Green manures in agriculture: A review

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Abstract
Restoration of soil fertility of arable land is a great challenge in the developing and populous countries like India. The country witnessed the benefits Green Revolution Technologies (GRTs) in boosting of grain yield and the after effect of GRTs during past few decades in terms of deterioration of soil fertility and land degradation, loss of soil flora and fauna, genetic erosion, ecological unbalance, yield plateauing and associated insecurity in livelihood of the farmers. Now maintenance of soil fertility and sustainability of agriculture production are of important concerns. Green manuring can play an important role in this regard as it showed versatile impacts like improvement of soil physico-chemical and biological properties and fertility, nutrient supply to succeeding crops, checking erosion and plant protection. The previous research activities on various aspects of green manures were reviewed here in favour of evergreen agriculture for the future.

Keywords: Land degradation, green manures, impacts, soil improvement, conservation, plant protection, yield, sustainability

Introduction
In India, land degradation is of basic accent in India to accomplish acceptable and sustainable agricultural systems. Out of total geographical area of the country (328.7 Mha), 304.9 Mha comprise the reporting areas are used with 264.5 Mha acclimated for agriculture, forestry, afforestation and added biomass production. According to the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP, 2004) about 146.8 Mha of area is base. Amidst altered sources and causes of coverage in degradation, adulterated agricultural practices may be of prime concern. In this context ample of the so-called Green Revolution Technologies (GRTs) may be remembered which added aliment atom resilience of agriculture in India, but accompanying brought an amount of albatross on agro-ecosystem by acerbic biodiversity and causing ecology pollution. GRTs resulted in boundless areas abasement by adopting inappropriate agricultural practices which has noticeably appeared as absolute and adverse impacts at present on the aliment and alimentation aegis of agricultural communities. The abnormal soil and crop management practices invited enormous soil erosion, which resulted in the accident of alluvium through the action of water and wind, and non-judicious use of water resources and waterlogging acquired soil salinization (Bhattacharya et al., 2015) [60]. Maheswarappa et al. (2011) [65] reported that the C-sustainability basis was top priority in 1960, and it adumbrated the minimum acceptance of off-farm as based on inputs and thereafter, by adopting GRTs from mid 1960s, the C-sustainability basis decreased. Agricultural activities and practices are amenable for area coverage in a many ways like growing crops in fragile and marginal angled lands without proper soil conservation measures, land clearing and deforestation, agricultural depression of soil nutrients loss estimated agricultural practices, assurance on chemical based nutrients, overgrazing, boundless irrigation, over drafting of groundwater and assurance on boundless use of bulb aegis chemicals.

Needs of green manuring
The present decline trend in crop production or its stagnation of crop yields in India is the accumulative after effect of abounding soil accompanying constraints. The documents of low crop yields are acceptance of inappropriate methods of soil management, across-the-board of the afire of crop residues, non-judicious adoption of agronomic practices (Florentin et al., 2011) [39] and asymmetric nutrients management. Further, depletion of soil organic matter, scant use of bio- and organic-fertilizer and poor management is as well amenable for lowering down crop yield per unit area of land (Martius et al., 2002; Salahin et al. 2013) [66, 88]. The depletion of soil organics amount with accretion agricultural practices are the aloft causes of low production of crops and depletion of soil abundance which may be advised as serious
threats to approaching sustainability of agriculture. Reduction in organic nutrients in soil leads to the abasement of soil water relationship and water accommodation and bargain organic assimilation capacity, lower cation exchange capacity. All these ultimately affects in the lower abasement of nutrients from mineralization of organic content (Bonini and Alves, 2010) [16]. Besides, intensive and accelerated agronomic practices promote huge organic depletion and keeping release of nutrient creating imbalance in soils afterwards bushing by manures or crop residues. The only solution is the appliance of organic manures and for accession of organic substances to the deficient soils is having the advantage of green manuring be accepted to consider. One feature that is accepted to abounding acceptable sustainable systems is the cartoon of abundance needs from organic rather than chemical fertilizer sources. Nitrogen is one of the nutrients a lot of important to crop growth, but is as well one of the lot of difficult to manage. Synthetic fertilizer N is calmly absent from the soil and crop system, with consistent economic and ecology costs. Moreover, organic C present in the soil enhances the dynamics of microbial action and improves soil fertility. The purposes green manuring may be ideal and it has able impacts versatile. In accession to accepted farming, added absorption is getting empiric during contest times to organic farming, which secures an ecologically cleaner and convalescent ambiance and it requires nutrient management through organic sources in which green manuring deserves added importance.

Green manuring crops
Green manuring is the action of agronomic practices and assimilation of legume and non-legume green plants into the soil either by adopting in-situ or the plants developed abroad and congenital into the soil for abundance improvement. The conveyance is acclimated in organic as able-bodied as in accepted agronomic practices as a source to enhance the superior ambit of the soil. Green admixture crops may be the plants of legume crops such as pigeon pea (Cajanus cajan), green gram (Vigna radiata), soybean (Glycine max), cowpea (Vigna unguiculata) or groundnut (Arachis hypogaea), cluster bean (Cyamopsis tetragonoloba); non-grain, aroma and beat legumes like sunn hemp (Crotalaria juncea), dhaincha (Sesbania species, S. aculeata), wild indigo (Tephrosia purpurea), black henna (Indigofera tinctoria), Barseem (Trifolium alexandrinum), broadbean (Vicia faba), white lupin (Lupinus albus), blue lupin (Lupinus angustifolius), yellow lupin (Lupinus luteus), common vetch (Vicia sativa), fenugreek (Trigonella foenumgraecum), candied clover (Mellilotus spp.), trefoil (Lotus spp.), black medic (Medicago lupulina), lucerne or alfalfa (Medicago sativa), subclover (Trifolium subterraneum), strawberry clover (T. fragiferum), Persian clover (Trifolium resupinatum), red clover (Trifolium pratense), white clover (Trifolium repens), Centosemia, Stylosanthes and Desmodium; abiding coarse multipurpose shrubs and copse acclimated for green leaf manuring, namely, Leucaena leucocephala (Subabul), Gliricidia spp., Cassia siamea (Kassod tree), Cassia auriculata, Derris indica, Azadirachta indica (neem), Cassia tora, Cassia accidentialis, Tephrosia candida, Dodonea viscosa, Hibiscus viscosa, Delonix elata, Delonix regia, Peltophorum ferrugenum, Cassia nigricans, Vitex negundo. Aswell close and subtopical grasses and weeds like Panicum maximum, Pennisetum purpureum, Tripsacum laxum, Adathoda vesica, Eichornia crassipes, Trinityhama portulacastrum, Ipomoea carnea, Calotropis gigantea can aftermath ample abundance of biomass and may be advised for green manuring. There are evidences of appliance non-legume crops and forages like agricultural rye (Secale cereale), oats (Avena sativa), barley (Hordeum vulgare), abiding ryegrass (Lolium perenne), Italian ryegrass (Lolium multiflorum), Westerwolds ryegrass (Lolium multiflorum), cocksfoot or orchard grass (Dactylis glomerata), altered Brassicas, namely, white alacrity (Sinapis alba), bristles turnips (Brassica rapa), beat abduction (Brassica napus), fodder reddish (Raphanus sativus), Phacelia (Phacelia tanacetifolia), buckwheat (Fagopyrum esculentum), chichory (Chichorum intybus) as green manures (Pieters, 1927; Palaniappa, 1994; Palaniappan and Annadurai, 1999) [82, 74, 59]. Dhaincha (Sesbania spp.), sunn hemp (Crotalaria juncea), berseem (Trifolium alexandrinum) and green gram (Vigna radiata) are the lot of frequently developed crops as green admixture legumes. Legumes accept a continued history of use as green admixture crops. High energy costs and adverse ecology impacts of fertilizer N accept led to renewed absorption in legumes for green manuring as an N antecedent for crops.

In India, green manuring had been broadly accomplished but in the endure few decades with the added burden for aliment production, attendance of altered aggressive and economic crops and availability of readily accessible low amount and high cost chemicals fertilizers, the absorption in green manuring had decreased. However, with access in soil problems, depletion of soil fertility and the public concern for abuse and conservation of energy, green manures accept afresh become important both to organic growers and low-input farmers practicing accepted agronomic practices (Kumar et al. 2014) [55]. Hence, there accept been renewed analysis during the endure two to three decades on green manures (Tiwari et al., 1980; Singh et al., 1992; Brar and Sidhu, 1995; Singh et al., 2007; Sinha et al., 2009; Roy and Kashem, 2014; Salahn et al., 2013; Dubey et al., 2015) [110, 99, 19, 97, 100, 85, 88, 35]. Altered advisers empiric assorted allowances of green manures which are presented as below.

Improvement of soil property and fertility enhancement
Different concrete properties of the soils are bigger by green manuring (Mac Rae and Mehuys, 1985) [63]. Pandey et al., 2008 [76] declared that green manuring helped to advance the physical and biochemical anatomy of the soil, prevented leaching losses of nutrients, added water holding capacity. The approved use of green manuring resulted in high organic matter reserves which added both soil physical and chemical properties if compared to controlled fields. In addition, usages of green manures amid crop sequences added the capability of nutrient recycling. Added soil qualities of able acreage reflected by higher crop yields (Egodawat et al., 2011) [57]. Some studies showed the abundant abeyant of green admixture for nutrient exchange to crops (Abediran et al., 2004) [2] and the advance of soil properties (Abediran et al., 2004; Shah et al., 2010; Ziblim et al., 2013; Carvalho et al., 2015) [2, 91, 117, 27]. Amongst the legume breed acclimated for green admixture in close regions, the Canavalia was one of the lot of favorable plants for agronomical use by their morphological and physiological characteristics (Heinrichs et al., 2002) [46], while Crotalaria was actual able as ambassador of dry accession (Ziblim et al., 2013) [117]. Mucuna appeared as another legume crop which had an abeyant for soil restoration, convalescent the morphological and physical of the properties of soil (Alvarenga et al., 1995) [6] As an important biological property, soil microbial biomass is advised as an ecological aspect to appraise changes in
properties of soil use and management (Lopes et al., 2010; Santos et al., 2012) [62, 87]. In addition, soil microbial biomass appear enzymes which played important functions in soil processes, such as the atomization of organic nutrients as declared by Silva et al. (2012) [90]. Thus, soil agitator action ability is to be accustomed as an indicator of soil superior due to its ascendancy on microbial advance (Burns et al., 2013) [24]. Soil microbial biomass is an acute indicator of soil and responds apprenticed to changes occurred in soil management. Several studies appear that soil microbial biomass bigger decidedly by appliance of legumes as green admixture (Biederbeck et al., 2005; Liu et al., 2006; Shah et al., 2010) [32, 61, 91].

It was acclaimed that the appliance of green manures to soil stimulated soil microbial advance activities as evident from earlier researchers, with consecutive mineralization of plant nutrients (Eriksen, 2005) [38], and accordingly added soil abundance and superior (Doran et al., 1988) [34]. Considering the microbiological action of the soil it may be mentioned that green admixture provides nutrients affluent in organic carbon for the microbial biomass which converts balf nutrients in bulb residues to accessible for the crops and it enhances assortment of soil micro-organisms. Leguminous green manures can fix ample abundance of atmospheric N2 and accommodate advantageous amounts of organic nutrient in soil. Non-leguminous green manures alone can access the organic nutrient in soil (Tejada et al., 2008) [105]. These absolute findings on soil microbial populations could be added by considering altered green admixture crops in agricultural system. Green manures and added organic matters (OM) amendments were acclimated to advance soil lith and abundance back aboriginal times (Mac Rae and Mehuys, 1985) [63]. Access in benign microbial action is about accompanying to access in organic matters (Sikora and Stott, 1996) [101]. Organic matter is basic as a aliment antecedent and acclimatized for benign microorganisms that are accompanying to ache suppression, advance in soil properties and crops (Schutter and Dick, 2001) [90]. The use of green manures in amid alternating crops helped to advance or access organic matters in soils (Pung et al., 2004) [84]. Atomization of green manures serves aloft functions for microflora by accouterment action for their advance and food C for accession of new corpuscle actual to soil-biota which arrive saprophytic ally on the decomposing litter. An alternation of biochemical changes takes abode which ultimately advance to the description of assorted compounds during atomization process. The nutrients appear by decomposers are congenital into the soil which advance the cachet of soil nutrients and recycled into the active animal (Kumar et al., 2014) [55]. Atomization is an action of abundant acceptance which changes the management and citizenry dynamics of soil micro-organisms (Akpor et al., 2006) [5]. The micro-organisms abide in the soil as continued as there is a carbon antecedent for energy. Soil inhabiting microorganisms are actual analytical for decomposing organic residues and recycling soil nutrients. The accession of green admixture or added organic amount helps in the access of microbial biomass. The microbial caliber is an indicator of availability of organic C for soil bacillus (Anderson and Domsch, 1989; Steiner et al., 2008) [7, 103]. Soil management practices which adapt the soil microbial biomass aswell affect the agitator activities (Dick et al., 1996) [33]. The Fluorescein diacetate (FDA) hydrolysis is a non proportional to the microbial advance and is complex in the transformation of soil organic nutrients

(Sicardi et al., 2004) [95]. Also, FDA hydrolysis is an acceptable indicator of soil microbial action and reflects the action of several enzymes, including lipases, esterase and proteases, and its action increases with soil microbial biomass (Schnurer and Rosswall, 1982) [89]. Carvalho et al., 2015 [27] showed that microbial metabolism was absolutely afflicted by Macuna and Canavalia, suggesting these legume breed ability access the soil microbial activity.

Green manures accepted as become important in accomplishing assembly sustainability as the organic matter is added to the soil by agricultural of green admixture crops and their incorporation. Previous studies had apparent the absolute after effect of green admixture on soil properties (Astier et al., 2006; Partey et al., 2014) [8, 81]. The nutrients are taken up by the green crops and captivated central the plant. Green manuring if done with legumes, atmospheric nitrogen is trapped from the air which adds to the soil and it is benign for accessory of soil fertility. The allowances green manuring is about interpreted as its accommodation to aftermath or accommodates nitrogen as acting for fertilizers. Green manures, decidedly the legumes accept almost added N than non-legumes with low C-N ratio (Bhuiyan and Zaman, 1996) [11]. These crops during atomization abscission nutrients and absorb in recycling the nitrogen, phosphorus and potassium in chip bulb nutrients arrangement (Palaniappan, 1994; Goyal et al., 1999; Sharma and Ghosh, 2000; Yadav et al., 2000; Singh et al., 2007; Kumar et al., 2014) [74, 493, 116, 97, 55]. Green manures added soil abundance in altered agricultural arrangement as empiric by altered advisers (Cavigelli and Thien, 2003) [28].

The findings of cowpea green manures on crop and sulphur uptake, management and appliance in Brassica campestris var. toria cv. TL-15 were advised (Dhillon and Dhillon, 1991) [32]. They begin that the green manuring with cowpea has added crop and sulphur uptake in toria. Contribution of altered green manures to phosphorus diet of rice was advised by Hundal et al. (1992) [48]. Sinha et al. (2009) [100] advised abscission of nutrients viz., Nitrogen, Phosphorus and Potassium apprenticed in clutter of decomposing green admixture crop Crotalaria juncea L. in affiliation to altered acute factors. Franzluebbers et al. (1994) [61] advised C and N mineralization kinetics during atomization of cowpea (Vigna unguiculata L.) to optimize management practices of green admixture agricultural systems. Brar and Sidhu (1997) [20] advised the aftereffect of soil water on arrangement of abscission of NH4-N and NO3-N during atomization of added green admixture balance in the class conditions. They appropriate that NH4-N accession added decidedly with abatement in soil water but the abscission of NO3-N decreased. Magid et al. (2001) [64] appear that nitrogen mineralization at low temperature during their studies on the atomization of green manures, viz., Medicago lupulina, Melilotus alba and Poa pratensis.

Green admixture crops accommodate a cogent access in the N accumulation for the afterwards crop (Talgre et al., 2009) [104]. The atomization of green admixture crop dhaincha (Sesbania aculeata L.) in the soil at delicious date adds 60-90 kg per ha nitrogen (Pandey et al., 2008) [76]. Altered advisers empiric the aftereffect of green manuring on abundance accession of rice (Sharma and Das, 1994) [92], sugarcane (Jayapaul et al. 2000; Bokhtiar et al. 2003) [49, 15] and rice-wheat agricultural arrangement (Kumar and Prasad, 2008) [50]. Salahin et al. (2013) [88] showed that green admixture crops like Sesbania aculeata, Mimosa invisa, Vigna radiata provided a cogent antecedent of absolute N, P, K, S, Zn, B, Ca, Mg, Cu and Fe.
to the consecutive crops and the recycled comestible was decidedy assortd amidst altered crops. These crops may enhance P diet of afterwards crops via an amount of mechanisms. They may catechumen almost bald built-in and balance fertilizer P to actinic forms added accessible to afterwards crops (Russell, 1973; Gardner et al., 1982; Braun and Helmeke, 1995) [86, 42, 21]. On decomposition, organic P in green admixture tissues could accommodate an almost labile anatomy of P to afterwards crops, appropriately accoutrement added of mineralize able soil organic P to supplement acid asleep P pools (Tiessen et al., 1994) [108]. Smith and Doran (1996) [102] appropriate that soil absolute organic carbon (TOC), accessible P, changeable K and soil pH are important attributes of soil superior because they accommodate indicators of soil comestible bartering capacity. Atomization processes are angry if green admixture residues are congenital into the soil can added access P availability by absorption CO₂, which forms H₂CO₃ in the soil solution, consistent in the dissolution of primary P-containing minerals (Tisdale et al., 1985) [109]. Also, organic acids appear during atomization may advice deliquesce soil mineral P (Sharpley and Smith, 1989) [94]. In soils with top P-fixing capacities, organic compounds appear during atomization processes may access P availability by blocking P-adsorption sites (Eastwood and Sartain, 1990) [36] or via anion barter (Kafkafi et al., 1988) [51]. Some amino acids, however, can access P adsorption by soil (Kafkafi et al., 1988) [51]. Repeated assimilation of green manures can aswell aftereffect in decreased soil aggregate body and added soil accession and damp assimilation and these factors that advices access P uptake by afterwards crops (Mac Rae and Mheuys, 1985) [63]. Adding crop residues to soil can access soil analysis P (Bumaya and Naylor, 1988; Li et al., 1990) [23, 60], access Po (Dalal, 1979) [30] and access P uptake by afterwards plants (Dalal, 1979; Thibaude et al., 1988) [30, 106] and abatement soil P sorption (Singh and Jones, 1976; Bumaya and Naylor, 1988) [98, 23]. However, P availability does not consistently access afterward green admixture assimilation (McLaughlin and Alston, 1986; Groffman et al., 1987; Bumaya and Naylor, 1988) [67, 45, 23] back the soil microbial biomass and soil sorption processes attempt for accessible P (White and Ayoub, 1983) [114]. Increases in soil P abundance afterward green manures may be difficult to ascertain back accepted soil P tests do not appraise readily mineralize able P (Campbell et al., 1984; Tiessen et al., 1994) [25, 108].

Prevention of nutrient loss and soil erosion
Under rainfed and dryland altitude fallowness is actual accepted during post-monsoon aeron and the bald soils are declared to a base by assorted acute agents like baking sunlight, top temperature and abortive torrential rain. Green admixture and awning crops anticipate nutrients getting done out of the soil as the top soil is covered by the canopy. Acceptable agronomical abundance can be accomplished through the concepts of able ability absorption and acreage management. Larson and Pierce (1996) [58] appear that the agreeable of organic amount in the soil is one of the attributes of abundance of the acreage that has a aloft access on the abundance of the land. Assimilation of green manures may accommodate added allowances such as abridgement of soil erosion, absorption of soil water, bigger assimilation of added crop nutrients, and with beneath assurance on off-farm actinic inputs (Bugg et al., 1991) [22]. Further, the amount of soil awning in the boiling and sub-humid tropics with top condensate and abundant slopes is huge, because the bearings are acclimatized for soil erosion. The acreage if remained bald is declared to face hitting by rain drops which may be able to cause soil particles to be dislodged. These soil particles are transported decline in water breeze and appropriately soil abrasion is occurred. But covered soil is beneath accessible to water (Florentin et al., 2011) [99].

Amelioration of problem soil
Soil alteration is capital to actual the problems of the soil to accomplish it accessible agricultural as able-bodied as for acceptable agriculture. Sodic soils are poor in organic carbon and added organic carbon and admixture are depleted if soil is larboard fallow. Green manuring in sodic soil is awful benign as it replaces the fallowness, adds organic amount into the soil, and appropriately increases abundance (Khun et al., 2000) [53]. Baig and Zia (2006) [9] appear that Sesbania green manuring decidedly bigger acid and saline-sodic soils by ameliorating the concrete and actinic backdrop of the soil. They mentioned that green manuring is advantageous for abbreviation salinity levels. Vakeesan et al. (2008) [111] declared that partially addle tamarind (Tamarindus indicus) leaves able for affirmation of soil salinity in the littoral regions of Srilanka. Getting hardly acerb in nature, tamarind leaves created a favourable ambiance for soil microbes. They added mentioned that green manuring of Pavetta indica, Thespesia, Azadirachta indica and sun hemp were as well able adjoins salinity. For affirmation of acid soil backup of the sodium ions with calcium ions is essential. Access in the abundance of bulb tissues in problems soil facilitates accelerated assembly of CO₂ and enhances the acid calcium cachet of soils. The availability of calcium ions, in turn, replaces the sodium ions, consistent in the advance of acid soils.

Efficient plant protection
Green manuring may be a benefaction to administer weeds, adverse soil-borne bacilli and bacilli and nematodes. Green manuring is advantageous in agreement of bulb aegis because it suppresses weeds (Blackshaw et al., 2001) [13] and enriches assortment as able-bodied as reduces the opportunities for weeds to become acclimatized to an accurate in agricultural system. Some green manures like clovers and rye as well bury specific allele-chemicals into the soil that arrest edger berry formation (Boydston and Hang, 1995) [17]. In the bald acreage weeds can abound fast, however, green manures awning the ground; analysis edger advance and appropriately abate the crop-weed antagonism for nutrients and accustomed resources. Green manuring has an absolute appose in managing soil-borne diseases as acclaimed by altered researchers. A lot of the soil-borne rhizome bacilli reside in the rhizosphere and can survive for continued periods in soil and these diseases to crops and ultimately amenable for crop loss. Green admixture reduces the ache accident acquired by several soil borne rhizome pathogens. Management of soil borne fungal diseases through green manuring has been appear by altered advisers (Abawi and Widmer., 2000; Conklin et al., 2002; Pung et al., 2004; Janvier et al., 2007; Larkin and Griffin, 2007) [1, 29, 84, 50, 57]. Papavizas and Davey (1960) [80] acclaimed bargain accident of Rhizoctonia ache in bean by the atomization of green bulb abstracts and it was due to the aftereffect of accelerated advance of associated microflora. Pung et al. (2004) [84] reports that that the soil-borne fungi Sclerotinia spp. was auspiciously managed by Brassica green admixture crops. They appropriate that Brassica green admixture crops
produced altered bio-fumigant isothiocyanates in fact which minimized the inoculum body of the pathogen. The crucifers’ green admixture crops accommodate glucosinolates that inhibits the fungal citizenry as appear by Lazzeri and Manici (2001) [59]. Blum and Kabana (2004) [14] recorded inferior achievement of Sclerotium rolfsii in agreement of germination, advance and reproduction afterwards alteration with bulb locations of kudzu, clover bean, and pine-bark forth with benzaldehyde in soybean and Tomato. The aftereffect of green manuring with Sesbania aculeata L. on three abeyant soil borne bulb bacilli viz., Rhizoctonia solani, Sclerotium rolfsii and Sclerotinia sclerotiorum was advised Kumar (2010) [54] and he recorded cogent abridgement in mycelial advance and sclerotia assembly of these soil borne pathogens. Ochiai et al. (2007) [72] advised green manuring findings on soil superior in affiliation to abolishment of Verticillium become of potato; they congenital three green admixture crops, namely winter pea (Pisum sativum L.), broccoli (Brassica oleracea L.) and Sudan grass (Sorghum vulgare) at altered rates. They acclaimed bargain inoculum body and become severity. Beforehand Davis et al. (1996) [31] as well recorded absolute appose of green manures crops like pea, broccoli, Sudan grass, barley and blah to abate the severity of Verticillium become in potato. Further, Larkin and Griffin (2007) [57] mentioned that Brassica crops including canola, rapeseed, radish, turnip, chicken mustard, and Indian alacrity as green manures bargain the diseases of potato acquired by soil-borne pathogens. Similarly green manuring with sunnhemp (Crotalaria juncea L.) was acclaimed to abate the severity of soil-borne bacilli (Kamil et al., 2009) [52]. Scientists as well other workers stated that green manuring reduces the acme of bacterial diseases (Akiew et al., 1996) [4], Cardoso et al. (2006) [26] advised on admittance of apica; locations of pigeon pea (Cajanus cajan) and crotalaria (Crotalaria juncea) and empiric bargain infection of ammonia bacterial wilt. Wiggins and Kinkel (2005) [115] congenital buckwheat and canola as green manures in altered crop sequences, namely, alfalfa-potato, corn-potato and potato-potato. They acclaimed that accident of Verticillium become was under with cover crop in potato developed in buckwheat congenital soil in allegory to dormant controls. They added empiric that bargain accident of Verticillium become and band in consecutively agricultural of potato with above-mentioned crop as blah or alfalfa compared to potato-potato agricultural system. Management of accepted band of potato by green manuring was empiric by several advisers’ workers (Millard and Taylor, 1927; Weinhold et al., 1964) [68, 113].

Green admixture can access annoyance levels in an amount of means as it may be begin or adverse and the aftereffect of green manuring abundantly depends on the blazon of green admixture crops acquainted and the consecutive crops grown. The green admixture crops may act as a abode for altered predators like ladybird beetles, hoverflies, lacewing bugs and abject wasps which abate adverse insect citizenry but they can as well abutment citizenry accretion of pernicious pests by arena role as another host as acclaimed in case of wireworms or slugs. Green admixture crops like blood-soaked clover, Phacelia nacifolia and buckwheat were appear to act as attractants to predators if developed in affiliation with added crops (Bowie et al., 1995; Hickman and Watten, 1996; Tillman et al., 1999) [18, 47, 107]. O’Donnell and Coaker (1975) [71] appears green manuring bargain citizenry of banknote basis fly (Delia radicum) significantly. But added bang populations in consecutive crops were empiric as the aftereffect of a grass clover ley getting sown (Frank, 1998) [40].

Green admixture plays cogent role in managing adverse nematodes of agronomical crops (Mojtahedi et al., 1991; Agbenin, 2011) [69, 3]. Prot et al., (1992) [80] appear that green admixture crops like Sesbania rostrata and Aeschynomene afraspera controlled adverse nematodes, namely, Hirschmanniella mucronata and H. oryzae in rice. Assimilation of green blade manures viz., Thespesia populnea, Calotropis gigantia, Azadiracta indica, Gliricidia maculata and Glycosmis pentaphylla was acclaimed to abate Meloidogyne incognita in amazon (Pakeerathan et al., 2009; Wang et al., 2002) [73, 122]. Green manuring of Crotalaria spp. is as well caring in managing Meloidogyne javanica and Meloidogyne incognita (Germani and Plenchette, 2004) [43]. Combined appliance of admixture and three green admixture crops namely Italian ryegrass, white alacrity and fodder radish were evaluated adjoin nematode transmitted Tobacco bang virus (TRV) by Zoon et al. (2002) [118] and bargain infection amount was noted.

**Conclusion**

The human induced land degradation is actual woeful as adulterated agronomical practices created ample accident of soil fertility. Green manures can play a cardinal role as it has able impacts on physical, actinic and biological superior of the soil and appropriately apology of soil fertility. Green manuring not alone improves soil quality, but as well fixes atmospheric nitrogen in the soil if legumes are considered. By accouterment arena awning and replacing fallowness in beneath accelerated agricultural system, it checks soil erosion and nutrient loss. Amelioration of botheration soils is as well accessible by accumulation green foliage into the soil. Besides, green manuring is benign in managing weeds, diseases and insect pests. In conclusion, it may be declared that to attain beloved anarchy and agronomical sustainability, green manuring may be one of the lots of acceptable options for tropical and sub-tropical climates.

**References**


41. Franzluebbers K, Weaver RW, Joo ASR, Franzluebbers AJ. Carbon and nitrogen mineralization from cowpea


49. Jayapaul GGP, Duraisingh RR, Senthivel T, Joseph M. Influence of population and stage of incorporation of intercropped green manure (Dhaicincha) and nitrogen levels on yield and quality of sugarcane. Indian Sugar. 2000; 49(12):989-991.


58. Larson WE, Pierce FJ. Conservation and enhancement of soil quality, the soil quality concept, Edited by The Soil Quality Institute, United States Department of Agriculture and Natural Resources Conservation Service, 1996; 11-38.


74. Palaniappan SP. Green Manuring; Nutrient potential and management. In: Tandon, H.L.S. (Eds.) Fertilizers,
Organic manure, Recyclable waste and Biofertilizers, Fertilizer development and Consultation Organization, New Delhi, 1994.
78. Partey ST, Preziosi RF, Robson GD. Short-term interactive effects of biochar, green manure, and inorganic fertilizer on soil properties and agronomic characteristics of maize, Agric. Res. 2014; 3:128-136


