-based cropping systems registered higher SOC concentration than soybean-based system in macro aggregates of 2-1 and 1-0.5 mm size whereas in micro-aggregates, reverse trend was observed (Fig. 56).

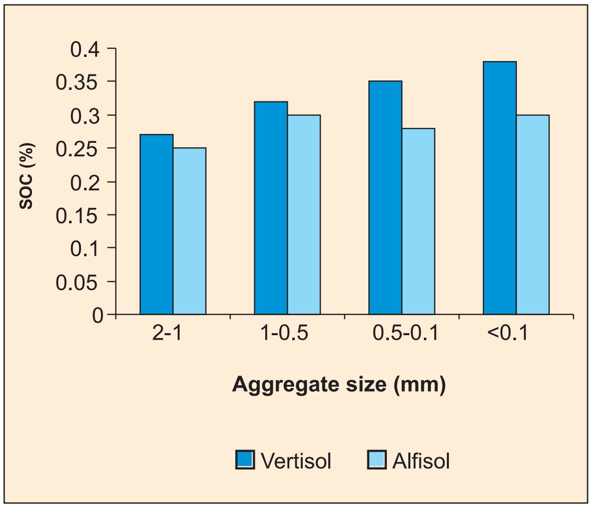

Fig. 47 Concentration of soil organic carbon in different size of aggregates of Vertisol and Alfisol.

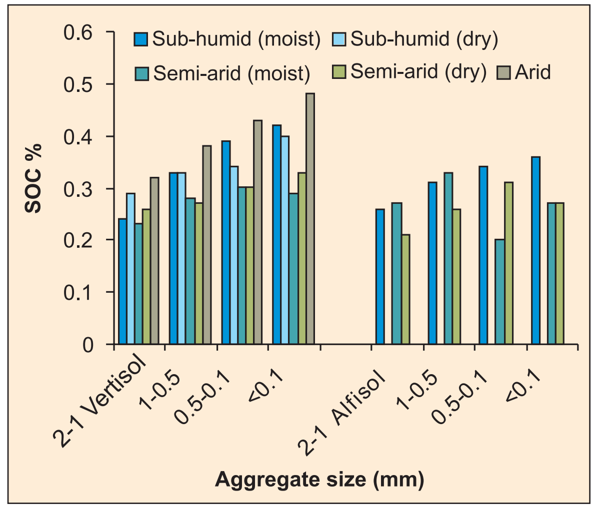

Fig. 48 Concentration of soil organic carbon in different size of aggregates under different agro-ecosystem.

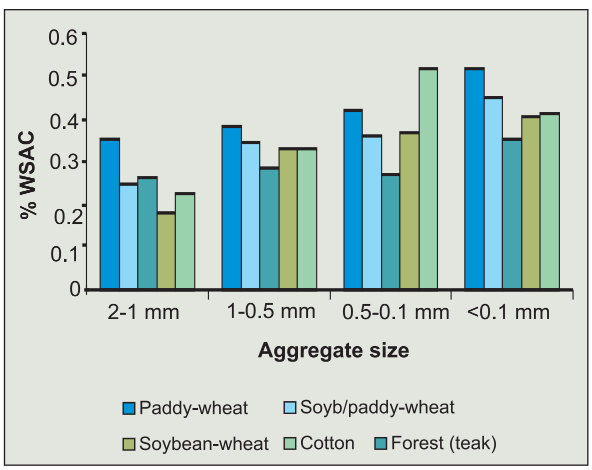

Fig. 49 Water stable aggregate cabon of Vertisol at 0-30 cm soil depth in sub-humid moist ecosystem.

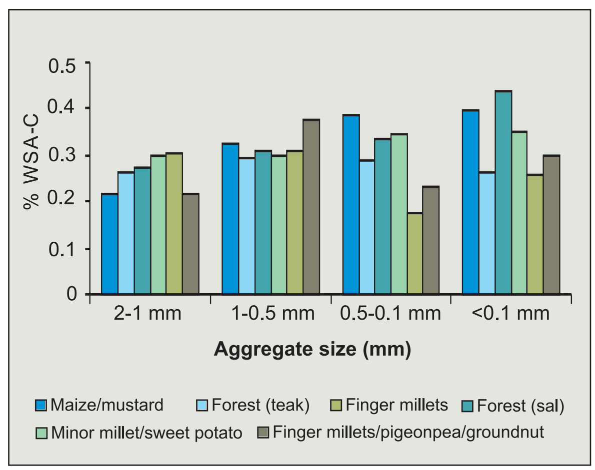

Fig. 50 Water stable aggregate carbon of Alfisol at 0-30cm under sub-humid moist ecosystem.

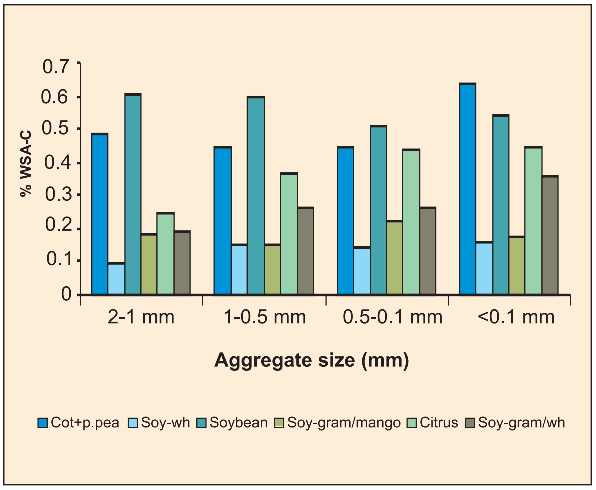

Fig. 51 Water stable aggregate cabon of Vertisol at 0-30 cm soil depth in sub-humid dry ecosystem.

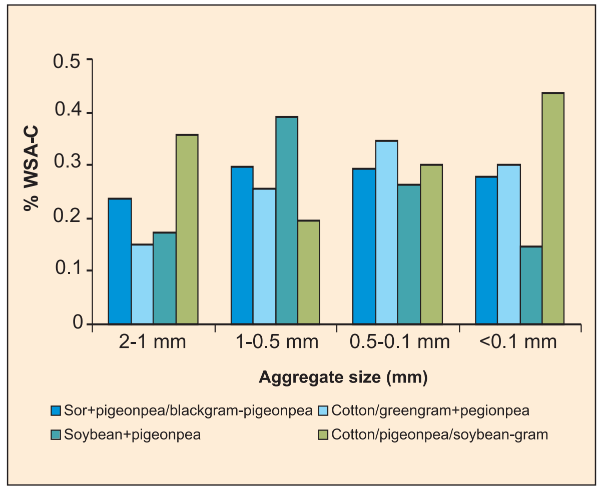

Fig. 52 Water stable aggregate cabon of Vertisol at 0-30 cm soil depth in semi-arid moist ecosystem.

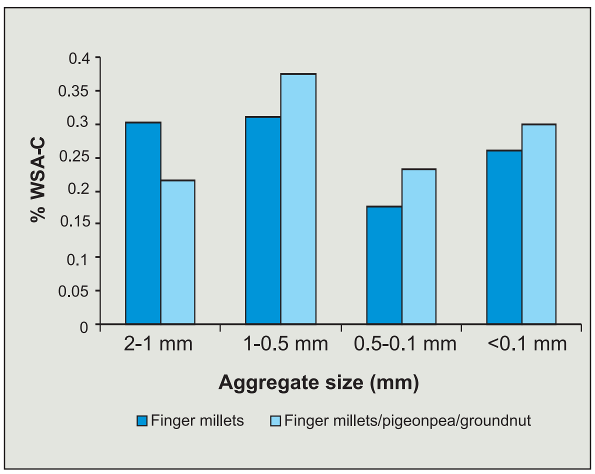

Fig. 53 Water stable aggregate of Alfisol at 0-30 cm under semi-arid moist ecosystem.

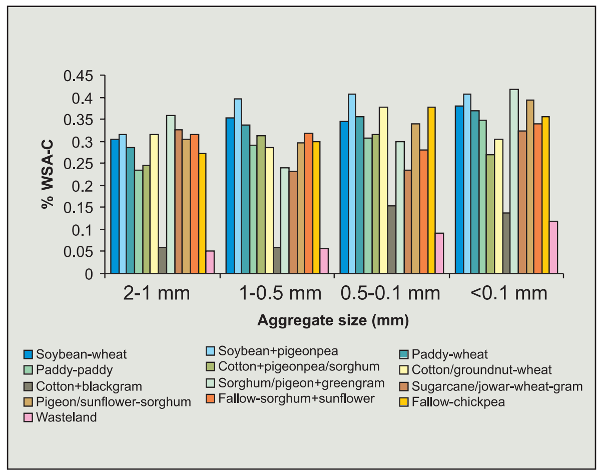

Fig. 54 Water stable aggregate carbon of Vertisol at 0-30 cm soil depth in semi-arid dry ecosystem.

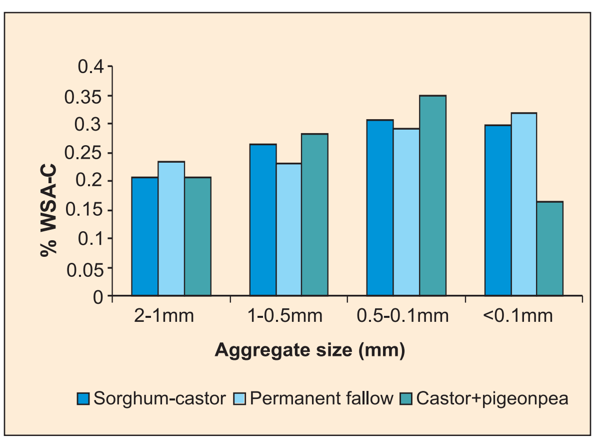

Fig. 55 Water stable aggregate of Alfisol at 0-30 cm under semi-arid dry ecosystem.

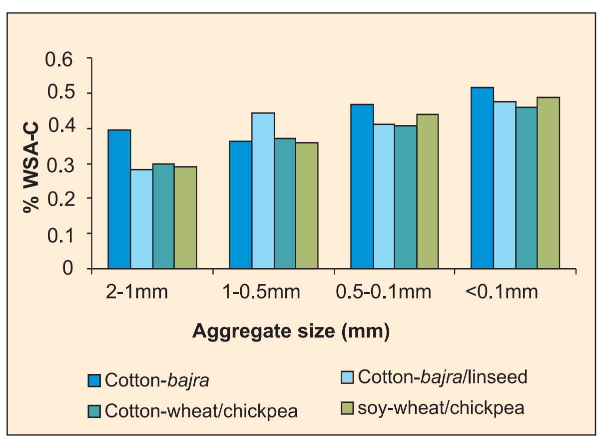

Fig. 56 Water stable aggregates of Vertisol at 0-30 cm under arid ecosystem

Effects of different landuse management on passive pool of carbon

(HA-C and FA-C)

HA-C was relatively higher in surface (0-30 cm) compared to sub-surface horizon, whereas FA-C was relatively higher in sub-surface horizons compared to surface horizons. The passive pools of C such as HA-C was relatively higher in Vertisol (26 to 36 %) compared to Alfisol (25 to 32%) (Figs. 15, 16), while FA-C was greater in Alfisol compared to Vertisol (Figs.17, 18).

The passive fraction of HA-C and FA-C in sub-humid dry region of Vertisol was maximum followed by sub-humid dry, arid, semi-arid dry and semi-arid moist (Fig.15 and 17), whereas in Alfisol, the content of these pools were maximum in sub-humid moists, followed by semi-arid moist and semi-arid dry ecosystem (Figs.16 and 18).

The content of HA-C under horticulture-based crop was maximum in sub-humid dry region in Vertisol and sub-humid moist region under forestry in Alfisol. (Figs. 15 and 16). There was not much variation of HA-C fraction in agriculture and forestry system in sub-humid moist and semi-arid moist region of Alfisol and the values decreased substantially in agriculture system of semi-arid regions in Alfisol (Fig.16). Similarly, there was no variation in FA-C of agriculture /or forestry system under subhumid moist regions of Alfisol and in wasteland in semi-arid region of Alfisol (Fig.18). There was not much variation in the content of FA-C in agriculture, horticulture or forestry in sub-humid moist, dry and semi-arid dry regions in Vertisol. However, the values decreased in agriculture or wasteland under semi-arid dry and dry region of Vertisols (Fig.17).

HA-C fraction was maximum under soybean-wheat system, followed by paddy-wheat (HM) system and the least was observed in paddy–wheat with low management system. FA contents varied from 22 to 43 % of soil organic matter and it was maximum (32% of SOM) in paddy-wheat system at 0-30 cm depths whereas in teak forest soil, these values were maximum (43 % of SOM) at 0-150 cm soil depth (Annexure 1). The similar trend of increasing pattern of FA fractions in sub-humid of dry regions at lower depth was observed. In Vertisols of semi-arid moist region, the content of HA varied between 22.6 and 28.7 % and it was maximum under intercropping system and the lowest was observed in cotton/pigeonpea/soybean-gram system with HM. The proportion of FA contents varied from 28% to 31.1 % of SOM and the similar trend to that of HA fraction was followed in these cropping system. There were no much variation in HA-fractions among inter cropping systems (cotton + pigeonpea, sorghum/ pigeonpea + gram, soybean-wheat system and fallow-chickpea) except soybean-wheat and paddy-wheat system under farmers practices in Vertisols of semi-arid dry regions. In case of FA concentration, reverse trend was observed under these systems in semi-arid dry regions. It was also observed that the contents of HA varied from 12.8 to 38.4 % of SOM and it was the lowest under sorghum/sunflower cotton system in Vertisols of semi-arid dry regions. Fulvic acid contents also followed similar trend to that of HA. In Vertisols of arid regions, there was not much variation among four cropping system in HA fractions but relatively higher values were observed under cotton-wheat/chickpea (HM) and soybean-chickpea system at lower depths in Vertisols of arid-regions. In Alfisols of sub-humid moist ecosystem, teak forest and in semi-arid dry regions, finger-millet (FM) cropping system registered the maximum HA content. The FA fractions also followed the similar trend to that of HA. In Alfisols of semi-arid dry regions, the HA fraction was maximum in sorghum-castor system and under permanent fallow system, HA fraction was relative higher under lower depths (0-150 cm).

Summary and conclusions

The study site was spread over a wide range of annual rainfall and the soils varied in texture from sandy-loam to clay. Significantly different levels of SOC were found amongst the landuse management practices. The salient findings on biological properties of these sites are given below.

- SOC of forest, namely teak, sal was two times higher than the corresponding cropped soils.
- The active pools of SMBC comprised 3.2 to 5.6 % of SOC in Vertisols and 1.2 to 5.7 % of SOC in Alfisols.
- WSC comprised 0.80 to14.1 % of SOC in Vertisols and 1.5 to 4.9 % of SOC in Alfisols.
- WSCarbohydrates comprised 15-40.3 % of SOC in Vertisols and 10.5 to 25 % of SOC in Alfisols.
- In sub-humid moist regions, the SMBC content followed the order: forest (teak)> soybean-wheat>paddy-wheat>cotton (HM).
- In case of sub-humid dry regions of Vertisols, the SMBC was maximum under horticultural system (citrus), followed by intercropping (cotton + pigeonpea) and mango-orchard.
- In semi-arid moist regions, SMBC and SR were higher under intercropping system (soybean+ pigeonpea) compared to soybean – gram system.
- The soil biological activity in terms of SMBC, SMBN, can be improved with concomitant increase of water-soluble carbon and carbohydrates by better management practices.
- Among the field crops, legume-based intercropping system (soybean + pigeonpea and green gram + pigeonpea) restored higher amount of SOC, SMBC compared to double crop in rotation (soybean-wheat/paddy-paddy cropping system).
- Among the horticultural-based cropping systems, citrus with high management has better SOC restoration compared to mango orchard. Cotton based cropping system either as intercropping or sequential cropping registered least improvement of SOC storage.
- In Vertisols, the percentage of water stable aggregates and concentration of carbon in WSA was higher than Alfisols. Water stable aggregates carbon concentration increased with decrease in size class. By and large, the maximum concentration of SOC in water stable aggregates was observed in <0.1 mm size aggregates.
- In 0-30 cm soil depth passive fraction of HA-C was relatively higher than FA-C in surface whereas, FA-C increased with soil depths. The percent variations in passive fractions among different cropping systems were not as pronounced as compared to active and slow pool of C.

References

Allmaras RR, Schomberg HH, Doughlas Jr, and **CL Dao TH.** 1999. Conservation tillage's unforeseen advantage. Res. Eng. Technol. Sustain. World 6, 7-8.

Batjes NH. 1996. Total C and N in soil of the world. Eur. J. Soil Sci. 47, 151-163.

Bremner JM. 1965. Total nitrogen. *In* C.A. Black (ed.) Methods of soil analysis. Part 2. Agronomy 9: 1149-1178. Am. Soc. Agron. Madison, Wis.

Bruce, JP., Frome, M., Haites, E., Janzen, H., Lal, R. and Paustian K. 1999. Carbon sequestration in soils. Journal of Soil and Water Conservation 54, 382-389.

Camberdella CA, and **ET Elliott.** 1992. Particulate organic matter changes across a grassland cultivation sequence. Soil Sci. Soc. Am. J. 56: 777-783.

Elliott ET. 1986. Aggregates structure and carbon, nitrogen, and phosphorus in native and cultivated soil. Soil Sci. Soc. Am. J. 50: 627-633.

Eswaran H, Van Den Berg E, and **Reich P.** 1993 Organic carbon in soils of the world. Soil Sci. Soc. Am. J. 57, 192-194.

Grant FR. 1997. Changes in soil organic matter under different tillage and rotation: mathematical modeling in ecosystem. Soil Sci. Soc. Am. J.61, 1159-1175.

Houghton RA. 1995. Changes in the storage of terrestrial carbon since 1850. In: Lal, R., Kimble, J., Levine, E., Stewart, B.A. (Eds.), Soils and Global Changes. CRC press, Boca Raton, FL, pp. 45-65.

IPCC. 1996. Climate Change 1995: the Science of Climate Change. Cambridge University Press, Cambridge.

Jenkinson DS and DS Powlson. 1976. The effect of biomodal treatments on metabolisms in soils. V.A. method of measuring soil biomass. Soil Biol. Biochem. 8:209-213

Lal R, Kimble JM, Follett RF and **Cole CV.** 1998. The Potential of US Cropland to Sequester Carbon and Mitigate the Greehouse Effect. Ann Arbor Press, Chelsea, MI, 128 pp.

Lal R, Kimble JM, Follett RF and **Cole CV.** 1999. Management of US cropland to sequester carbon in soil, J. Soil Water Cons. 54, 374-381.

Larson WE, Clapp EC, Pierre WH and **Morachan YB.** 1972. Effects of increasing amounts of organic residue on continuous corn. II. Organic C, N, P and S. Agron. J. 64, 204-208.

Manna and **A Swarup.** 2000. Effect of integrated use of organic C and fertilizer N on soil microbial biomass dynamics, turnover and activity of enzymes under legume-cereal system in a swell-shrink (Typic Haplustert) soil. Korean J. Environ. Agric. 19: 375-387

McGill WB, KB Cannon, JA Robertson and **FD Cook.** 1986. Dynamics of soil microbial biomass and water-soluble organic C in Breton L after 50 years of cropping to two rotations. Can. J. Soil Sci. 66: 1-19.

Nelson DW and **LE Sommers.** 1975. A rapid and accurate method for the determination of organic carbon in soils. Proc. Indiana Acad. Sci. 84: 456-462.

Parton WJ, DS Schimel, CV Cole and **DS Oiima.** 1987. Analysis of factors controlling soil organic matter levels in Great Plains grasslands. Soil Sci. Soc. Am. J. 51: 1173-1179.

Paustian K, Parton WJ and **Persson J.** 1992. Modeling of soil organic matter in organic amended and nitrogen-fertilized long-term plots. Soil Sci. Soc. Am. J. 56, 476-88.

Rasmussen PE, Allmaras RR, Rhode CR and **Roager Jr NC.** 1980. Jcrop residue influences on soil carbon and nitrogen in a wheat-fallow system. Soil Sci. Soc. Am. J. 44, 596-600.

Reicosky DC, Dugas WA and **Tolbert HA.** 1997. Tillage-induced soil carbon dioxide loss for different cropping system. Soil Till. Res. 41, 105-118.

Reicosky DC, Kemper WD, Longdale GW, Douglas Jr CL and **Rasmussen PE.** 1995.soil organic matter changes resulting from tillage and biomass production. J. Soil Water Cons.50 253-262.

Sarminto JL and **Wofsy SC (Co-Chairs).** 1999. A US Carbon Cycle Science Plan. A Report of the Carbon and Climate Working group. Prepared at the request of agencies of the US Global Change Research Program. 400 Virgina Ave., Sw, Site 750, Washington, D.C. 69 pp.

Schiesinger WH. 1995. An overview of the global carbon cycle. In: Lal, R., Kimble, J.M. Levine, E. Stewart, B.A. (Eds.), Soils and Global Change. CRC, Boca Raton, FL, pp. 9-25.

Schimel DS. 1995. Terrestrial ecosystems and the carbon cycle. Global Change Biol. 1, 77-91.

Stevenson FJ. 1994. Humus chemistry: Genesis, composition, reactions. 2nd ed. John Wiley and Sons, New York.

van Veen JA, JN Ladd and **MJ Frissel.** 1984. Modelling carbon and nitrogen turnover through the microbial biomass in soil. Plant Soil 76: 257-274.

Annexure 1

BM Spots and their site characteristics for systematic arraying of soil analytical data

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Sub-humid (Moist) Mean Annual Rainfall> 1100 mm					
1	Jabalpur/MP	Kheri	Agriculture (HM) Paddy-wheat	1448	P 27

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-20	181.8	230	22.0	-3.39	14.82	188	0.18	36.1	21.3	46	9.2	0.34	0.37	0.41	0.5	0.6	62.2
20-42	167.9	196	18.1	-2.69	11.37	189	0.16	20.2	30.8	38	8.7	0.38	0.41	0.45	0.56	0.62	58.9
42-63	148.5	176	15.6	-3.38	11.49	167	0.15	20	30.5	30	6.9	0.31	0.36	0.18	0.48	0.59	49
63-84	124.9	165	13.9	-2.30	11.08	179	0.13	19.8	32.1	26	6.5	0.54	0.63	0.49	0.43	1.03	77.1
84-115	112.4	145	11.3	-2.82	8.86	160	0.11	18.7	31.3	21	6	0.29	0.35	0.4	0.52	0.57	80.4
115-160	108.2	132	11.7	0.45	6.80	150	0.09	15.5	30.1	20	5.8	0.31	0.36	0.18	0.48	0.62	83.5
0-30	177.2	218.3	20.7	-3.2	13.7	188.3	0.17	30.8	24.5	43.3	9.0	0.35	0.38	0.42	0.52	0.61	61.1
0-50	170.3	206.1	19.3	-3.1	12.8	185.1	0.17	26.5	27.0	39.9	8.6	0.35	0.39	0.39	0.52	0.61	58.6
0-100	145.9	177.1	15.6	-2.8	10.9	177.6	0.14	19.8	31.1	31.1	7.4	0.38	0.44	0.39	0.51	0.69	64.1
0-150	135.6	167.8	14.8	-2.1	10.2	169.3	0.13	20.8	29.6	28.6	7.0	0.35	0.40	0.34	0.50	0.66	70.7

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Sub-humid (Moist) Mean Annual Rainfall> 1100 mm					
2	Jabalpur/MP	Kheri	Agriculture (LM) Soybean/paddy-wheat	1448	P 28

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-14	87.4	111	9.3	1.89	6.75	109	0.15	30.9	20.8	37	8.9	0.19	0.31	0.35	0.48	0.6	80.4
14-32	83.3	108	8.4	0.37	6.34	194	0.14	20.1	39.9	35	7.2	0.3	0.37	0.37	0.42	0.67	78.7
32-61	63.8	81	7.0	-0.15	5.95	186	0.12	19.6	29.3	29	6.9	0.32	0.41	0.38	0.4	0.93	70.9
61-82	61.1	61	5.9	-2.25	3.82	163	0.11	18.2	30.1	28	6.7	0.28	0.31	0.4	0.38	0.66	80.3
82-112	54.1	57	4.3	-1.36	3.27	160	0.1	17.7	30	24	5.9	0.29	0.35	0.26	0.4	0.49	75.5
112-133	52.7	44	4.8	-1.07	3.13	151	0.09	13.9	29.5	22	5.5	0.19	0.21	0.3	0.21	0.59	81.5
133-156	50.0	37	4.3	1.16	2.52	139	0.08	12.2	28.1	18	5.2	0.17	0.23	0.27	0.31	0.65	80.5
0-30	76.8	99.0	7.9	0.2	6.2	154.33	0.14	25.14	30.99	35.93	7.99	0.25	0.34	0.36	0.45	0.64	79.49
0-50	71.2	88.6	7.4	-0.3	5.8	189.73	0.14	22.94	30.74	33.40	7.57	0.28	0.37	0.37	0.43	0.74	76.37
0-100	59.4	65.9	5.9	-1.0	4.5	173.73	0.12	20.64	30.31	30.09	7.01	0.28	0.36	0.36	0.41	0.70	76.44
0-150	59.1	60.6	5.6	-0.4	3.9	161.4	0.11	18.50	29.92	27.10	6.51	0.26	0.32	0.33	0.37	0.66	77.53

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Moist) Mean Annual Rainfall> 1100 mm																	
3	Nagpur/ Maharashtra	Boripani	Forest (Teak)	1279	P 15												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-16	229.7	384.4	7.3	5.2	35.3	305	0.18	30.2	22.3	23	9.8	0.28	0.22	0.18	0.31	0.58	75.1
16-44	226.7	254.4	9.1	6.1	22.3	275	0.18	20.9	33.9	21	7.9	0.24	0.36	0.38	0.4	0.43	67
44-57	194.6	221.0	8.9	4.1	21.7	252	0.14	25.1	33.1	20	6.3	0.34	0.19	0.25	0.16	0.67	76.3
57-94	193.1	113.3	7.9	3.5	12.1	225	0.12	21.3	33	18	5.8	0.36	0.41	0.37	0.28	0.75	73.6
95-						195	0.08	18.2	32.8	15	5.3	0.29	0.21	0.12	0.14	0.49	71.2
0-30	228.3	323.7	8.2	5.6	29.3	291.0	0.180	25.86	27.7	22.067	8.9	0.2613	0.28533	0.273333	0.352	0.51	71.32
0-50	223.8	292.0	8.5	5.6	26.4	281.8	0.175	24.38	30.1	21.52	8.3	0.2648	0.2948	0.3004	0.3424	0.5068	70.708
0-100	197.0	203.4	7.8	4.4	19.2	253.5	0.147	22.92	31.5	19.72	7.1	0.3068	0.325	0.3118	0.2944	0.6072	72.199
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Moist) Mean Annual Rainfall> 1100 mm																	
4	Bhopal/MP	Nabibagh	Agriculture(HM) Soybean-wheat	1209	P 5												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-15	216.0	183.8	13.8	5.2	17.6	300	0.19	35.9	25.7	34	17.8	0.24	0.33	0.39	0.36	0.52	63
15-42	212.9	157.8	11.9	4.4	18.5	200	0.18	33.1	22.7	31	11.8	0.13	0.33	0.31	0.32	0.8	66
42-69	196.1	105.8	12.1	2.4	12.5	200	0.09	32.6	20.1	32	10.3	0.11	0.32	0.32	0.29	0.64	62
69-107	179.4	94.7	16.5	1.4	11.1	140	0.08	30.2	19.7	28	5.5	0.07	0.3	0.3	0.32	0.78	66
107-135	154.9	68.7	13.2	1.9	10.8	100	0.06	29.1	18.6	26	2.1	0.07	0.3	0.22	0.21	0.77	69
135-150	124.4	79.8	12.3	1.9	11.0	100	0.05	28.3	16.8	20	1.1	0.06	0.16	0.12	0.13	0.76	67
0-30	205.1	133.6	12.0	3.4	15.7	250.0	0.19	34.50	24.20	32.50	14.80	0.19	0.33	0.35	0.34	0.66	64.50
0-50	199.5	121.1	12.6	2.9	14.2	230.0	0.17	33.86	23.18	32.06	13.36	0.16	0.33	0.34	0.33	0.69	64.46
0-100	177.1	97.4	13.0	2.4	12.5	196.4	0.13	32.49	21.52	30.79	10.34	0.12	0.32	0.32	0.32	0.71	64.47
0-150	182.0	110.6	13.6	2.6	13.2	166.1	0.10	31.33	20.42	28.69	7.65	0.10	0.30	0.28	0.28	0.73	65.64

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Moist) Mean Annual Rainfall> 1100 mm																	
5	Bhopal/MP	Nabibagh	Agriculture(FM) Soybean-wheat	1209	P 6												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-23	161.0	228.4	15.3	1.9	18.9	285	0.36	39.4	28.9	36	4.4	0.18	0.33	0.41	0.49	0.88	64
23-42	158.0	221.0	10.2	2.8	20.1	200	0.11	33.7	25.2	33	3.6	0.19	0.3	0.33	0.41	0.98	65
42-69	148.8	180.1	11.4	1.6	14.5	200	0.12	30.4	23.4	30	2.9	0.15	0.29	0.3	0.33	0.85	77
69-107	141.2	139.3	12.6	1.8	14.1	200	0.08	29.5	18.7	29	1.5	0.11	0.22	0.25	0.25	0.86	76
107-135	110.7	119.6	13.2	2.2	12.7	100	0.03	25.4	16.7	20	1.4	0.09	0.18	0.2	0.26	0.87	78
135-150						100	0.03	24.5	15.5	20	1.3	0.08	0.1	0.15	0.14	0.96	78
0-30	160.32	226.67	14.10	2.10	19.20	265.17	0.30	38.07	28.04	35.30	4.21	0.18	0.32	0.39	0.47	0.90	64.23
0-50	157.92	217.86	12.75	2.19	18.66	239.10	0.23	35.79	26.61	33.90	3.86	0.18	0.31	0.36	0.43	0.91	66.46
0-100	151.01	186.32	12.45	1.97	16.44	219.55	0.16	32.82	23.55	31.64	2.94	0.15	0.28	0.32	0.36	0.88	71.42
0-150	127.92	153.03	11.36	1.81	13.98	184.37	0.12	30.45	21.24	28.18	2.42	0.13	0.24	0.27	0.31	0.89	73.52

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Moist) Mean Annual Rainfall> 1100 mm																	
6	Nagpur/ Maharashtra	Panjri	Agriculture(HM) Cotton	1127	P 4												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-13	225.1	235.8	12.1	4.4	20.0	258	0.2	38.8	23.7	28	60.3	0.24	0.3	0.5	0.45	0.55	69
13-38	219.0	198.7	10.5	3.5	17.5	252	0.19	33.3	21.1	27	25.3	0.21	0.35	0.53	0.39	0.52	78.4
38-60	196.1	206.1	13.9	3.3	18.8	246	0.18	30.2	19.2	26	13.6	0.16	0.23	0.28	0.29	1.05	82.4
60-89	194.6	150.4	10.0	3.0	16.8	234	0.05	33.1	18.5	27	11.7	0.23	0.43	0.49	0.45	1.07	83.7
89-131	170.2	91.0	10.4	2.9	12.2	234	0.03	30.3	13.8	24	10.8	0.18	0.2	0.23	0.3	1.21	81.5
131-150	135.1	76.1	10.8	1.3	11.6	192	0.03	29.1	12.6	23	12	0.16	0.21	0.22	0.17	1.46	89.9
0-30	195.4	180.1	12.1	3.2	17.9	254.6	0.19	35.68	22.23	27.43	40.47	0.22	0.33	0.52	0.42	0.53	74.33
0-50	192.2	161.1	11.3	3.1	16.9	252.12	0.19	33.99	21.32	27.02	31.59	0.21	0.31	0.46	0.38	0.66	76.92
0-100	153.5	115.1	10.4	2.2	13.6	244.26	0.13	32.95	19.46	26.58	21.74	0.21	0.32	0.43	0.38	0.88	79.94
0-150	187.18	147.99	11.05	2.99	15.54	235.52	0.10	31.91	17.42	25.59	18.24	0.19	0.28	0.36	0.34	1.02	81.52

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm					
7	Adilabad Andhra Pradesh	Nipani	Agriculture(FM) Cotton+pigeonpea	1071	P 48

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-13	180.4	405.1	17.7	4.3	27.6	338	0.21	48.2	21.9	59	16.5	0.63	0.33	0.42	0.63	0.72	55.4
13-35	111.0	135.0	8.3	3.2	8.5	325	0.18	20.8	28.6	53	15.5	0.54	0.4	0.37	0.49	1.14	66.5
35-62	104.1	74.3	5.2	2.1	5.3	300	0.17	20.3	38.1	47	14.2	1.03	0.13	0.4	0.51	1	65.7
62-88	97.1	67.5	7.1	1.5	4.3	292	0.17	20	37.7	38	13.8	0.6	0.33	0.27	0.43	1.07	69.1
88-127	69.4	64.1	4.9	1.4	3.9	280	0.15	19.8	37.2	32	10.2	0.46	0.19	0.55	0.3	0.92	61.2
127-155	62.4	54.0	3.4	1.4	3.6	268	0.14	19.5	35.5	26	9.5	0.13	0.19	0.22	0.22	1	58.5

0-30	100.8	71.1	6.0	1.8	4.8	330.63	0.19	32.67	25.70	55.60	15.93	0.58	0.37	0.39	0.55	0.96	61.69
0-50	96.0	69.3	6.2	1.7	4.6	320.88	0.18	27.77	29.71	52.76	15.37	0.71	0.30	0.39	0.53	0.99	63.37
0-100	76.0	59.1	4.7	1.4	3.9	305.96	0.18	23.90	33.69	45.74	14.20	0.69	0.27	0.38	0.48	1.00	64.88
0-150	95.10	104.96	6.71	2.04	6.91	295.47	0.17	22.49	34.60	40.24	12.76	0.56	0.25	0.39	0.40	0.99	63.24

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm					
8	Adilabad Andhra Pradesh	Pangidi	Agriculture(FM-I) Cotton+ pigeonpea	1071	P 49

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-14	249.8	236.3	30.0	4.3	14.7	305	0.19	42.8	20.1	53	13.8	0.52	0.38	0.4	0.84	0.42	73.2
14-36	235.9	202.6	17.7	2.2	16.2	288	0.17	22.1	38.2	48	12.7	0.28	0.64	0.58	0.62	0.55	80
36-62	194.3	135.0	13.7	3.3	8.2	272	0.17	22.3	37.6	42	11.8	0.32	0.56	0.51	0.6	0.72	79.6
62-87	166.5	101.3	12.0	0.2	5.5	255	0.16	21.8	35.8	36	10.9	0.63	0.79	0.87	0.78	1.36	90.3
87-110	208.1	337.6	19.6	-1.9	25.9	246	0.14	21.3	34.8	30	10.2	1.2	0.62	0.44	0.36	0.45	57.8

0-30	242.37	218.33	23.47	3.17	15.49	295.93	0.18	31.76	29.75	50.33	13.21	0.39	0.52	0.50	0.72	0.49	76.83
0-50	228.13	193.12	20.05	3.08	13.53	288.28	0.18	27.95	32.96	47.72	12.76	0.36	0.54	0.51	0.68	0.56	77.98
0-100	206.06	181.98	17.22	1.73	12.49	272.51	0.17	24.87	34.47	41.80	11.85	0.53	0.62	0.59	0.65	0.77	78.63
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm																	
9	Adilabad Andhra Pradesh	Pangidi	Agriculture(ITDA) Soybean	1071	P 50												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-11	166.5	236.3	16.5	4.7	17.1	315	0.2	44.5	20.7	55	15.2	0.6	0.63	0.58	0.64	0.45	72.7
11*27	138.8	168.8	13.7	-1.4	12.1	298	0.19	21.1	39.2	48	13.8	0.63	0.58	0.39	0.46	0.74	74.6
27-41	124.9	168.8	10.8	-1.8	11.2	275	0.18	20.8	38.5	43	12.9	0.49	0.58	0.89	0.64	0.86	78.4
41-55	97.1	67.5	9.0	0.4	5.5	240	0.13	20	38	29	8.2	0.9	0.55	0.7	0.75	0.85	60.8
0-30	147.55	193.57	14.46	0.79	13.86	301.93	0.19	29.65	32.35	50.07	14.22	0.61	0.60	0.51	0.54	0.65	74.28
0-50	133.49	165.44	12.66	0.16	11.77	284.86	0.18	25.97	34.72	44.72	12.85	0.63	0.59	0.63	0.60	0.73	72.76
0-100																	
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm																	
10	Indore Madhya Pradesh	Sarol	Agriculture(HM) Soybean-wheat	1053	P 7												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-14	249.6	209.8	22.4	5.5	21.2	321	0.22	40.1	18.9	58	4.8	0.1	0.13	0.19	0.15		
14-28	211.4	180.1	13.0	2.3	22.1	144	0.21	38.3	17.6	38	3.1	0.12	0.24	0.17	0.18	0.69	71.8
28-57	202.2	165.3	12.0	3.0	19.4	138	0.11	36.6	18.9	36	2.1	0.12	0.18	0.16	0.17	0.83	76.5
57-85	185.5	165.3	11.7	2.7	17.5	130	0.1	33.3	19.1	33	1.9	0.1	0.11	0.13	0.11	0.86	75.4
85-109	165.6	139.3	9.9	2.6	17.2	78	0.05	30.3	16.1	27	1.7	0.09	0.1	0.11	0.12	1.06	84.8
109-130	150.4	124.4	9.1	2.2	16.8	56	0.03	26.4	16.2	27	1.1	0.08	0.11	0.09	0.11	1.56	81.4
0-30	228.60	193.00	17.29	3.82	21.48	226.2	0.21	39.03	18.29	47.20	3.83	0.11	0.18	0.18	0.17	0.38	38.61
0-50	218.06	181.91	15.17	3.51	20.63	190.92	0.17	38.06	18.54	42.72	3.14	0.11	0.18	0.17	0.17	0.56	53.76
0-100	199.96	169.69	13.17	3.13	19.15	153.22	0.13	35.46	18.35	37.17	2.50	0.11	0.15	0.15	0.14	0.74	66.07
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.													
BLACK SOILS																		
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm																		
11	Indore Madhya Pradesh	Sarol	Agriculture(FM) Soybean-wheat	1053	P 8													
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-17	220.6	183.8	11.4	7.7	19.0	258	0.16	33.2	27.1	30	3.5	0.08	0.15	0.12	0.1	1.54	80.5
17-44	203.8	169.0	11.9	5.3	15.1	223	0.16	32.5	25.5	29	3.1	0.09	0.1	0.11	0.19	0.53	56.4
44-79	165.6	157.8	10.5	3.9	17.6	216	0.15	31.6	22.1	27	2.9	0.07	0.12	0.15	0.13	0.73	76.7
79-102	150.4	146.7	12.6	3.7	14.6	150	0.11	30.2	22	27	2.5	0.1	0.11	0.11	0.09	0.81	79.1
102-127	142.7	124.4	10.4	3.7	15.0	114	0.1	30.3	23.1	28	2.2	0.12	0.13	0.08	0.06	0.73	75.7
127-152	109.1	109.6	9.8	3.8	14.5	114	0.1	27.7	19.5	20	2.1	0.07	0.08	0.06	0.09	1.02	79.7
0-30	209.93	174.43	11.74	6.19	16.53	235.83	0.16	32.76	26.09	29.37	3.25	0.09	0.12	0.11	0.16	0.90	65.24
0-50	204.90	172.69	11.58	5.96	16.73	234.06	0.16	32.63	25.64	29.10	3.21	0.08	0.12	0.12	0.15	0.90	67.03
0-100	182.05	162.93	11.50	4.91	16.53	211.17	0.15	31.82	23.85	28.05	2.97	0.08	0.12	0.13	0.13	0.83	72.37
0-150	163.89	148.11	11.07	4.52	15.94	179.26	0.13	30.91	23.03	26.79	2.70	0.09	0.11	0.11	0.11	0.84	74.14

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.													
BLACK SOILS																		
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm																		
12	Indore Madhya Pradesh	Sarol	Agri-horticul(HM) Soy-gram mango orchard	1053	P 9													
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-18	257.2	217.3	16.1	4.6	19.3	234	0.19	40.1	27.1	57	3.4	0.18	0.13	0.26	0.19	0.99	77.5
18-45	232.8	180.1	11.9	3.1	21.2	228	0.16	39.2	26.3	40	2.7	0.19	0.19	0.16	0.15	1.09	78.3
45-66	216.0	143.0	10.5	5.4	16.9	223	0.15	36.3	23.4	28	2.4	0.13	0.15	0.1	0.15	1.12	83
66-90	206.8	146.7	11.1	4.2	15.8	223	0.15	31.3	20.2	25	2.1	0.1	0.11	0.09	0.11	0.83	72.8
90-124	196.1	131.8	15.4	2.4	17.5	210	0.14	30	18.3	20	2.1	0.13	0.12	0.1	0.12	1.46	83.7
124-159	161.0	131.8	9.3	3.7	12.9	120	0.07	28.4	16.5	17	2	0.08	0.08	0.1	0.11	1.32	78.7
0-30	247.43	202.41	14.45	4.02	20.06	231.6	0.18	39.74	26.78	50.20	3.12	0.18	0.15	0.22	0.17	1.03	77.82
0-50	239.89	189.78	13.31	3.88	20.09	229.66	0.17	39.23	26.30	44.92	2.92	0.18	0.16	0.19	0.16	1.06	78.48
0-100	223.75	166.16	12.54	4.05	18.29	225.03	0.16	35.94	23.57	34.94	2.56	0.15	0.14	0.14	0.14	1.05	78.36
0-150	208.47	154.72	12.44	3.73	17.23	204.42	0.14	33.68	21.50	29.44	2.39	0.13	0.13	0.13	0.13	1.16	79.28

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm																	
13	Nagpur Maharashtra	Linga	Horticulture (HM) Citrus	1011	P 1												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-15	156.5	235.8	23.4	2.5	19.3	240	0.19	32.1	30.1	29	26.5	0.23	0.45	0.52	0.51	0.37	44
15-41	125.9	202.4	11.8	1.5	22.8	228	0.16	32.1	23.2	28	17.2	0.21	0.3	0.31	0.32	0.83	79
41-70	110.7	195.0	10.4	1.6	11.3	223	0.12	30.1	22.8	27	11.7	0.15	0.2	0.28	0.26	0.74	78
70-95	95.4	180.1	8.7	1.0	10.8	223	0.15	30.1	18.9	24	5.8	0.15	0.19	0.18	0.3	0.71	80
95-135	84.7	150.4	10.2	1.0	10.3	138	0.09	30.1	18.8	20	3.1	0.11	0.18	0.15	0.18	0.72	56
135-15	83.2	117.0	10.9	-1.0	7.7	120	0.07	28.1	18	18	3	0.09	0.09	0.15	0.12	0.58	52
0-30	141.19	219.12	17.59	2.01	21.04	234	0.18	32.10	26.65	28.50	21.85	0.22	0.38	0.42	0.42	0.60	61.50
0-50	132.34	211.10	15.03	1.82	19.66	230.7	0.16	31.74	25.20	28.12	19.00	0.21	0.33	0.37	0.37	0.68	68.32
0-100	116.91	197.99	12.28	1.54	15.30	224.3	0.15	30.92	22.90	26.60	13.62	0.18	0.26	0.29	0.32	0.70	73.00
0-150	105.68	178.19	11.66	1.16	13.36	192.6	0.13	30.45	21.40	24.11	9.99	0.15	0.22	0.24	0.27	0.69	66.64

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm																	
14	Nagpur Maharashtra	Linga	Horticulture (LM)* Citrus	1011	P 3												
Soil depth	Soil Despiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-16	106.1	213.5	20.8	3.0	14.2	318	0.19	38	21.6	46	14	0.31	0.4	0.51	0.54	0.16	14
16-44	93.9	180.1	12.0	2.9	13.7	264	0.18	33.7	19.2	26	8.4	0.23	0.32	0.4	0.41	0.29	32
44-69	89.3	176.4	9.6	1.4	14.6	228	0.1	32.1	19.5	26	6.4	0.2	0.31	0.32	0.33	0.5	40
69-102	80.1	172.7	10.6	1.7	9.5	216	0.11	31.1	18.9	27	2.5	0.15	0.31	0.3	0.3	0.51	45
102-128	69.5	150.4	9.3	2.1	10.6	204	0.1	30.7	18	25	2.1	0.1	0.2	0.22	0.2	0.59	48
128-150	89.3	117.0	9.0	1.4	7.8	192	0.08	30.2	14	23	2.3	0.11	0.19	0.19	0.11	0.52	29
0-30	100.39	197.95	16.67	2.95	13.97	292.8	0.19	35.99	20.48	36.67	11.39	0.27	0.36	0.46	0.48	0.22	22.40
0-50	97.23	190.37	14.51	2.74	13.98	276.96	0.17	34.88	20.00	32.40	9.95	0.25	0.34	0.43	0.44	0.27	27.20
0-100	90.42	182.24	12.37	2.16	12.71	248.76	0.14	33.18	19.57	29.51	6.97	0.21	0.33	0.37	0.38	0.39	35.15
0-150	86.49	167.03	11.33	2.05	11.59	232.24	0.12	32.29	18.47	27.74	5.38	0.18	0.28	0.31	0.31	0.45	36.61

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Sub-humid (Dry) Mean Annual Rainfall 1100-1000 mm					
15	Nagpur Maharashtra	Linga	Agriculture (FM) Soy-gram/wheat	1011	P 2

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-13	202.2	202.4	16.2	2.9	23.1	240	0.21	40.1	23.8	58	21.1	0.2	0.35	0.34	0.41	0.31	26
13-33	180.9	191.3	13.8	3.1	20.7	228	0.16	38.3	18.7	57	17	0.18	0.2	0.21	0.32	0.24	41
33-55	156.5	180.1	13.7	2.9	14.1	186	0.13	33.4	18.4	51	14.9	0.11	0.2	0.2	0.21	0.4	45
55-81	125.9	176.4	11.6	2.7	10.8	162	0.11	32.4	19.1	40	13	0.1	0.11	0.13	0.21	0.52	60
81-119	115.2	135.6	14.4	1.4	8.5	132	0.1	30.2	18.1	28	11.5	0.11	0.11	0.13	0.18	0.57	68
119-150	109.1	98.4	11.8	2.4	5.5	114	0.05	30.1	18.1	27	9.2	0.09	0.09	0.15	0.12	0.59	79
0-30	190.14	196.09	14.86	3.01	21.74	233.2	0.18	39.08	20.91	57.43	18.78	0.19	0.27	0.27	0.36	0.27	34.50
0-50	178.13	190.37	14.41	2.98	19.08	216.84	0.16	37.10	19.92	55.22	17.35	0.16	0.24	0.24	0.31	0.31	38.46
0-100	151.53	175.81	13.64	2.60	14.66	184.92	0.14	34.38	19.29	45.88	14.99	0.13	0.18	0.19	0.25	0.42	50.00
0-150	138.17	154.72	13.34	2.41	11.98	163.56	0.11	32.97	18.89	39.71	13.35	0.12	0.15	0.17	0.22	0.47	58.27

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm					
16	Bidar Karnataka	Bhatumbra	Agriculture (FM) Sorghum+pigeonpea/ blackgram-pigeonpea	977	P 42

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-12	227.6	125	27.1	1.53	8.39	215	0.16	37.2	19.5	45	8.5	0.245	0.315	0.285	0.3		
12--37	148.5	135	9.9	0.29	8.64	250	0.17	20.2	37	37	8.2	0.23	0.285	0.3	0.265		
37-79	130.4	111	13.4	-2.11	6.24	195	0.16	20.5	36.8	25	7.1	0.31	0.415	0.46	0.41		
79-110	97.1	74	8.0	3.88	5.20	188	0.15	20.1	36.5	35	6.4	0.295	0.315	0.355	0.415		
0-30	180.12	131.00	16.76	0.79	8.54	236	0.17	27.00	30.00	40.20	8.32	0.24	0.30	0.29	0.28	0.00	0.00
0-50	162.77	126.47	14.91	-0.04	7.96	227.3	0.17	24.36	32.75	35.80	7.99	0.25	0.33	0.34	0.31	0.00	0.00
0-100	139.61	111.15	13.00	0.19	6.88	209.68	0.16	22.35	34.71	32.50	7.40	0.28	0.35	0.38	0.36	0.00	0.00
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm					
17	Amravati Maharashtra	Ashra	Agriculture (FM)* Cotton/greengram+ pigeonpea	975	P 10

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-14	219.0	284.1	13.6	5.0	28.3	280	0.19	32.8	21.6	32	11.2	0.12	0.34	0.4	0.37	0.26	36.7
14-40	194.5	254.8	11.0	4.7	21.7	264	0.18	19.7	32.6	29	9.7	0.18	0.18	0.3	0.24	0.31	45.9
40-59	180.9	235.8	9.4	4.7	19.6	240	0.15	17.5	31.8	23	6.7	0.23	0.27	0.03	0.1	0.67	46.5
59-91	139.7	165.3	12.3	4.5	15.6	218	0.14	16.2	30.1	21	6.5	0.22	0.18	0.25	0.28	0.35	59.7
91-125	119.8	143.0	10.1	2.5	14.7	204	0.11	12.9	30.7	20	6	0.15	0.13	0.27	0.24	0.46	67.4
125-150	93.9	117.0	7.0	1.7	12.0	182	0.08	11.8	30.2	18	5.3	0.09	0.16	0.04	0.24	0.39	57
0-30	205.93	268.46	12.24	4.84	24.77	271.47	0.18	25.81	27.47	30.40	10.40	0.15	0.25	0.35	0.30	0.29	41.61
0-50	198.63	259.20	11.42	4.79	23.11	263.68	0.18	22.93	29.36	28.64	9.52	0.17	0.24	0.27	0.25	0.37	43.44
0-100	171.07	216.58	11.39	4.49	19.63	241.56	0.16	19.38	29.94	24.91	7.98	0.19	0.22	0.24	0.24	0.40	51.08
0-150	149.66	187.71	10.43	3.70	17.53	225.37	0.14	17.04	30.11	22.94	7.21	0.17	0.19	0.21	0.24	0.41	54.78

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm					
18	Amravati Maharashtra	Ashra	Agriculture (FM) Soybean+ pigeonpea	975	P 11

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-14	225.1	250.7	23.1	5.4	19.1	325	0.18	38.1	26.1	29	14	0.15	0.31	0.28	0.1	0.36	61
14-35	194.6	232.1	9.4	5.4	18.4	270	0.16	20.2	35	26	10.5	0.19	0.46	0.25	0.19	0.61	80.3
35-69	174.8	247.0	9.5	4.9	18.2	228	0.13	19.5	34.9	24	8.3	0.34	0.19	0.25	0.16	0.4	61.5
69-107	165.6	105.8	9.0	4.7	17.5	190	0.1	16.8	34.6	21	6.6	0.3	0.48	0.37	0.28	0.41	62.9
107-150	148.8	91.0	11.1	3.9	13.5	175	0.09	10.9	34	18	5.8	0.19	0.21	0.1	0.18	0.42	57.5
0-30	208.86	240.78	15.78	5.41	18.74	295.67	0.17	28.55	30.85	27.40	12.13	0.17	0.39	0.26	0.15	0.49	71.29
0-50	197.21	241.77	13.25	5.24	18.54	272.80	0.16	25.00	32.48	26.24	10.82	0.22	0.34	0.26	0.16	0.48	69.26
0-100	183.15	200.62	11.23	5.00	18.14	238.62	0.13	21.41	33.60	24.19	9.03	0.27	0.35	0.29	0.20	0.44	65.81
0-150	176.19	168.04	10.64	4.84	17.66	221.41	0.12	19.48	33.89	22.93	8.17	0.27	0.38	0.30	0.22	0.43	64.48

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm																	
19	Amravati Maharashtra	Ashra	Agriculture (HM) Cotton/pigeonpea/ soybean-gram	975	P 12												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-12	220.6	213.5	29.3	2.5	19.4	295	0.21	31.3	22.2	27	10.1	0.34	0.22	0.39	0.4	0.66	67.5
12--40	191.6	187.6	11.6	3.5	17.7	260	0.17	18.2	30.2	23	9.2	0.37	0.18	0.24	0.46	0.56	68.3
40-79	158.0	124.4	8.9	3.1	14.5	245	0.15	19.3	30	20	7.5	0.33	0.21	0.3	0.49	0.56	71.2
79-116	139.7	94.7	10.4	2.5	10.9	210	0.08	15.9	29.8	19	6.4	0.13	0.34	0.07	0.51	0.56	80.7
116-150	115.2	98.4	9.2	2.9	12.5	180	0.09	12.7	29.3	16	5.2	0.09	0.11	0.03	0.2	0.57	81.3
0-30	203.16	197.95	18.71	3.07	18.37	274	0.186	23.44	27	24.6	9.56	0.358	0.196	0.3	0.436	0.6	67.98
0-50	191.81	181.16	15.34	3.16	17.45	265.4	0.1756	21.564	28.24	23.36	9.076	0.3548	0.1956	0.288	0.4516	0.584	68.688
0-100	171.05	146.55	12.44	3.01	15.22	247.85	0.1481	19.718	29.078	21.47	8.057	0.3004	0.2301	0.2457	0.475	0.572	71.939
0-150	145.89	114.94	9.88	2.87	13.06	219.5	0.13	17.72	29.21	19.97	7.23	0.23	0.21	0.18	0.42	0.57	75.00

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm																	
20	Kota Rajasthan	Jhalipura	Agriculture (FM-I) Soybean-wheat	842	P 32												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-12	154.0	297	12.8	-1.30	21.79	144	0.11	34	21	32	3.5	0.31	0.37	0.4	0.41		
12--31	120.7	250	8.8	-2.32	21.68	101	0.1	31	20	23	2.9	0.3	0.34	0.31	0.36		
31-48	111.0	236	9.9	-2.68	17.17	99	0.09	26	18	20	2.5	0.26	0.3	0.34	0.32		
48-74	102.7	213	8.8	-3.18	15.29	76	0.06	21	16	21	2.4	0.28	0.31	0.29	0.33		
74-110	94.4	189	8.2	-2.70	12.15	46	0.04	22	18	19	1.6	0.27	0.34	0.31	0.36		
110-148	80.5	155	9.5	-1.05	9.37	39	0.03	20	15	15	1.4	0.29	0.34	0.3	0.39		
148-165	74.9	111	8.3	-1.85	7.74	30	0.02	21	15	19	1.1	0.2	0.27	0.23	0.3		
0-30	134.05	268.75	10.43	-1.91	21.72	118.2	0.104	32.2	20.4	26.6	3.14	0.304	0.352	0.346	0.38		
0-50	124.69	255.11	10.14	-2.23	19.91	109.64	0.0974	29.62	19.4	24.06	2.888	0.288	0.3324	0.341	0.3572		
0-100	111.52	227.76	9.31	-2.58	16.79	85.02	0.0735	25.57	18.22	22.01	2.436	0.2814	0.329	0.3207	0.3514		
0-150	102.03	205.28	9.28	-2.19	14.48	70.03	0.06	23.86	17.35	19.99	2.10	0.28	0.33	0.31	0.36		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
21	Kota Rajasthan	Jhalipura	Agriculture (FM-II) Paddy-wheat	842	P 33

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-13	162.4	155	11.7	1.21	9.96	111	0.093	30	23	29	3.1	0.28	0.37	0.43	0.42		
13-36	148.5	135	13.9	-2.91	9.33	105	0.06	32	22	25	2.9	0.29	0.31	0.3	0.33		
36-58	138.8	125	12.6	-2.27	7.30	95	0.05	28	20	24	2.5	0.28	0.34	0.4	0.37		
58-82	136.0	105	9.9	0.04	6.72	90	0.03	27	19	21	2.3	0.23	0.28	0.31	0.3		
82-107	119.3	118	10.0	-2.93	8.12	80	0.02	22	17	19	1.5	0.29	0.3	0.31	0.38		
107-132	93.0	135	7.6	-1.84	9.28	67	0.01	20	16	16	1.1	0.28	0.31	0.28	0.32		
132-156	80.5	118	6.4	-3.31	8.81	49	0.01	21	11	15	1	0.27	0.34	0.4	0.38		
0-30	154.49	143.83	12.95	-1.12	9.60	107.6	0.07	31.13	22.43	26.73	2.99	0.29	0.34	0.36	0.37		
0-50	149.37	137.48	12.96	-1.66	8.93	103.76	0.07	30.36	21.70	25.76	2.84	0.28	0.33	0.36	0.36		
0-100	139.90	125.12	11.67	-1.53	8.12	95.48	0.05	27.86	20.07	23.26	2.44	0.27	0.32	0.34	0.35		
0-150	123.99	125.62	10.28	-1.86	8.40	84.43	0.04	25.45	18.16	20.86	2.00	0.27	0.32	0.34	0.35		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
22	Akola Maharashtra	Paral	Agriculture (LM) Cotton+pigeonpea/ sorghum	794	P 13

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-9	150.4	180.1	14.9	5.0	19.7	275	0.19	35.2	19.8	27	7.8	0.33	0.3	0.12	0.18	0.37	26.7
9--35	141.2	176.4	12.3	3.1	14.3	252	0.13	20.2	30.3	25	7.5	0.19	0.45	0.31	0.15	0.34	47.1
35-69	135.1	143.0	13.2	2.7	14.1	220	0.11	19.7	30.1	21	6.4	0.24	0.15	0.15	0.31	0.38	72.2
69-105	124.4	131.8	11.3	2.6	12.6	204	0.09	16.9	29.8	20	6.3	0.09	0.24	0.21	0.3	0.39	52.5
105-132	119.8	150.4	10.2	2.2	13.7	185	0.08	14.6	29.5	19	5.8	0.07	0.19	0.25	0.4	0.39	70.1
132-150	112.2	109.6	11.9	0.8	11.9	164	0.07	11.8	29.5	18	5.6	0.31	0.22	0.04	0.3	0.27	36.1
0-30	143.94	177.52	13.07	3.64	15.93	258.90	0.15	24.70	27.15	25.60	7.59	0.23	0.41	0.25	0.16	0.35	40.98
0-50	141.01	167.05	13.03	3.31	15.22	246.54	0.13	22.75	28.35	24.16	7.22	0.23	0.33	0.23	0.20	0.36	50.96
0-100	134.74	151.56	12.53	3.00	14.21	228.31	0.12	20.36	29.13	22.27	6.78	0.19	0.27	0.21	0.25	0.37	55.47
0-150	129.00	145.66	12.00	2.57	13.79	211.99	0.10	18.18	29.26	21.09	6.45	0.18	0.25	0.20	0.29	0.36	55.68

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm																	
23	Akola Maharashtra	Paral	Agriculture (LM) Cotton+pigeonpea/ sorghum	794	P 14												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-8	200.7	247.0	20.0	7.0	22.3	268	0.2	36.1	19.8	20	10.1	0.39	0.42	0.4	0.32	0.26	43.2
8--35	187.0	202.4	9.3	4.3	20.1	255	0.15	23.9	30.5	21	8.5	0.21	0.15	0.37	0.4	0.32	50
35-68	150.4	176.4	9.8	3.7	16.1	230	0.11	22.6	30.2	19	7.8	0.16	0.18	0.24	0.4	0.42	68.1
68-97	142.7	187.6	9.4	3.5	16.1	200	0.1	19.7	29.9	18	7.2	0.09	0.11	0.18	0.3	0.49	69
97-129	124.4	154.1	10.2	1.9	15.6	185	0.09	15.8	29.5	15	6.5	0.16	0.15	0.49	0.4	0.65	64.7
129-150	93.9	157.8	8.1	0.5	15.9	138	0.08	13.5	29.1	13	5.8	0.5	0.17	0.3	0.4	0.74	71.5
0-30	190.65	214.29	12.19	5.01	20.71	258.47	0.16	27.15	27.65	20.73	8.93	0.26	0.22	0.38	0.38	0.30	48.19
0-50	178.19	201.74	11.19	4.54	19.26	249.58	0.15	25.46	28.70	20.24	8.55	0.22	0.20	0.34	0.39	0.34	54.34
0-100	161.28	191.64	10.39	4.01	17.65	229.74	0.12	22.99	29.34	19.21	7.96	0.17	0.17	0.28	0.36	0.41	61.38
0-150	144.71	179.65	10.02	3.12	17.00	208.25	0.11	20.27	29.34	17.53	7.38	0.22	0.17	0.32	0.38	0.50	63.44

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm																	
24	Mehboobnagar Andhra Pradesh	Jajapur	Agriculture (FM-I) Sorghum/pigeonpea+ green-gram	792	P 35												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-12	108.2	226	11.5	1.98	15.03	225	0.17	40.1	20.3	46	3.2	0.37	0.18	0.27	0.43	0.84	73.9
12--35	88.8	206	6.1	0.83	11.50	204	0.16	20.1	31.1	41	10	0.35	0.28	0.32	0.41	0.84	73.2
35-48	58.3	95	4.4	1.55	6.99	188	0.14	19.7	30.8	36	8.5	0.26	0.21	0.31	0.37	0.75	71.1
48-76	52.7	74	4.5	2.40	5.17	167	0.12	19.3	30.2	32	8.1	0.31	0.28	0.3	0.33	0.95	82
76-96	50.0	54	7.6	0.74	3.29	150	0.11	18.6	29.1	29	7.8	0.24	0.21	0.31	0.27	0.94	79.2
96-126	43.0	68	6.3	-0.43	4.78	133	0.1	18.1	28.9	28	6.9	0.21	0.37	0.28	0.31	0.92	78.3
126-155	38.9	47	5.3	-0.76	3.11	128	0.09	17	28	26	5.8	0.27	0.33	0.26	0.41	0.8	75.9
0-30	96.58	214.05	8.25	1.29	12.91	212.40	0.16	28.10	26.78	43.00	7.28	0.36	0.24	0.30	0.42	0.84	73.48
0-50	84.31	177.39	6.88	1.32	11.00	204.24	0.16	24.78	28.42	40.70	7.92	0.33	0.24	0.31	0.40	0.81	72.74
0-100	67.47	121.11	6.38	1.43	7.65	180.44	0.14	21.84	29.03	35.51	7.89	0.30	0.25	0.30	0.35	0.88	76.88
0-150	58.65	100.00	6.19	0.76	6.43	163.83	0.12	20.42	28.84	32.69	7.39	0.28	0.28	0.29	0.35	0.88	76.97

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm																	
25	Mehboobnagar Andhra Pradesh	Jajapur	Agriculture (FM-I) Paddy-paddy	792	P 36												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-10	167.9	209	18.3	4.63	14.55	310	0.19	43.8	21.2	52	16	0.21	0.16	0.31	0.28	1.07	79.2
10--28	106.8	155	7.7	0.74	9.62	298	0.18	20.1	38.7	48	12.5	0.12	0.31	0.17	0.26	0.96	76.5
28-53	88.8	122	3.4	1.72	6.85	204	0.116	20.3	38	38	10.8	0.23	0.3	0.31	0.4	1.07	78.3
53-76	61.1	101	2.8	0.01	6.62	175	0.13	21.2	36.7	29	10.2	0.18	0.31	0.33	0.39	0.94	81.9
76-98	52.7	108	1.1	0.05	6.16	164	0.12	21.5	37.2	24	9.5	0.21	0.18	0.32	0.3	0.97	78.2
98-128	47.2	98	3.5	0.30	5.42	128	0.09	21	37.9	22	8.2	0.3	0.27	0.18	0.22	0.97	75
128-150	41.6	81	8.3	-2.34	5.38	120	0.08	20.2	38.2	18	7.8	0.22	0.31	0.25	0.31	0.99	81.7
0-30	127.20	173.31	11.26	2.04	11.26	302.00	0.18	28.00	32.87	49.33	13.67	0.15	0.26	0.22	0.27	1.00	77.40
0-50	111.12	151.26	7.94	1.95	9.38	259.04	0.15	24.93	34.89	44.40	12.45	0.19	0.28	0.26	0.33	1.03	77.83
0-100	84.81	128.30	5.03	1.05	7.88	214.53	0.14	23.10	35.97	35.73	11.15	0.19	0.26	0.29	0.33	1.00	78.81
0-150	71.45	115.69	5.23	0.41	7.06	184.51	0.12	22.28	36.66	30.57	10.11	0.22	0.27	0.26	0.31	0.99	78.52

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
BLACK SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm																	
26	Medak Andhra Pradesh	Kasireddipalli	Agriculture (HM) Soybean+pigeonpea	764	P 39												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-12	97.1	243	10.9	6.83	18.14	292	0.19	39.2	20.2	50	15.1	0.31	0.42	0.39	0.43		
12--31	69.4	226	7.5	2.51	13.93	228	0.18	19.5	37.9	46	14.6	0.32	0.38	0.42	0.39		
31-54	61.1	196	5.6	4.83	13.46	204	0.16	19.2	37.5	40	19.2	0.28	0.38	0.39	0.41		
54-84	88.8	155	10.0	0.79	11.96	188	0.15	19	37.6	33	8.6	0.42	0.41	0.3	0.35		
84-118	74.9	128	10.8	0.74	7.62	155	0.12	29.5	36.8	29	7.8	0.32	0.34	0.41	0.41		
118-146	69.4	101	5.9	-0.45	5.45	140	0.1	20.1	38	25	7.5	0.39	0.28	0.41	0.38		
146-157	76.3	71	7.1	-3.27	5.47	128	0.09	20	38.2	23	6.8	0.31	0.37	0.4	0.41		
0-30	80.48	232.96	8.86	4.24	15.62	253.6	0.18	27.38	30.82	47.60	14.80	0.32	0.40	0.41	0.41		
0-50	72.88	218.71	7.61	4.43	14.76	234.24	0.17	24.11	33.50	44.68	16.47	0.30	0.39	0.40	0.41		
0-100	77.51	184.31	8.75	2.76	12.73	206.48	0.16	23.25	35.42	38.48	12.83	0.34	0.39	0.37	0.39		
0-150	75.65	159.07	8.43	1.76	10.56	185.8	0.14	23.32	36.14	34.41	11.07	0.35	0.36	0.38	0.39		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
27	Medak Andhra Pradesh	Kasireddipalli	Agriculture (TM) Fallow-chickpea	764	P 40

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-12	127.7	152	10.7	0.93	11.29	215	0.18	36.9	19.7	45	9	0.32	0.28	0.31	0.41		
12--30	106.8	169	5.4	0.42	11.30	200	0.17	20.1	33.9	39	8.7	0.24	0.31	0.42	0.32		
30-59	74.9	155	3.9	1.55	12.03	186	0.15	20.2	33.2	35	8.3	0.31	0.29	0.33	0.36		
59-101	68.0	145	2.1	1.27	8.24	172	0.13	19.8	30.8	30	7.2	0.29	0.26	0.34	0.29		
101-130	68.0	128	5.8	0.20	7.33	154	0.11	18.9	31.2	28	6.7	0.3	0.27	0.29	0.33		
130-160	56.9	101	2.5	3.39	5.54	138	0.1	18	38.1	25	6.5	0.31	0.31	0.41	0.35		

0-30	115.17	162.06	7.50	0.62	11.29	206.00	0.17	26.82	28.22	41.40	8.82	0.27	0.30	0.38	0.36		
0-50	99.08	159.36	6.05	0.99	11.59	198.00	0.16	24.17	30.21	38.84	8.61	0.29	0.29	0.36	0.36		
0-100	84.16	153.18	4.26	1.16	10.25	186.26	0.15	22.02	30.72	34.87	8.01	0.29	0.28	0.35	0.33		
0-150	77.29	141.40	4.31	1.27	9.05	173.49	0.13	20.87	31.80	32.19	7.55	0.29	0.28	0.34	0.33		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
28	Sholapur Maharashtra	Konheri	Agriculture (FM) Pigeonpea/sunflower-sorghum	742	P 45

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-13	88.8	95	4.3	1.53	6.70	200	0.17	37.2	19.2	44	10.2	0.31	0.24	0.38	0.41		
13-33	61.1	88	5.7	-0.09	6.11	198	0.16	19.1	36.8	36	8.5	0.3	0.34	0.31	0.38		
33-69	55.5	68	5.2	1.89	4.91	175	0.15	18.6	36.8	33	7.2	0.24	0.25	0.31	0.28		
69-93	52.7	37	5.8	-0.24	2.39	168	0.12	18.6	36.3	30	6.8	0.25	0.29	0.3	0.33		
93-113	47.2	34	7.5	-2.08	1.78	142	0.11	17.9	35.9	29	6.5	0.32	0.29	0.24	0.4		
113-129	45.8	27	5.8	2.19	1.45	135	0.19	17.8	35.7	24	5.8	0.33	0.41	0.38	0.37		
129-160	41.6	24	6.1	-1.37	1.30	122	0.08	17.7	35.2	17	5.5	0.32	0.28	0.3	0.27		

0-30	73.08	90.71	5.09	0.61	6.36	198.87	0.16	26.94	29.17	39.47	9.24	0.30	0.30	0.34	0.39		
0-50	66.38	82.65	5.18	1.00	5.85	190.70	0.16	23.64	32.22	37.06	8.50	0.28	0.28	0.33	0.35		
0-100	59.70	65.43	5.50	0.65	4.56	178.86	0.14	21.07	34.33	34.03	7.71	0.27	0.28	0.31	0.34		
0-150	54.60	52.74	5.77	0.30	3.53	163.03	0.14	19.97	34.73	30.14	7.09	0.29	0.29	0.31	0.34		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
29	Sholapur Maharashtra	Konheri	Agriculture (LM) Fallow-sorghum+ sunflower	742	P 46

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-13	88.8	111	6.4	2.89	8.07	204	0.15	36.8	20.1	41	9.2	0.32	0.3	0.28	0.34		
13-34	74.9	101	4.9	2.21	6.71	190	0.13	20.1	35.8	53	8.3	0.31	0.33	0.28	0.34		
34-53	76.3	84	11.8	-2.90	6.29	164	0.11	20.2	35.2	49	7.5	0.24	0.31	0.39	0.4		
53-83	69.4	57	10.9	-5.34	4.49	139	0.1	19.8	24.7	51	6.8	0.3	0.29	0.33	0.36		
83-117	65.2	44	1.6	4.57	3.58	125	0.09	19.3	34.1	40	5.3	0.29	0.24	0.31	0.3		
117-155	61.1	34	9.8	-3.34	1.97	120	0.08	18.7	33.9	39	5.2	0.31	0.28	0.28	0.33		

0-30	80.95	105.68	5.55	2.51	7.30	196.07	0.14	27.34	29.00	47.80	8.69	0.31	0.32	0.28	0.34		
0-50	83.56	103.58	8.21	0.58	7.30	195.16	0.14	25.69	33.64	51.54	8.73	0.30	0.33	0.34	0.38		
0-100	73.68	76.47	7.66	-0.54	5.61	160.53	0.11	22.06	30.03	47.87	7.31	0.29	0.30	0.32	0.35		
0-150	69.95	63.38	7.44	-0.57	4.58	147.59	0.10	21.01	31.34	45.03	6.61	0.30	0.29	0.31	0.34		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
30	Nasik Maharashtra	Kalwan	Agriculture (FM) Sugarcane/jowar-wheat-gram	692	P 47

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-13	158.2	391.6	26.9	-2.9	25.9	305	0.22	52.3	26.2	164	14.2	0.57	0.36	0.42	0.6		
13-34	111.0	135.0	8.2	0.7	9.1	285	0.19	24.7	44.5	64	13.5	0.52	0.41	0.37	0.49		
34-53	97.1	101.3	5.9	1.3	6.0	270	0.18	22.3	39.2	68	12.2	0.49	0.2	0.4	0.52		
53-83	83.3	67.5	5.6	1.1	4.6	255	0.16	20.8	38.1	44	10.1	0.5	0.36	0.33	0.45		
83-117	69.4	50.6	5.1	0.2	4.2	210	0.15	20.2	38.2	48	9.8	0.46	0.21	0.48	0.36		
117-155	55.5	33.8	4.2	0.7	2.0	105	0.13	20.1	37.9	49	9.6	0.3	0.19	0.24	0.27		

0-30	131.46	246.24	16.29	-0.89	16.36	293.67	0.20	36.66	36.57	107.33	13.80	0.54	0.39	0.39	0.54		
0-50	114.40	185.56	11.99	-0.09	12.11	274.00	0.19	30.12	36.27	88.72	12.73	0.50	0.31	0.38	0.51		
0-100	99.10	127.39	8.88	0.39	8.51	263.00	0.18	25.90	38.12	69.04	11.70	0.50	0.31	0.39	0.48		
0-150	86.14	98.09	7.43	0.44	6.59	222.23	0.16	23.98	38.08	62.25	11.02	0.45	0.28	0.37	0.42		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
31	Tuticorin Tamil Nadu	Kovilpatti	Agriculture Sorghum+sunflower/ cotton	660	P 19

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-6	217.5	198.7	12.8	6.1	19.4	67	0.05	13	10	59	6						
6--20	190.0	180.1	10.4	4.4	16.3	40	0.03	14	11	52	5						
20-41	165.6	172.7	11.2	2.4	15.7	36	0.03	13	12	45	4						
41-74	150.4	172.7	11.0	2.5	16.6	30	0.02	12	13	39	2		Canker				
74-104	135.1	135.6	8.6	1.9	16.1	35	0.01	10	12	30	3						
104-118	127.5	120.7	10.3	2.6	13.9	28	0.01	11	13	31	2						
118-128	109.1	135.6	8.2	2.4	17.0	20	0.009	12	12	20	1						
128-140	93.9	117.0	8.3	2.6	13.2	201	0.01	11	13	21	1						
0-30	187.39	181.36	11.16	4.08	16.69	44.07	0.03	13.47	11.13	51.07	4.87						
0-50	175.93	177.89	11.13	3.43	16.45	39.76	0.03	13.10	11.66	47.56	4.16						
0-100	159.17	165.64	10.43	2.81	16.38	36.18	0.02	12.03	12.07	40.94	3.34						
0-150	142.66	151.50	9.90	2.71	15.71	58.48	0.02	11.73	12.29	35.40	2.71						

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
32	Tuticorin Tamil Nadu	Kovilpatti	Waste land	660	P 20

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-11	191.6	235.8	11.8	3.6	24.0	147	0.16	28	26	47	9	0.065	0.075	0.095	0.13		
11--31	150.4	176.4	12.0	2.9	17.6	157	0.13	25	17	41	7	0.045	0.047	0.09	0.11		
31-55	144.2	172.7	10.6	3.1	16.8	116	0.09	20	16	35	4	0.025	0.031	0.07	0.1		
55-79	147.3	131.8	11.2	2.6	14.7	117	0.06	21	13	32	6	0.02	0.032	0.06	0.09		
79-99	125.9	105.8	11.2	2.0	13.7	109	0.07	19	16	30	2	0.013	0.015	0.06	0.08		
99-105	96.9	154.1	11.1	1.6	15.5	105	0.05	20	15	27	1	0.013	0.012	0.03	0.06		
0-30	165.46	198.20	11.91	3.12	19.94	153.33	0.14	26.10	20.30	43.20	7.73	0.05	0.06	0.09	0.12		
0-50	157.10	188.07	11.43	3.10	18.69	139.22	0.12	23.76	18.60	40.04	6.30	0.04	0.05	0.08	0.11		
0-100	147.27	157.02	11.30	2.75	16.60	126.34	0.09	21.92	16.57	35.72	5.20	0.03	0.04	0.07	0.10		
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
33	Tuticorin/ Tamil Nadu	Kovilpatti	Agriculture (HM) Cotton+blackgram	660	P 21

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-9	180.9	187.6	12.0	3.8	18.1	102	0.011	52	24	19	20	0.07	0.08	0.22	0.21	0.1	7.5
9--20	160.6	165.3	12.8	2.4	14.8	105	0.09	33	20	72	11	0.06	0.06	0.12	0.11	0.29	35.4
20-58	154.9	139.3	11.4	2.9	15.5	69	0.08	29	21	48	9	0.05	0.04	0.13	0.1	0.22	33
58-100	142.7	113.3	9.5	2.8	14.9	59	0.05	28	19	42	6	0.03	0.04	0.14	0.1	0.36	61.2
100-126	133.6	98.4	13.6	2.2	12.2	50	0.04	27	24	43	3	0.03	0.03	0.1	0.09	0.19	72.1
126-155	103.0	94.7	11.8	2.0	13.1	43	0.039	28	22	40	2	0.02	0.02	0.08	0.06		

0-30	164.80	163.29	12.09	2.98	16.02	92.10	0.06	37.37	21.53	48.10	13.03	0.06	0.06	0.15	0.14	0.21	26.23
0-50	160.85	153.68	11.83	2.93	15.81	82.86	0.07	34.02	21.32	48.06	11.42	0.06	0.05	0.14	0.12	0.21	28.94
0-100	152.76	135.56	10.81	2.89	15.41	71.73	0.06	31.09	20.32	45.51	8.95	0.04	0.05	0.14	0.11	0.28	42.81
0-150	141.48	122.58	11.44	2.63	14.48	63.37	0.05	29.89	21.23	44.19	6.81	0.04	0.04	0.12	0.10	0.22	41.04

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
34	Rajkot Gujarat	Semla	Agriculture Cotton/groundnut-wheat	635	P 29

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-17	144.3	145	11.3	0.99	10.71	69	0.19	40	29	30	11.8	0.28	0.19	0.45	0.3	0.37	46.3
17-42	130.4	128	9.7	0.61	6.70	60	0.11	32	27	26	10	0.36	0.41	0.28	0.31	0.66	71.5
42-57	116.6	111	8.2	-1.11	6.49	39	0.11	31	22	25	5	0.31	0.37	0.25	0.28	0.52	61.5
57-86	93.0	84	8.8	-0.82	5.04	32	0.09	33	20	22	9	0.18	0.21	0.26	0.31	0.39	39.4
86-115	79.1	78	7.9	1.43	5.57	30	0.06	32	19	21	7	0.14	0.19	0.24	0.23	0.5	71.3
115-144	149.9	108	19.7	1.31	8.71	33	0.05	30	18	19	6	0.19	0.25	0.31	0.3	0.82	74.8
144-155	158.2	155	22.0	2.31	9.18	30	0.04	26	16	11	4	0.12	0.22	0.29	0.31	1.06	75.2

0-30	138.30	137.86	10.62	0.83	8.97	65.10	0.16	36.53	28.13	28.27	11.02	0.31	0.29	0.38	0.30	0.50	57.22
0-50	132.94	131.34	10.02	0.46	8.03	59.70	0.14	34.56	26.88	27.20	9.81	0.32	0.33	0.33	0.30	0.54	61.33
0-100	112.66	108.82	9.24	0.11	6.71	46.06	0.11	33.50	23.44	24.67	8.85	0.26	0.28	0.29	0.29	0.49	56.38
0-150	118.32	107.41	11.65	0.57	7.08	41.29	0.09	32.37	21.65	22.66	7.92	0.23	0.26	0.29	0.29	0.58	62.19

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
35	Bellary/ Karnataka	Teligi	Agriculture (LM) Paddy-paddy	632	P 43

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-10	112.4	122	8.2	1.80	9.05	315	0.21	43.2	21.2	53	14	0.32	0.36	0.4	0.41		
10--25	108.2	108	4.4	1.90	6.26	298	0.18	21.6	39.9	48	8.5	0.33	0.31	0.41	0.39		
25-44	94.4	84	5.0	0.51	4.69	280	0.17	21.2	40.2	46	8.2	0.24	0.37	0.35	0.38		
44-69	84.6	64	4.5	-1.25	4.32	164	0.15	20.8	40.2	36	7.1	0.23	0.31	0.28	0.31		
69-97	80.5	47	8.4	-1.28	3.47	140	0.14	20.5	39.6	31	6.8	0.3	0.28	0.28	0.31		
97-123	69.4	44	3.6	1.37	2.66	128	0.11	20.1	39.8	30	6.4	0.21	0.26	0.3	0.28		
123-150	63.8	47	5.8	0.35	3.58	125	0.11	19.8	39.5	28	6	0.3	0.31	0.34	0.29		
0-30	107.31	108.60	5.78	1.63	6.93	300.67	0.19	28.73	33.72	49.33	10.28	0.31	0.34	0.40	0.40		
0-50	100.96	96.49	5.42	0.97	5.99	278.48	0.18	25.67	36.31	46.80	9.32	0.28	0.34	0.37	0.38		
0-100	91.18	74.99	6.02	-0.07	4.87	213.44	0.16	23.13	38.08	39.82	8.10	0.27	0.32	0.33	0.34		
0-150	82.92	65.23	5.61	0.23	4.30	184.42	0.14	22.07	38.60	36.19	7.46	0.27	0.31	0.32	0.32		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Semi-arid (Dry) Mean Annual Rainfall 850-550 mm					
36	Bellary/ Karnataka	Teligi	Agriculture (HM) Paddy-paddy	632	P 44

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-10	148.5	236	16.1	0.60	16.12	292	0.2	40.8	20.5	51	8.2	0.27	0.28	0.31	0.42		
10--34	97.1	233	10.0	1.24	13.62	264	0.18	21.2	39.2	47	8.2	0.23	0.28	0.31	0.36		
34-54	88.8	213	4.3	-0.14	12.35	228	0.17	21.1	38.5	44	7.3	0.33	0.36	0.4	0.38		
54-89	80.5	189	4.1	2.01	11.73	210	0.17	20.9	38.9	39	6.7	0.29	0.31	0.29	0.33		
89-119	70.8	169	3.0	0.60	13.50	198	0.16	20.6	38.1	39	6.5	0.26	0.33	0.26	0.31		
119-142	54.1	138	4.1	-0.34	7.96	145	0.14	19.8	37.5	31	6.4	0.27	0.31	0.32	0.34		
142-160	41.6	101	4.6	-1.85	6.49	128	0.13	19.5	37.3	20	5.6	0.19	0.28	0.3	0.31		
0-30	114.25	234.09	12.04	1.03	14.45	273.33	0.19	27.73	32.97	48.33	8.20	0.24	0.28	0.31	0.38		
0-50	104.74	227.15	9.40	0.67	13.71	258.08	0.18	25.09	35.24	46.84	7.91	0.27	0.31	0.34	0.38		
0-100	91.88	206.83	6.62	1.10	12.94	233.44	0.17	22.97	36.96	43.12	7.31	0.28	0.31	0.32	0.35		
0-150	80.73	185.90	5.66	0.66	11.90	209.77	0.16	22.00	37.21	39.51	6.98	0.27	0.31	0.31	0.34		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Arid Mean Annual Rainfall <550 mm					
37	Rajkot Gujarat	Sokada	Agriculture (FM-i) Cotton-bajra	533	P 30

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-11	184.6	179	17.8	-5.05	10.34	100	0.16	30	23	28	2.9	0.38	0.33	0.44	0.52	0.82	74.9
11--32	115.2	138	11.2	-2.44	7.49	112	0.09	28	24	26	2.6	0.4	0.38	0.48	0.51	0.86	79.8
32-57	101.3	105	10.5	-1.88	5.88	95	0.06	26	23	29	2.4	0.32	0.42	0.32	0.38	0.76	69.3
57-91	102.7	91	10.9	-1.55	3.09	86	0.08	24	22	25	1.9	0.33	0.26	0.4	0.37	0.81	69.6
91-107	113.8	84	11.5	-4.45	5.00	67	0.04	22	20	23	1.5	0.18	0.45	0.3	0.41	0.79	74.3
107-135	97.1	74	10.0	-1.11	4.59	30	0.03	24	19	20	1.1	0.19	0.22	0.23	0.29	0.78	73.4
0-30	140.61	153.28	13.58	-3.40	8.53	107.6	0.12	28.73	23.63	26.73	2.71	0.39	0.36	0.47	0.51	0.85	78.00
0-50	125.44	135.18	12.37	-2.81	7.54	103.24	0.09	27.72	23.42	27.52	2.59	0.37	0.38	0.41	0.47	0.82	74.94
0-100	114.97	113.51	11.65	-2.46	5.68	93.54	0.08	25.82	22.60	26.36	2.25	0.33	0.35	0.39	0.42	0.81	72.67
0-150	109.80	100.90	11.16	-2.17	5.34	74.09	0.07	25.12	21.45	24.38	1.88	0.29	0.32	0.34	0.38	0.80	72.96

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Arid Mean Annual Rainfall <550 mm					
38	Rajkot Gujarat	Sokada	Agriculture (FM-II) Cotton-bajra/ linseed	533	P 31

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-11	140.2	142	13.7	-2.81	7.91	112	0.18	33	21	28	3.2	0.28	0.31	0.39	0.52	0.96	89
11--37	134.6	135	11.4	-2.66	8.30	98	0.08	30	20	26	2.9	0.28	0.52	0.42	0.45	0.87	74
37-63	88.8	111	8.4	-2.64	7.90	89	0.05	29	18	25	2.5	0.4	0.28	0.28	0.33	0.88	75.1
63-98	80.5	108	8.9	0.22	6.66	77	0.03	26	19	23	2.3	0.28	0.36	0.31	0.41	0.86	75.7
98-145	95.7	95	11.3	-1.48	5.63	69	0.03	25	17	22	1.7	0.34	0.31	0.28	0.34	0.92	75
145-160	93.0	78	8.4	-3.38	5.32	65	0.02	23	16	20	1.4	0.28	0.15	0.3	0.3	0.79	71.4
0-30	136.64	137.53	12.23	-2.71	8.16	103.13	0.12	31.10	20.37	26.73	3.01	0.28	0.44	0.41	0.48	0.90	79.50
0-50	123.92	130.39	11.10	-2.69	8.11	98.74	0.09	30.40	19.70	26.18	2.86	0.31	0.41	0.38	0.43	0.89	77.59
0-100	103.59	119.38	9.99	-1.64	7.52	89.27	0.06	28.57	19.18	24.83	2.60	0.31	0.37	0.34	0.41	0.88	76.55
0-150	100.88	110.54	10.33	-1.65	6.88	82.38	0.05	27.31	18.42	23.82	2.29	0.32	0.35	0.32	0.39	0.89	75.91

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Arid Mean Annual Rainfall <550 mm					
39	Ahmednagar/ Maharashtra	Nimoni	Agriculture (HM) Cotton-wheat/ chickpea	520	P 51

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-13	213.7	170.8	23.5	4.9	10.4	275	0.19	40.1	20.3	48	10.8	0.31	0.44	0.48	0.52	0.32	70.1
13--38	122.1	178.3	14.6	4.5	10.6	270	0.18	19.9	34.1	45	10.3	0.29	0.32	0.35	0.41	0.57	70.7
38-55	55.0	66.8	5.6	1.0	4.3	252	0.16	19.3	38.2	43	9.8	0.31	0.37	0.41	0.42	0.28	64.9
55-94	48.8	52.0	3.1	0.1	2.9	244	0.15	18.6	38.2	41	9.5	0.3	0.31	0.28	0.31	0.43	70.4
94-128	45.8	44.6	3.4	1.3	2.3	238	0.13	18.2	37.2	37	8.3	0.21	0.24	0.3	0.29	0.23	68.5
128-150	30.5	52.0	3.1	0.6	2.6	225	0.12	17.7	37.1	29	7.2	0.2	0.29	0.32	0.33	0.32	69.3
0-30	161.80	175.05	18.44	4.69	10.50	272.17	0.18	28.65	28.12	46.30	10.52	0.30	0.37	0.41	0.46	0.46	70.44
0-50	129.81	149.59	14.74	3.77	9.02	266.98	0.18	25.01	31.50	45.30	10.31	0.30	0.36	0.40	0.44	0.44	69.15
0-100	89.45	101.09	9.08	2.03	5.99	255.53	0.16	21.82	34.79	43.01	9.85	0.30	0.34	0.35	0.38	0.41	69.39
0-150	72.66	83.34	7.15	1.69	4.79	247.78	0.15	20.54	35.58	39.83	9.17	0.27	0.31	0.33	0.36	0.37	69.21

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
BLACK SOILS					
Arid Mean Annual Rainfall <550 mm					
40	Ahmednagar/ Maharashtra	Nipimpri	Agriculture (FM) soy/wheat/chickpea	520	P 52

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-13	76.3	118.8	9.1	0.3	8.9	300	0.2	42.3	20.6	48	11.2	0.3	0.42	0.53	0.56		
13--38	61.1	111.4	7.1	1.6	8.8	285	0.19	21.8	35.3	46	10.1	0.28	0.31	0.37	0.43		
38-55	64.1	96.6	6.1	3.4	6.9	265	0.17	20.1	36.1	45	9.7	0.32	0.35	0.43	0.42		
55-94	61.1	89.1	7.7	0.8	4.7	245	0.16	19.8	38.3	42	8.5	0.31	0.29	0.25	0.33		
94-128	45.8	74.3	3.5	0.6	4.2	205	0.14	19.2	35.8	39	8.3	0.23	0.3	0.22	0.3		
128-150	30.5	44.6	2.6	1.1	2.7	200	0.13	18.7	37.1	28	7.6	0.21	0.27	0.31	0.28		
150-165	33.6	44.6	2.5	0.7	3.5	185	0.11	18.1	36.8	26	7.3	0.2	0.24	0.32	0.26		
0-30	67.67	114.63	7.95	1.04	8.83	291.50	0.19	30.68	28.93	46.87	10.58	0.29	0.36	0.44	0.49		
0-50	65.76	109.78	7.36	1.68	8.36	284.10	0.19	26.72	31.67	46.28	10.29	0.29	0.35	0.43	0.46		
0-100	62.64	98.94	7.20	1.37	6.61	263.15	0.17	23.24	34.73	44.11	9.44	0.30	0.32	0.35	0.40		
0-150	54.79	86.36	5.84	1.19	5.59	243.03	0.16	21.82	35.27	40.79	8.96	0.27	0.31	0.32	0.36		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
RED SOILS					
Sub-humid (Moist) Mean Annual Rainfall >1100 mm					
41	Dindori Madhya Pradesh	Dadarghuri	Agriculture (LM) Maize/mustard	1420	P 23

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-11	290.0	304	31.3	-3.04	20.23	325	0.18	49.2	23.8	56	16.1	0.21	0.31	0.4	0.38	0.88	77
11--29	190.1	270	26.5	2.05	17.22	310	0.13	22.8	38.2	48	15.2	0.22	0.33	0.38	0.41	0.96	78.1
29-55	162.4	236	14.5	0.60	12.93	295	0.12	22.6	37.8	41	12	0.17	0.28	0.26	0.32	0.83	75.4
0-30	226.74	282.48	28.28	0.18	18.32	315.5	0.15	32.48	32.92	50.93	15.53	0.22	0.32	0.39	0.40	0.93	77.70
0-50	200.43	263.35	22.55	0.32	16.08	307	0.14	28.52	34.86	46.82	14.05	0.20	0.30	0.33	0.37	0.89	76.72
0-100																	
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
RED SOILS					
Sub-humid (Moist) Mean Annual Rainfall >1100 mm					
42	Dindori/MP	Dardarghuri	Forest(Teak)	1420	P 24

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-10	273.4	355	17.0	-2.13	20.24	558	0.22	56	23.9	65	20.8	0.28	0.31	0.3	0.4	0.77	68.8
10--26	190.1	172	11.9	5.74	12.03	520	0.15	28.5	39.5	52	18.3	0.28	0.3	0.29	0.17	1.08	83.2
26-50	101.3	122	3.3	-0.62	8.78	305	0.1	22.1	39.2	47	16.3	0.17	0.21	0.27	0.3	0.87	79.4
0-30	206.02	226.21	12.43	2.27	14.33	504	0.17	36.81	34.26	55.67	18.87	0.27	0.29	0.29	0.26	0.95	77.89
0-50	164.13	184.34	8.77	1.11	12.11	424.4	0.14	30.93	36.24	52.20	17.84	0.23	0.26	0.28	0.28	0.92	78.50
0-100																	
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
RED SOILS																	
Sub-humid (Moist) Mean Annual Rainfall >1100 mm																	
43	Umeria/MP	Karkeli	Forest(Sal)	1352	P 25												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-11	217.9	172	19.1	2.22	10.24	250	0.21	35.8	20.1	43	9.2	0.28	0.41	0.38	0.55	0.94	76.5
11*23	63.8	71	4.5	-0.18	4.66	216	0.19	21.2	32.3	40	9	0.22	0.18	0.32	0.41	0.95	70.6
23-47	61.1	51	6.5	-0.22	3.67	214	0.15	19.8	30.1	35	8.5	0.35	0.38	0.29	0.31	0.9	79.7
47-77	55.5	61	4.8	1.76	3.93	204	0.15	18.5	33.2	32	8.1	0.15	0.25	0.31	0.36	0.68	71.3
77-101	45.8	81	2.7	1.56	4.77	182	0.13	16.8	31.6	28	7.8	0.18	0.28	0.32	0.33	0.85	75.6
101-123	51.3	54	1.3	2.19	6.60	180	0.1	14.9	30.7	23	6.9	0.16	0.23	30	0.31	0.8	75.8
123-137	41.6	47	1.2	2.42	3.43	165	0.09	12.6	30	19	6.8	0.17	0.3	0.28	0.38	0.84	77.1
137-152	40.2	44	1.4	-0.06	4.39	130	0.08	11.3	29.9	16	6.5	0.13	0.31	0.12	0.28	0.83	74.8
0-30	119.66	103.31	10.32	0.69	6.48	228	0.19	26.23	27.31	39.93	8.96	0.27	0.31	0.34	0.44	0.93	74.89
0-50	95.89	82.85	8.67	0.44	5.37	221.8	0.17	23.58	28.61	37.78	8.75	0.29	0.33	0.32	0.39	0.91	76.31
0-100	73.46	76.47	6.25	1.05	4.84	207.84	0.16	20.65	30.54	33.97	8.36	0.23	0.30	0.32	0.37	0.83	74.79
0-150	64.18	67.66	4.62	1.26	4.93	192.84	0.14	18.22	30.46	29.37	7.83	0.20	0.29	4.65	0.35	0.83	75.16

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
RED SOILS																	
Sub-humid (Moist) Mean Annual Rainfall >1100 mm																	
44	Umeria Madhya Pradesh	Karkeli	Agriculture (LM) Minor millet./ sweet potato	1352	P 26												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-15	119.3	149	10.1	-2.33	8.33	240	0.19	34.5	20.3	43	9	0.31	0.27	0.41	0.37		
15-39	68.0	101	9.6	-2.58	5.53	235	0.12	22.1	33.1	37	8.2	0.29	0.33	0.28	0.33		
39-62	54.1	64	4.0	3.56	4.11	228	0.16	20.7	32.7	36	8	0.22	0.31	0.4	0.42		
62-84	63.8	51	0.9	4.28	3.44	210	0.12	19.2	31.8	29	7.7	0.21	0.28	0.38	0.41		
84-127	50.0	54	3.7	1.05	5.17	192	0.1	18.5	33	20	6.5	0.27	0.32	0.43	0.36		
127-155	45.8	41	6.1	-1.12	3.04	185	0.09	13.8	32.5	17	6.4	0.2	0.26	0.39	0.32		
0-30	93.67	124.92	9.86	-2.45	6.93	237.50	0.16	28.30	26.70	40.00	8.60	0.30	0.30	0.35	0.35		
0-50	80.34	107.30	8.52	-1.15	6.06	234.96	0.15	25.51	29.17	38.58	8.40	0.28	0.31	0.35	0.36		
0-100	68.70	81.13	5.54	0.96	5.11	221.76	0.14	22.42	30.79	33.19	7.89	0.26	0.30	0.37	0.38		
0-150	61.81	70.02	5.30	0.66	4.80	210.77	0.12	20.40	31.45	28.33	7.41	0.25	0.30	0.39	0.37		

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
RED SOILS					
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm					
45	Bangalore Karnataka	Vijaypura	Agriculture (FM) Finger millets	924	P 16

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-9	226.7	209.8	26.6	3.5	18.7	237	0.38	43	30	69	16	0.37	0.25	0.22	0.22	0.25	21.5
9--22	232.8	176.4	15.3	1.2	17.2	180	0.31	36	31	52	10	0.43	0.37	0.16	0.36	0.35	43.7
22-42	177.8	154.1	10.0	2.0	14.2	200	0.21	33	35	52	8	0.39	0.39	0.34	0.39	0.41	46.4
42-69	158.0	131.8	10.1	1.8	15.2	170	0.09	35	29	48	8	0.31	0.25	0.21	0.22	0.24	20.5
69-98	135.1	113.3	11.9	1.6	11.9	130	0.05	33	22	45	5	0.28	0.16	0.16	0.36	1.61	58.2
98-120	124.4	98.4	13.0	1.0	11.5	119	0.06	31	23	41	3	0.16	0.2	0.13	0.24	1.79	53.2
120-150	103.0	61.3	11.6	0.3	10.5	105	0.03	29	20	39	3	0.03	0.1	0.12	0.19		
0-30	216.29	180.49	17.30	2.07	16.84	202.43	0.30	37.30	31.77	57.10	11.27	0.40	0.34	0.23	0.33	0.34	37.76
0-50	197.73	166.38	14.40	2.01	15.96	196.66	0.25	35.90	32.10	54.42	9.96	0.38	0.34	0.25	0.32	0.34	37.07
0-100	170.54	143.06	12.84	1.83	14.55	170.71	0.16	34.79	28.40	50.20	8.01	0.34	0.27	0.21	0.31	0.72	40.37
0-150	150.89	120.75	12.61	1.41	13.33	150.67	0.12	33.13	26.00	46.73	6.34	0.25	0.22	0.18	0.28	0.72	34.01

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
RED SOILS					
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm					
46	Bangalore Karnataka	Vijaypura	Agriculture Finger millets/pigeonpea/ red gram/groundnut	924	P 17

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-12	179.4	232.1	20.0	5.5	23.4	184	0.21	27	20	46	9	0.07	0.22	0.22	0.25	0.11	6.6
12--37	168.7	235.8	9.7	3.8	21.0	134	0.06	25	18	42	5	0.31	0.48	0.24	0.33	0.57	58.9
37-62	156.5	180.1	11.0	3.2	19.4	121	0.05	25	20	38	3	0.22	0.34	0.24	0.27	0.65	51.9
62-92	161.0	139.3	15.5	2.1	15.9	129	0.03	21	15	36	5	0.21	0.15	0.06	0.15	1.1	61.4
92-116	170.2	131.8	11.8	2.7	15.1	120	0.02	30	13	30	3	0.13	0.1	0.13	0.28	0.39	13
116-143	158.0	135.6	11.4	3.5	14.6	105	0.01	29	11	26	2	0.1	0.21	0.21	0.19	0.81	35.6
0-30	172.94	234.35	13.82	4.45	21.96	154	0.12	25.80	18.80	43.60	6.60	0.21	0.38	0.23	0.30	0.39	37.98
0-50	168.06	220.46	12.50	4.03	21.16	142.62	0.09	25.48	19.00	41.92	5.44	0.23	0.38	0.24	0.30	0.48	44.53
0-100	164.73	184.17	13.16	3.25	18.89	134.13	0.06	24.44	17.44	38.72	4.82	0.21	0.28	0.17	0.25	0.68	47.95
0-150	163.78	167.57	12.63	3.24	17.51	126.02	0.05	26.07	15.51	34.91	3.99	0.18	0.25	0.18	0.24	0.68	41.42

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.										
RED SOILS															
Semi-arid (Moist) Mean Annual Rainfall 1000-850 mm															
47	Bangalore Karnataka	Vijaypura	Agriculture (HM) Finger millet	924	P 18										
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-11	185.5	235.8	17.3	6.7	22.3	200	0.02	36	29	50	19	0.07	0.13	0.09	0.04	0.08	6.9
11--32	156.5	187.6	9.8	5.2	16.4	86	0.01	33	24	50	9	0.28	0.37	0.15	0.28	0.19	24.2
32-64	144.2	176.4	9.4	3.6	15.8	65	0.02	30	25	48	6	0.22	0.27	0.16	0.19	0.23	33.3
64-100	139.7	143.0	9.0	3.0	15.5	50	0.005	27	26	46	4	0.28	0.34	0.24	0.37	0.36	45.5
100-130	121.3	131.8	5.7	2.8	13.7	38	0.01	25	21	28	5	0.2	0.33	0.25	0.21	0.35	26.5
130-150	103.0	131.8	7.8	2.2	14.1	23	0.01	24	19	22	3	0.16	0.34	0.16	0.09	0.17	18.3
0-30	167.09	205.25	12.56	5.72	18.54	127.8	0.01	34.10	25.83	50.00	12.67	0.20	0.28	0.13	0.19	0.15	17.86
0-50	158.44	194.16	11.31	4.94	17.45	103.52	0.02	32.58	25.46	49.28	10.12	0.21	0.28	0.14	0.19	0.18	23.67
0-100	149.69	173.25	10.21	4.06	16.53	78.86	0.01	30.21	25.59	47.92	7.34	0.24	0.30	0.18	0.26	0.25	32.88
0-150	137.80	159.45	9.00	3.57	15.63	63.24	0.01	28.34	23.79	40.48	6.29	0.22	0.31	0.19	0.23	0.26	29.66

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
RED SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 1000-850 mm																	
48	Rangareddy Andhra Pradesh	Hayathnagar	Agriculture (HM) Sorghum-castor	764	P 37												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C%				MWD (mm)	WSA (%)
												2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm		
0-12	172.1	111	13.4	-2.92	7.64	225	0.17	37.2	20	46	12	0.27	0.21	0.25	0.2	0.91	82.1
12--29	102.7	95	7.7	-0.58	7.11	200	0.16	20.1	37.2	38	11.2	0.12	0.23	0.24	0.18	0.82	88.6
29-67	84.6	74	6.5	0.42	5.09	182	0.13	20.3	37.5	32	9.5	0.17	0.31	0.34	0.16	0.89	80.5
67-101	47.2	61	3.8	-0.63	4.22	140	0.09	19.8	36.9	28	8.7	0.26	0.18	0.12	0.21	0.86	78.7
0-30	129.84	100.61	9.93	-1.48	7.25	209.4	0.16	26.95	30.33	41.00	11.46	0.18	0.22	0.25	0.19	0.86	85.73
0-50	111.76	90.08	8.58	-0.72	6.39	198.44	0.15	24.29	33.20	37.40	10.68	0.18	0.26	0.28	0.18	0.87	83.64
0-100	85.84	77.72	6.66	-0.50	5.45	176.36	0.13	22.13	35.15	33.38	9.83	0.20	0.24	0.24	0.18	0.87	81.48
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
RED SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 1000-850 mm																	
49	Rangareddy Andhra Pradesh	Hayathnagar	Agriculture (LM) Sorghum-castor	764	P 38												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-16	208.1	267	22.9	-3.65	18.20	245	0.18	38	21.3	47	13.2	0.24	0.28	0.32	0.35	1.09	82.8
16-41	166.5	165	12.9	2.51	10.53	205	0.18	20.9	38.5	45	9.8	0.22	0.33	0.42	0.47	0.78	58.1
41-62	134.6	142	10.2	-0.50	10.15	185	0.16	20.2	38.7	38	8.5	0.31	0.35	0.42	0.38	0.81	89.1
62-89	112.4	132	9.4	-1.55	9.27	164	0.13	21.1	38	31	7.2	0.31	0.33	0.29	0.39	0.82	83.2
89-115	102.7	122	9.1	-2.27	7.84	138	0.12	21	38.2	28	6.9	0.3	0.28	0.36	0.3	0.57	57.4
0-30	188.72	219.46	18.23	-0.78	14.62	226.33	0.18	30.02	29.33	46.07	11.61	0.23	0.30	0.37	0.41	0.95	71.27
0-50	174.09	193.59	15.61	0.00	12.92	214.20	0.18	26.25	33.03	44.38	10.65	0.24	0.32	0.39	0.42	0.88	71.58
0-100	144.84	162.73	12.58	-0.73	11.04	188.76	0.16	23.55	35.62	38.20	9.05	0.28	0.32	0.36	0.39	0.82	75.26
0-150																	

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.												
RED SOILS																	
Semi-arid (Dry) Mean Annual Rainfall 1000-850 mm																	
50	Medak/AP	Patancheru	Permanent fallow	764	P 41												
Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	Avil.-P (ppm)	WSA-C% 2-1mm	1-0.5mm	0.5-0.1mm	<0.1mm	MWD (mm)	WSA (%)
0-4	81.9	159	11.7	3.77	11.83	228	0.18	38.2	20.1	46	9.9	0.27	0.21	0.29	0.32	0.6	68.2
4--11	79.1	132	8.4	2.77	9.23	205	0.17	30	38.1	37	8.7	0.2	0.24	0.3	0.34	1.63	62.3
11--38	69.4	111	5.5	2.41	7.17	198	0.16	20.3	37.6	36	7.9	0.24	0.23	0.29	0.31	0.48	51.6
38-65	61.1	98	6.2	1.02	6.20	180	0.14	19.8	37.5	32	6.5	0.21	0.24	0.32	0.37	0.14	14
65-79	47.2	88	5.2	1.04	5.21	155	0.12	19.5	37	25	6.3	0.32	0.31	0.22	0.3	0.25	40.8
79-109	45.8	68	4.6	0.09	4.66	142	0.1	19.2	38.1	25	6.2	0.4	0.32	0.38	0.42	0.29	39.2
109-163	44.4	68	12.5	-0.99	4.05	128	0.09	18.5	38.2	19	6	0.22	0.29	0.32	0.38		
0-30	73.31	122.45	7.03	2.68	8.27	203.63	0.17	24.95	35.38	37.57	8.35	0.23	0.23	0.29	0.32	0.76	56.31
0-50	69.74	114.79	6.58	2.24	7.60	197.06	0.16	22.97	36.25	35.98	7.84	0.23	0.23	0.30	0.33	0.57	45.40
0-100	60.25	98.55	5.91	1.44	6.44	177.05	0.14	21.22	36.93	31.54	7.08	0.28	0.26	0.31	0.35	0.40	38.75
0-150	82.58	132.32	11.46	1.04	8.52	242.31	0.18	30.53	56.02	41.58	10.10	0.40	0.41	0.47	0.54	0.43	42.27

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
RED SOILS					
Semi-arid (Dry) Mean Annual Rainfall 1000-850 mm					
51	Mehboobnagar Andhra pradesh	Kaukuntala	Agriculture (FM) Castor+ pigeonpea	674	P 34

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-8	79.1	101	6.6	3.89	5.25	275	0.19	39.1	19.8	48	0.2	0.42	0.31	0.15	0.37	46.4
8*27	68.0	95	4.0	2.54	6.80	258	0.18	19	30.7	42	0.19	0.23	0.39	0.16	0.41	71.8
27-43	54.1	71	5.0	1.86	5.28	242	0.16	18.6	30.3	38	0.31	0.25	0.18	0.22	0.53	75.1
43-68	33.3	64	3.1	1.46	4.93	240	0.14	15.8	29.8	36	0.17	0.19	0.26	0.4	0.45	68.8
68-98	31.9	47	3.4	2.33	2.76	236	0.11	15.5	29.1	31	0.24	0.25	0.15	0.31	0.85	79.8
98-121	54.1	37	5.4	1.85	3.45	235	0.1	14.9	28.6	29	0.15	0.21	0.2	0.26	1.1	79.7
121-156	47.2	30	2.9	1.43	2.43	208	0.09	14.2	28	26	0.08	0.19	0.25	0.28	0.51	49.8
156+	41.6	34	3.6	0.54	2.88	195	0.08	13.8	27.7	24	0.32	0.21	0.3	0.49	0.8	57.5
0-30	69.57	93.97	4.80	2.83	6.24	260.93	0.18	24.32	27.75	43.20	0.20	0.28	0.35	0.16	0.41	65.36
0-50	60.47	83.80	4.61	2.39	5.80	253.08	0.17	21.64	28.70	40.84	0.23	0.26	0.29	0.21	0.45	68.37
0-100	46.89	68.37	3.98	2.19	4.69	245.24	0.15	18.61	29.02	36.78	0.22	0.24	0.24	0.28	0.58	72.10
0-150	47.96	56.65	3.97	2.00	4.08	236.61	0.13	17.24	28.76	33.61	0.18	0.23	0.24	0.27	0.64	68.86

Sl.No.	District/State	Series	System	MAR (mm)	Profile No.
RED SOILS					
Semi-arid (Dry) Mean Annual Rainfall 1000-850 mm					
52	Coimbatore Tamil Nadu	Palathurai	Agriculture Hosegram/ vegetables	612	P 22

Soil depth	Soil respiration	Biomass C	Min-N	Net-N	Bio-N	WSC (ppm)	WS Carbo(%)	HA-C (%)	FA-C (%)	DHA ug TP	WSA-C% 2-1mm	WSA-C% 1-0.5mm	WSA-C% 0.5-0.1mm	WSA-C% <0.1mm	MWD (mm)	WSA (%)
0-16	191.6	195.0	21.5	6.5	20.2	100	0.08	25	14	85						
16-33	161.0	165.3	16.5	4.4	15.3	40	0.03	22	16	57						
33-46	171.7	150.4	15.0	2.7	13.9	35	0.04	21	17	57			Canker			
46-73	150.4	102.1	13.5	1.1	13.1	38	0.02	24	11	45						
73-95	109.1	91.0	11.9	0.4	11.7	30	0.02	20	10	27						
0-30	177.32	181.11	19.17	5.54	17.93	72.00	0.06	23.60	14.93	71.93						
0-50	172.73	165.86	17.48	4.39	16.34	57.74	0.05	22.86	15.22	65.00						
0-100	150.41	130.99	15.06	2.56	14.35	45.71	0.03	22.35	12.84	50.14						
0-150																

About IISS

Since the middle of sixties the research on nutrients, water and energy leaned heavily towards applied aspects and has already paid rich dividends to Indian agriculture and Indian economy as a whole. However, if Indian agriculture is to become nationally more sound and internationally more competitive, it will have to receive greater support from basic and strategic research. In the years to come, the sustainability of soil productivity will encounter the problems associated with poor resource base, high inputs, mainly fertilizer and water, high-energy use and environmental degradation. Therefore, the future gains of enhancing food production in a sustainable manner can essentially be realized through the generation and adoption of more appropriate nutrient and water management technologies that are based on basic and sound strategic research information. In view of the fast changing scenario of Indian agriculture, and the growing importance of enhancing and sustaining productivity of soil resource, the ICAR established the Indian Institute of Soil Science (IISS) in 1988 at Bhopal, Madhya Pradesh, India to conduct basic and strategic research on this aspect. IISS has been actively engaged in the research work under National Agricultural Technology Project (NATP).

Please write to:
Director, Indian Institute of Soil Science
Nabibagh, Berasia Road,Bhopal - 462038, INDIA
Phone : +91-755-2730946 /2732162/2730970/2733372
Fax : +91-755-2733310
Email : director@iiss.ernet.in

About ICRISAT

ICRISAT
Science with a human face

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

Company Information

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

ICRISAT-Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India
Tel +91 11 32472306 to 08
Fax +91 11 25841294

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550
Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey (Regional hub WCA)
BP 12404, Niamey, Niger (Via Paris)
Tel +227 20722529, 20722725
Fax +227 20734329
icrisatsc@cgiar.org

ICRISAT-Bamako
BP 320
Bamako, Mali
Tel +223 2223375
Fax +223 2228683
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776,
Bulawayo, Zimbabwe
Tel +263 83 8311 to 15
Fax +263 83 8253/8307
icrisatzw@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi
Tel +265 1 707297/071/067/057
Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
c/o IIAM, Av. das FPLM No 2698
Caixa Postal 1906
Maputo, Mozambique
Tel +258 21 461657
Fax +258 21 461581
icrisatmoz@panintra.com

www.icrisat.org

02-2008