Original Research Article

Carbonsequestrationinsugarcaneplant-soilsystemasinfluencedbynutrientintegrationpracticesunderIndo-GangeticplainsofIndia

Abstract

Sugarcaneisamulti-purposecrop.Thecapabilityofsugarcanecroptosequestratecarbonintosoilandplantisofgreatimportance.Underthisstudythecarbonsequestrationinplantedsugarcaneandtheir rhizospheric soilunderdifferentnutrientmanagementpracticeswasassessed.As IPCC reported,thattherising temperatureofearthsurfaceresultedofGHGsemissionwhich causesglobalwarming.Inordertostabilizetheglobaltemperature,theanthropogenicCO_2hastobemitigatedtoasignificantlevelandthesurplusatmosphericCO_2inplantsandsoilhastobesunk,underthis circumstance,sugarcanecultivationplayspivotalroleinutilisingCO_2since itisaC_4planthavinghighefficiencyofutilisingCO_2duringphotosynthesis.ThereisanotherinterventionmightbeenhancingtheCO_2capturebychangingthenutrientmanagementpracticeswhichenhanceschlorophyllsynthesisbythewayofincreasingnitrogenefficiencyinsugarcane.ThedifferenttreatmentcompositionenhancesphotosynthesiswheremoreCO_2hasbeencaptured.Thusthesugarcanecropandrhizosphericsoilsactasimportantcarbonsinksindecarbonisationofatmospherethatultimatelyreducescarbonlevel and causes the global cooling.

SoilPropertiesandCarbonStorage:Theresultsshowedthatsoilphysicalpropertiesandchemicalpropertiesweresignificantlydifferedamongtreatmentsduetoapplicationofdifferentorganicamendmentsovercontrol.Soilorganiccarbon(SOC)wasanalysedwhichrangesfrom0.47to0.67%.Thedifferentorganicamendmentstreatmentshadaconsiderableeffectonsoilbulkdensityandporositywithsignificantimprovementinsoilcarbonstorage.

PlantCarbonStorage:Thecarbonstocksindifferentsugarcaneplantparts,includingroots,shootsandleavesweresignificantlydifferent.Thehighestamountofcarbonstockwasfoundinleaves(877.08 $kgha^{-1}$)under T_6followedbyroots(668.74$kgha^{-1}$) in T_2 and carbonstockinshoots(422.77 $kgha^{-1}$) in T_5showingthat30.41 %and107.58%morecarbonswerestoredintheleavesascomparedtotherootsandshoots while in roots 58.18% more carbon stored in comparison to shoots.Thetotalcarbonstorageinsugarcanebiomassincludingabovegroundpartsandbelowground parti.e. roots,indifferenttreatmentwassignificantlydifferent.Themean value of carbonstoredintheabovegroundparts(leavesandstalks)wassignificantlyhigher(1239.65$kgha^{-1}$)thanthatofundergroundplantpart(621.73$kgha^{-1}$)(roots).Theresultsshowedthatthesugarcanefarmingpracticeshavepromisingeffectforcarbonsequestrationandconsequentlyenhancingthemitigationofclimatechangeimpacts.

Keywords:*Sugarcane,carbon storage,climate change, photosynthesis,carbonsequestration.*

Introduction*:*

Sugarcaneisaperennialgrasscultivatedcommerciallyover90countrieswithwidespreadglobal areaofapproximately26×10^6haandworldwideharvestof1.83billiontones(AnayaandHuber-Sannwald,2015).Sugarcaneismainlyusedforsugarproduction.Itisalsousedforlivestockfeedingandproducingethanolasabiofuel(Goldemberg,2007).However,thecapabilityofsugarcanecropbeing C4 plant tosequestratecarbonintoplant andsoil isofgreatimportance.Theleadingcauseofclimatechangeisgreenhousegasses(GHGs),includingcarbondioxide(CO_2)mainlyemittedfromhuman'sunsustainableactivities(D'Alessandroetal.,2010).AsInter-governmentalPanelonClimateChange(IPCC,2015)reported,thatthetemperatureofearthsurfaceis expectedtoriseby1.4°Cto5.8°Cattheendofthecentury,duetoGHGsemissionandglobalwarming, so inordertostabilizetheglobaltemperature,theanthropogenicCO_2hastobemitigated(Davisetal.,2010)andthesurplusatmosphericCO_2inplantsandsoilhastobesunk,underthiscircumstance,sugarcane cultivationplayspivotalroleinutilisingCO_2fromatmosphere since, itisaC_4planthavinghighefficiencyofutilising solar radiation and consuming more amount of CO_2duringphotosynthesis.CertaininterventionshelpfulinenhancingCO_2capturebythenutrientintegrationstrategywhichultimatelyenhanceschlorophyllsynthesisbythewayofincreasingnitrogenefficiency.Thesustainableapproachesmightbe enhancingtheCO_2capturebysugarcanefarming(Scharlemannetal.,2014;SadeghiandRaeini,2016).The croplandsoilsact asimportantcarbonsinks(Nadeuetal.,2015) whichplayapotentialroleinreduction of atmospheric carbon (Lal,2001).Previousstudieshaveindicatedthatleavingsugarcaneleavesandtrashesonsoil,improvesphysical,chemicalandbiologicalpropertiesofsoil(Meieretal.,2006).Mulching withthesugarcaneresiduesonthesoilimprovessoilbiologicalactivity(Yadavetal.,1994),decreases soilbulkdensity(Tominagaetal.,2002),enhancessoilaggregation&infiltrationrate(Galdosetal.,2009)andreducesgasemissionscomparedtothetraditionalburningof crop residue after harvesting.Afarmwithburnedresidueshad30%lowercarboncontentparticulateorganicmatterand microbialbiomasscarbonthanthoseofafarmwherethetrashesandresidueswereleftonthesoil(Alireza et al., 2020).Asurveyalsoshowedthatleavingthesugarcaneresiduebiomassesinsoilreturnedaremarkableorganicmattercomparedtothesoilswherethesugarcaneresidueswereburned(deFigueiredoetal.,2010).Ontheotherhand,heavysugarcanebiomassinaboveandundergroundpartsofthesoilscouldact asimportantpoolsforcarbonsequestrationandconsequentlyenhancingthemitigationofclimatechangeimpacts.However,thereisnotmuchresearchcarriedoutonthecapabilityofcarbonsequestrationinsugarcanefarmsinIndia.ThisstudythereforewasconductedtoexaminethestatusofcarbonsequestrationinsugarcanefarmlandsinBihar.Thetotalareaofsugarcanecultivation is about3.15lakhhainaflatplainmanagedwithplantcultivationsysteminBihar. As per the mean value of carbon stored by sugarcane farming @1861.37 kg/ha only Bihar state can sequester carbon upto 586.33 Mkg/ha through sugarcane farming.ThedifferenttreatmentcompositionenhancesphotosynthesiswheremoreCO_2hasbeencaptured.Underthisstudythecarbonsequestrationinplantedsugarcaneandsoilunderdifferentnutrient managementpracticeswereassessed.ThispaperiswrittenwiththeObjectivesas,toestimatecarbonstorageinsugarcaneplantandsoilsystem;toevaluatethechangesinsoilphysical,chemicalandbiologicalproperties;aswellascorrelationstudyamongsoilpropertiesandcarbonstorage.

MaterialandMethods

ExperimentalSite and treatment details

Theexperimentconductedatchhawaniyaexperimentalfarm in the year 2022-2023neartheBurhiGandakriverinBihar,India,situatedatcoordinates26.0039°N,85.6753°E.atan altitudeof52.0mabovesealevel.Thissiteexperiencesanannualrainfallof1909mm,arelativehumidityof80.45%,andanaveragetemperatureof22.45°C.Thissitefallswithintheusticmoistureregimeofthesubtropicalregionof India.TheexperimentalsoilisclassifiedasEntisolsorder,FluventssuborderandTypicUstifluventgreatgroup.

Theexperimentwasconducted with eight treatments and three replications inarandomizedcompletedesign, the treatment details are as follows.**T_1:** Control; **T_2:** FYM @ 20 t ha^{-1}; **T_3:** BC @20 t ha^{-1}; **T_4:** VC @ 5.0 t/ha; **T_5:** GM with mung; **T_6:** ST @ 10 t ha^{-1}; **T_7:** FYM + BC + VC; **T_8:** RDF. Notation: FYM: farm Yard Manure; BC: Biocompost; VC: vermicompost; GM: green manure; ST: sugarcane trash

Soilsamplingandlaboratoryanalysis:

Thesoilsampleswererandomlycollectedat0-30cmtoplayerandsoilorganiccarbonwereanalysedinlaboratory following the standard procedure.Simultaneously,bothabovegroundandundergroundpartsofsugarcaneplantsweresampledandthecarboncontentofeachpartwasmeasuredseparately.Thetotalsoilorganiccarbonandsequestratedcarboninplantpartslikeroot, stemandleaveswereanalysed.Theair-driedsoilsamplesweresievedthrougha2-mmscreenandpreparedforanalysisinthesoillaboratory.Soiltexturewasdeterminedusingthehydrometermethod(Bouyoucos,1962).SoilpHwasdeterminedusinganelectricpHmeter(Pageetal.,1982)andelectricalconductivity(EC)wasdeterminedfromasoil-water (1:1)suspensionusinganelectricconductivitymeter(Carter,2008).Soilbulkdensitywasdeterminedusingacoresamplerof8cmdiameterandsoilorganiccarbon(SOC)wasmeasuredusingwet titration method(Walkley and Black 1934).

Plantsamplinglaboratoryanalysis:

Fiveplantsamplesweretakenfromeachtreatmentsrandomly,eachwithinanareaof1m^2beforetheharvesting.Theplantsamplesweremweightedimmediatelytoestimatethegroundbiomass.Theleavesandstemsweresubsequentlyseparatedanddriedinanovenat65°Ctillgetthetwoconstantweighandthenre-weighted.Theplantundergroundpartsincludingrootsandbasalpartswerealsosampledwithinthedepthof0-60cmanddriedinanovenandthenweightedaccordingly.Inordertodetermineplantorganiccarbon,theleaves,stemsandrootswerehammer-milledtopassthrougha0.5mmsieve.ThecarboncontentwasthendeterminedusingaCHNanalyzerandthemeanvalueswereusedforthestatisticalanalysisusingtheANOVAprocedure.

ResultsandDiscussion

SoilPropertiesandCarbonStorage

ThesoilphysicalpropertiesunderdifferenttreatmentsaresummarizedinTable1.ThetreatmentsincludevariousorganicamendmentssuchasFYM,BC,VC,GMwithmung,ST,aswellas inorganic

amendments.Thesoilphysicalparameterslikesand,silt,andclaycomposition,moisturecontent,bulkdensityandporespace,mechanicalresistancewererecorded.Acrossalltreatments,thesoilcompositionintermsofsand,silt,andclaycontentshowedminimalvariation.However,itisnoteworthythattreatmentsinvolvingorganicamendmentsgenerallyexhibitedslightlyhighersandcontentcomparedtothecontrolandRDFtreatments.Conversely,claycontentwasslightlyhigherintreatmentsinvolvingSTandRDFcomparedtoorganicamendmenttreatments.Thesevariations,althoughminor,mighthaveimplicationsforsoilstructureandwaterretentioncapacity.Themoisturecontentofthesoilvariedsignificantlyamongtreatments,withFYM+BC+VCtreatmentshowingthehighestmoisturecontent(42.15%)followedbyST(44.97%)andVC(43.21%).Conversely,thecontroltreatmentexhibitedthelowestmoisturecontent(36.42%).Thisindicatesthatorganicamendments,particularlyacombinationofFYM,BC,andVC,cansignificantlyimprovesoilmoistureretention,whichiscrucialforplantgrowthanddroughtresistance.ThefindingisinaccordancewiththeworkofMishraetal.
(2020).Bulkdensity,anindicatorofsoilcompaction,wasnotablylowerintreatmentsinvolvingorganicamendmentscomparedtothecontrolandRDFtreatments.Amongtheorganicamendments,BCandFYM+BC+VCtreatmentsexhibitedthelowestbulkdensity,suggestingimprovedsoilstructureandporosity.Thiswasfurthersupportedbyhigherporespacepercentagesobservedinthesetreatments,indicatingbetteraerationandwaterinfiltrationcapacities.Thebulkdensityandporespacereportedinthisstudyareconsistentwithpreviousresearchfindings(Rivenshieldetal.,2007),whichsuggestthatorganicamendmentspositivelyinfluencetodecreasebulkdensityandincreasemacroporosityinsoils.Mechanicalresistance,representingsoilstrengthorcompaction,showedconsiderablevariationamongtreatments.BCtreatmentexhibitedthelowestmechanicalresistance(1.54MPa),indicatingsofterandlesscompactedsoil,whilethecontroltreatmentshowedthehighestresistance(1.65MPa).ThissuggeststhatorganicamendmentsparticularlyBC,canmitigatesoilcompactionandimprovesoilworkability,facilitatingrootgrowthandnutrientuptakeSharifiet.al.
(2011).Overall,theresultsdemonstratethatorganicamendments,especiallyacombinationofFYM,BC,andVC,positivelyinfluencesoilphysicalproperties,enhancingmoistureretention,reducingcompaction,andimprovingsoilstructureandporosity.TheseFindingsunderscoretheimportanceofincorporatingorganicinputspracticesinpromotingsustainablesoilmanagementandenhancingsugarcaneproductivity that ultimately sequester more carbon from atmosphere.

Table1. Effect of different organic and inorganic amendments onsoilphysicalpropertiesunder sugarcanecultivation

Treatments	Sand(%)	Silt(%)	Clay(%)	Moisturecontent(%)	Bulkdensity(g cm^{-3})	PoreSpace(%)	MechnicalResistance(Mpa)
T_1	31.83	54.75	13.42	36.42	1.37	45.42	1.65
T_2	32.86	53.89	13.25	41.08	1.39	46.16	1.74
T_3	33.13	53.61	13.26	43.92	1.32	45.65	1.54
T_4	31.63	54.12	14.25	43.21	1.35	47.49	1.63
T_5	32.16	55.69	12.15	39.56	1.36	46.25	1.59
T_6	32.65	53.23	14.12	44.97	1.34	46.53	1.61
T_7	31.73	53.83	14.44	42.15	1.28	45.13	1.52
T_8	31.15	54.89	13.96	38.45	1.32	45.18	1.58
Mean Value	32.14	54.25	13.60	41.22	1.34	45.97	1.61
SEm±	1.6	0.69	0.49	1.31	0.02	0.79	0.03
CD(P=0.	2.1	1.98	1.26	3.98	0.09	2.38	0.08

05)							

Note:T1: Control; T2: FYM @ 20 t ha-1; T3: BC @20 t ha-1; T4: VC @ 5.0 t/ha; T5: GM with mung; T6: ST @ 10 t ha-1; T7: FYM + BC + VC; T8: RDF.

Chemicalpropertiesofrhizospheric soil underexperimentalfield

Table2presentsthesoilchemicalpropertiesandthe organiccarbon(SOC)storageinrhizospheric soil of plantedsugarcaneunderdifferenttreatments.

pHandElectricalConductivity(EC)

ThepHvaluesofsoilrangedfrom8.14to8.59acrossdifferenttreatments,indicatingalkalinesoilconditions.TherewerenosignificantdifferencesinpHamongtreatments,suggestingthattheapplicationoforganicamendmentsorRDFdidnotsignificantlyaltersoilacidity.Similarly,EC valuesvariedslightlyamongtreatments,reflectingvariationsinsoilsalinitylevels.Overall,thesoilremainedwithinacceptablerangesforsugarcanecultivation.TheoptimalsoilpHforsugarcanecanrangefromslightlyacidictoalkaline,dependingonthespecificconditionsoftheplantation.OrganicmattershelpoptimisingthepHofsoilmakingitsuitableforuptakeofnutrients,thismatchingwiththework ofRuslietal. (2022).

SoilOrganicCarbon(SOC)and its CarbonStorage

Thesoilorganiccarboncontentrangedfrom0.47%to0.67%acrosstreatments,withthehighestvalueobservedinthesugarcanetrashtreatmentandthelowestintheFYM+BC+VCtreatment.However,whenconsideringSOCstorage,whichtakesintoaccountsoildepthandbulkdensity,theSTtreatmentexhibitedthehighestSOCstorage(1376.85t/ha),followedbyVC(1174.50t/ha)andRDF(1287.00t/ha).Conversely,theFYM+BC+VCtreatmentshowedthelowestSOCstorage(902.40t/ha).TheseresultssuggestthatincorporatingSTorVCcansignificantlyenhanceSOCstorage,contributingtosoilfertilityandcarbonsequestration.Soilorganiccarbonisaffecteddirectlybythefarmmanagement practicessuchascroptype,manureapplication,tillageintensities,irrigationefficiency,harvestingapproachesandthelifeperiodofcropplants(WestandMarland,2002;Smith,2004).Ithasbeenreportedthatsoiltextureparticularlyclaycontenthaveakeyroleincapabilityofsoilcarbonsequestration(ReedererandSchuman,2002).ThisisconsistentwiththeresultsreportedbyGhanbarianetal.(2015)andSadeghiandRaeini(2016).However,accordingtoanotherresearch,soilbulkdensityandsandcontenthad negativeeffectsonsoilcarbonstorage.Thisresultisinaccordancewiththeresultsofastudyconducted bySumanetal.(2009)whoreportedthatreductioninsoil bulk density wouldleadtoincreaseinSOCofsugarcanefarms.Itseemsthatthedifferencesinchemicalandphysicalpropertiesofsoilindifferent nutrient management asoutlinedabovemighthavecausedtheconsiderabledifferencesinsoilorganiccarboncontent.

Availablemacro and secondary nutrients

Theavailabilityofnutrientssuchasnitrogen(N),phosphorus(P),potassium(K),andsulphur(S)variedamongtreatmentswhiletherewerenosignificantdifferencesinavailableNamongtreatments,ST@10tha^{-1}treatmentexhibitedsignificantlyloweravailablephosphoruscomparedtoothertreatments..ThesugarcanetrashtreatmentexhibitedthehighestlevelsofavailableN(284.36kg/ha),availableP(24.48kg/ha),availableK(193.05kg/ha),andavailableS(16.98mg/kg),indicatingefficientnutrientcycling anddecompositionoforganicmatter.Conversely,theFYM+BC+VCtreatmentshowedthelowestlevelsofavailablenutrients,suggestingpotentiallimitationsinnutrientreleaseandavailability.Thesefindingshighlighttheimportanceofselectingappropriateorganicamendmentstomeetthenutrientrequirementsofsugarcanecrops.Conversely,RDFtreatmentshowedthehighestavailablephosphorusc ontent.AvailablepotassiumcontentwashighestinST@10tha^{-1}treatment,whileavailablesulphurcontentsshowednosignificantdifferencesamongtreatments.Overall,theresultsdemonstratethatorganicamendments,particularlySTandVC,canpositivelyinfluencesoilchemicalproperties,enhanceSOCstorage,andimprovenutrientavailability.However,theeffectivenessoforganicamendmentsmayvarydependingonfactorssuchasapplicationrate,soiltype,andenvironmentalconditions.

Table2. Effect of different organic and inorganic amendments onsoilchemicalproperties andsoilorganiccarbonstorage ofplantedsugarcanefield

Treatments	pH (1:2.5)	EC (dSm^{-1})	SOC (%)	Soilorganic carbonstorage***** (t/ha)	AvailableN (kg/ha)	AvailableP (kg/ha)	AvailableK (kg/ha)	AvailableS (mg/kg)
T_1	8.14	0.82	0.51	1025.51	254.18	22.04	139.62	15.69
T_2	8.16	0.54	0.49	1021.65	219.32	19.15	120.59	14.38
T_3	8.15	0.48	0.59	1168.20	228.04	23.23	151.62	15.29
T_4	8.53	0.62	0.58	1174.50	284.36	22.98	152.38	16.49
T_5	8.59	0.68	0.53	1081.20	235.42	24.48	123.69	16.98
T_6	8.49	0.38	0.67	1376.85	168.52	21.14	172.32	16.42
T_7	8.16	0.62	0.47	902.40	238.26	18.98	152.18	15.93
T_8	8.43	0.73	0.65	1287.00	258.04	21.09	193.05	13.04
MeanValue	**8.33**	**0.61**	**0.56**	**1129.66**	**235.77**	**21.63**	**150.68**	**15.53**
SEm±	0.06	0.02	0.05	39.51	9.4	0.97	5.79	0.63
CD(P=0.05)	0.21	0.08	0.16	138.9	28.20	2.92	17.93	1.97

***Soilorganiccarbonstorage(t/ha)**=1ha×soildepth(m)×soilbulkdensity(g/cm^3)×SOC(%)

CarbonSequestrationinDifferentCaneParts

Theplantsequesteredcarbon(kgha^{-1})contentindifferentplantpartsofplantedsugarcaneundervarioustreatmentsissummarizedinTable 3.Thebelow-groundcarbonstorage,primarilyinroots,rangedfrom586.45to668.74kgha^{-1}acrosstreatments.Thehighestbelow-groundcarbonstoragewasobservedintheFYM@20tha^{-1}treatment,whilethecontroltreatmentexhibitedtheloweststorage.Treatmentsinvolvingorganicamendmentsgenerallyshowedhigherbelow-groundcarbonstoragecomparedtothecontrolandRDFtreatments.Theabove-groundcarbonstorage,includingstemsandleaves,rangedfrom398.77to422.77kgha^{-1}forstemsand779.14to872.15kgha^{-1}forleavesacrosstreatments.Thehighestabove-groundcarbonstorageinstemswasobservedintheST@10tha^{-1}treatment,whilethehigheststorageinleaveswasobservedintheBC@20tha^{-1}treatment.Again,treatmentsinvolvingorganicamendmentsgenerallyshowedhigherabove-groundcarbonstoragecomparedtothecontrolandRDFtreatments.Theresultsofthisstudyalsoindicatedthatsugarcaneleavesandrootshadhighercarbonstoragethanshoots(Tables3).Severalstudieshavefoundthatperennialplantswithwoodyorganshadhigherpotentialtoreservetheorganiccarboncomparedtoannualplants(Ghanbarianetal.,2015).Overall,1291.82kgha^{-1}(66%))carbonstoragebelongedtotheabovegroundplantorgansofT_6and668.74kgha^{-1}belongedtotherootsofsugarcaneofT_2showingthattheconsiderablecarbonstoragecapabilityofsugarcane.Thetotalstoredcarbonaboveground,comprisingstemsandleaves,rangedfrom1201.91to12

91.82kgha^{-1}acrosstreatments.ThehighesttotalstoredcarbonabovegroundwasobservedintheST@10tha^{-1}treatment.Additionally,thetotalstoredcarbon(combiningbelow-groundandabove-groundcarbon)rangedfrom1774.11to1947.19kgha^{-1},withthehighestvalueobservedintheST@10tha^{-1}treatment.Thecarbonsequestrationvaluesreportedinthisstudyalignwithpreviousresearchfindings(Gaoetal.,2007),whichsuggestthatorganicamendmentspositivelyinfluencecarbonstorageinagriculturalsystems.Overall,theresultsindicatethattreatmentsinvolvingorganicamendmentscontributetohighercarbonsequestrationinbothbelow-groundandabove-groundcanepartscomparedtoconventionaltreatments.Thishighlightstheimportanceoforganicfarmingpracticesinenhancingcarbonsequestrationpotentialinsugarcanecultivation,whichcancontributetomitigatingclimatechangeimpacts.However,furtherresearchisneededtoassessthelong-termeffectsofthesetreatmentsoncarbonsequestrationandsoilhealth.

Table3.Effect of different organic and inorganic amendments onplant sequesteredcarbon(kgha^{-1})indifferentpartsofplantedsugarcane

Treatments	Storedcarbon(kgha^{-1})				
	belowground	aboveground		Totalstoredcarbonaboveground	Totalstoredcarbon(kgha^{-1})
	Roots	Stems	Leaves	stem+leaf	Root+Stem+Leaf
T_1	586.45	403.12	784.54	1187.66	1774.11
T_2	668.74	420.12	785.48	1205.6	1874.34
T_3	598.12	398.77	872.15	1270.92	1869.04
T_4	645.31	405.87	862.31	1268.18	1913.49
T_5	616.69	422.77	779.14	1201.91	1818.60
T_6	655.37	414.74	877.08	1291.82	1947.19
T_7	596.53	419.64	867.14	1286.78	1883.31
T_8	606.61	412.15	792.15	1204.3	1810.91
Mean Value	621.73	412.15	827.50	1239.65	1861.37
SEm±	17.29	7.97	24.61	26.31	49.51
CD(P=0.05)	53.82	23.78	73.63	84.23	163.32

CorrelationcoefficientsamongdifferentsoilpropertiesandSOC

Table4displayscorrelationcoefficientsamongdifferentsoilpropertiesandtheSoilOrganicCarbon(SOC%)inthegivendataset.Correlationcoefficientsrangefrom-1to1,where-1indicatesastrongnegativecorrelation,1indicatesastrongpositivecorrelation,and0suggestsnocorrelation.**Sand(%)andSOC(%):**ThecorrelationcoefficientbetweensandcontentandSOC%is-0.03448,indicatingaveryweaknegativecorrelation.ThissuggeststhatthereislittletonorelationshipbetweenthesandcontentinthesoilandthepercentageofsoilorganiccarbonArunratetal.(2020).**Silt(%)andSOC(%):**ThecorrelationcoefficientbetweensiltcontentandSOC%is-0.19752,indicatingaweaknegativecorrelation.ThereisaslighttendencyforhighersiltcontenttobeassociatedwithlowerSOC% (Matus,2021). **Clay(%)andSOC(%):**ThecorrelationcoefficientbetweenclaycontentandSOC%is0.243831,indicatingaweakpositivecorrelation.ThissuggeststhathigherclaycontentinthesoilmaybeassociatedwithaslightlyhigherpercentageofSOC.

Moisture(%)andSOC(%): Thecorrelationcoefficientbetweensoilmoistureand SOC%is0.332486,indicatingamoderatepositivecorrelation.Thissuggeststhatassoilmoistureincreases,theremay beatendencyforhigherSOC%. **BulkDensity(gcm^{-3})andSOC(%):**Thecorrelationcoefficientbetweenbulkdensityand SOC%is-0.13615,indicatingaweaknegativecorrelation.Thereisaslighttendencyforhigherbulkdensitytobe associatedwithlowerSOC%.

PoreSpace(%)andSOC(%): Thecorrelationcoefficientbetweenporespaceand SOC%is0.225035,indicatingaweakpositivecorrelation.Thissuggeststhathigherporespaceinthesoilmaybeassociatedwithaslightlyhigherpercentageof SoilOrganicCarbon.

MechanicalResistance(Mpa)andSOC(%): Thecorrelationcoefficientbetweenmechanicalresistanceand SOC%is-0.19117,indicatingaweaknegativecorrelation.Thereisaslighttendencyforhighermechanicalresistancetobeassociatedwithlower SOC%.

pHandSOC(%): ThecorrelationcoefficientbetweenpHandSOC%is0.535278,indicatingamoderatepositivecorrelation.ThissuggeststhathigherpHlevelsinthesoilmaybeassociatedwithahigherpercentageofSOC. **EC(dSm^{-1})andSOC(%):**Thecorrelationcoefficientbetweenelectricalconductivity(EC)andSOC%is-0.37008,indicatingamoderatenegativecorrelation.Thissuggeststhathigherelectricalconductivity maybeassociatedwithlowerSOC%.

Insummary,whilesomecorrelationsareweak,theresultssuggestthatsoilpropertiessuchasclaycontent,soilmoisture,pH,andelectricalconductivitymayhavesomeinfluenceonthepercentageofSOCinthegivendataset.

Table4:CorrelationcoefficientsamongdifferentsoilpropertiesandSOC%

	Sand (%)	Silt (%)	Clay (%)	Moisture (%)	Bulkdensity (gcm^{-3})	PoreSpace (%)	Mechnical Resistance (Mpa)	pH (1:2.5)	EC (dSm^{-1})	SOC (%)
Sand(%)	1									
Silt(%)	-0.50443	1								
Clay(%)	-0.3725	-0.61342	1							
Moisture(%)	0.522121	-0.77546	0.355895	1						
Bulkdensity(gcm^{-3})	0.28321	0.25712	-0.53539	-0.31101	1					
PoreSpace(%)	0.165652	-0.14636	0.005791	0.478477	0.448434	1				
MechnicalResistance (Mpa)	0.206593	0.013519	-0.20349	-0.23237	0.900452	0.387794	1			
pH (1:2.5)	-0.30522	0.36479	-0.11291	0.144917	0.101304	0.601097	-0.06322	1		
EC(dSm^{-1})	-0.72655	0.78556	-0.17978	-0.91598	0.115572	-0.36154	0.039509	-0.0564	1	
SOC(%)	-0.03448	-0.19752	0.243831	0.332486	-0.13615	0.225035	-0.19117	0.535278	-0.37008	1

Conclusion:-

ThefindingsofthisstudyunderscorethepotentialofsugarcanecultivationasasubstantialcarbonpoolinIndia.Throughtheaccumulationofhighbiomassandtheretentionofcropresiduesonthesoilsurface,sugarcanecultivationcontributestocarbonstorage,soilprotectionagainsterosionandenhancementofcropproductivity.It is concluded that apromisingeffectofsugarcanecultivationoncarbonsequestration,withsignificantimprovementsinsoilphysicalandchemicalpropertiesduetotheapplicationofvariousorganicamendments was occurs.Moreover,thecarbonstorageindifferentpartsofthesugarcaneplantdemonstratestheefficacyofsugarcanefarmingpracticesincarbonsequestration.However,tofullyvalidatethesefindings,itisimperativetocontinuethisstudyovermultiplecyclesofsugarcanecultivation,includingratooncrops.Overall,sugarcanefarmingemergesasaneffectivestrategyforcarbonsequestration,contributingtothemitigationofclimatechangeimpactsandthereductionofatmosphericcarbonlevels.Thusthesugarcanecropandrhizosphericsoilsactasimportantcarbonsinksindecarbonisationofatmospherethatultimatelyreducescarbonlevelandcausesglobalcooling.

References

Alireza Azizi, GholamabbasGhanbarian , Ali Hassanli, Mahmoud Shomeili, (2020). Carbon sequestration in sugarcane plant and soil with different cultivation systems, *Iran Agricultural Research*, 38(2), 47-54. magiran.com/p2124820.

Anaya, C.A., & Huber-Sannwald, E. (2015). Long-termsoilorganiccarbonandnitrogendynamicsafterconversionoftropicalforesttotraditionalsugarcaneagricultureinEastMexico.*Soil and Tillage Research*,147:20–29.

Arunrat,N.;Kongsurakan,P.;Sereenonchai,S.;Hatano,R.SoilOrganicCarboninSandyPaddyFieldsofNortheastThailand:AReview.*Agronomy***2020**,*10*,1061.

Bouyoucos,G.J.(1962).Hydrometermethodimprovedformakingparticlesizeanalysesofsoils.*Agronomy Journal*,54(5),464-465.

Carter,M.R.(2008).Soilsamplingandmethodsofanalysis.CRCPress.

D'Alessandro,D.M.,Smit,B.,&Long,J.R.(2010).Carbondioxidecapture:prospectsfornewmaterials.*AngewandteChemie International Edition*,49(35),6058-6082.

Davis,S.J.,Caldeira,K.,&Matthews,H.D.(2010).FutureCO_2emissionsandclimatechangefromexistingenergyinfrastructure.*Science*,329(5997),1330-1333.

DeFigueiredo,E.B.,Panosso,A.R.,Romão,R., and LaScala,N.(2010).GreenhousegasemissionassociatedwithsugarproductioninsouthernBrazil.*Carbon Balance and Management*,5(1),3.

Galdos,M.V.,Cerri,C.C.,&Cerri,C.E.P.(2009).SoilcarbonstocksunderburnedandunburnedsugarcaneinBrazil.*Geoderma*, 153 (3-4), 347-352.

Gao, Y. H., Luo, P., Wu, N., Chen, H., & Wang, G. X. (2007). GrazingintensityimpactsoncarbonsequestrationinanalpinemeadowontheeasternTibetanPlateau.*Research Journal of Agriculture and Biological Sciences*,3(6),642647.

Ghanbarian,G.,Hassanli,A.,andRajabi,V.(2015).ComparingpotentialcarbonsequestrationofdifferentpartsofmountainalmondandgrapeplantsandsoilinFarsprovince.*Journal of Natural Environment*,68(2):257265.

Goldemberg,J.(2007).Ethanolforasustainableenergyfuture.Science,315(5813),808-810.Graham,M.H.,Haynes,R.J.,&Meyer,J.H.(2002).Soilorganicmattercontentandquality:effectsoffertilizerapplications,burningandtrashretentiononalong-termsugarcaneexperimentinSouthAfrica.*Soil Biology and Biochemistry*,34(1),93-102.

IPCC,(IntergovernmentalPanelonClimateChange).(2015).Mitigationofclimatechange.Vol.3.CambridgeUniversityPress.1435p.,

Lal,R.(2001).Worldcroplandsoilsasasourceorsinkforatmosphericcarbon.*Advances in Agronomy*.71,145-191.

MatusFJ.(2021)FinesiltandclaycontentisthemainfactordefiningmaximalCandNaccumulationsinsoils:ameta-analysis.*Sci Rep. Mar*19;11(1):6438.

Meier,E.A.,Thorburn,P.J.,Wegener,M.K.,&Basford,K.E.(2006).TheavailabilityofnitrogenfromsugarcanetrashoncontrastingsoilsinthewettropicsofNorthQueensland.*Nutrient Cycling in Agroecosystems*,75(13),101-114.

Mishra,P.,Sahoo,T.R.,Rahman,F.H.,Mohapatra,N.,Sahoo,P.K.,Mohapatra,R.K.,andMishra,S.N.(2020).EffectofDifferentMulchingonMoistureContentinSoil,WeedDynamicsandYieldofTomato(*Lycopersiconesculentum*L.)inPostFloodSituationinCoastalOdisha.*Journal of Experimental Agriculture International*.32-38.

Nadeu,E.,Gobin,A.,Fiener,P.,VanWesemael,B.,&VanOost,K.(2015).Modellingtheimpactofagriculturalmanagementonsoilcarbonstocksattheregionalscale:theroleoflateralfluxes.*Global Change Biology*,21(8),3181-3192.

Nosetto,M.D.,Jobbágy,E.G.,&Paruelo,J.M.(2006).Carbonsequestrationinsemi-aridrangelands:comparisonofPinusponderosaplantationsandgrazingexclusioninNWPatagonia.*Journal of Arid Environments*,67(1),142156.

Page,A.L.,Miller,R.H.&Keeney.D.R.(1982).Methodsofsoilanalysis.Part2:Chemicalandmicrobiologicalproperties.AmericanSocietyofAgronomy.Madison,WI.

Reeder,J.D., and Schuman,G.E.(2002).InfluenceoflivestockgrazingonCsequestrationinsemi-aridmixed-grassandshort-grassrangelands.*Environmental Pollution*,116(3),457-463.

Rivenshield,AandBassuk,N(2007).UsingOrganicAmendmentstoDecreaseBulkDensityandIncreaseMacroporosityinCompactedSoils.*Arboriculture and Urban Forestry*.33.

RusliLS,AbdullahR,YaacobJS,OsmanN.(2022)OrganicAmendmentsEffectsonNutrientUptake,SecondaryMetabolites,andAntioxidantPropertiesofMelastomamalabathricumL.*Plants (Basel)*.6;11(2):153.

Sadeghi,H.,&Raeini,M.G.N.(2016).CapabilityinvestigationofcarbonsequestrationinArtemisiaaucheriBioss.*International Journal of Environmental Science and Technology*,13(1),159-164.

Scharlemann,J.P.,Tanner,E.V.,Hiederer,R.,&Kapos,V.(2014).Globalsoilcarbon:understandingandmanagingthelargestterrestrialcarbonpool.*Carbon Management*,5(1),81-91.

Sharifi,M.,AandMohsenimanesh,A(2011).Soilmechanicalresistancemeasurementbyanuniquemulti-conetipshorizontalsensor.*Int. Agrophysics*.26.

Smith,P.(2004).Carbonsequestrationincroplands:thepotentialinEuropeandtheglobalcontext.*European Journal of Agronomy*,20(3),229-236.

Suman,A.,Singh,K.P.,Singh,P.,&Yadav,R.L.(2009).Carboninput,lossandstorageinsub-tropicalIndianInceptisolundermulti-ratooningsugarcane.*Soil and Tillage Research*,104(2),221-226.

Tominaga,T.T.,F.A.M.Cassaro,O.O.S.Bacchi,K.Reichardt,J.C.M.Oliveira,andTimm,L.C.(2002).Variabilityofsoilwatercontentandbulkdensityinasugarcanefield.*Soil Research*,40(4),604-614.

West,T.O., and Marland,G.(2002).Asynthesisofcarbonsequestration,carbonemissions,andnetcarbonfluxinagriculture:comparingtillagepracticesintheUnitedStates.*Agriculture, Ecosystems & Environment*,91(1-3),217-232.

Yadav,R.L.,Prasad,S.R.,Singh,R., and Srivastava,V.K.(1994).Recyclingsugarcanetrashtoconservesoilorganiccarbonforsustainingyieldsofsuccessiveratooncropsinsugarcane.*Bioresource Technology*,49(3),231-235.