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The Importance of Agroforestry to Climate Change Matigation in Tropical Africa: Review

Running title: AFS Carbon Stock in Tropics

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Abstract :- The main crucial agroforestry systems (AFS) of tropics Africa are homestead, woody species planting and multistory dwelling and spread the woody plants. The traditional AFS interaction important for shading like Coffee, improve soil fertility, climate regulation, alternative income source, and reducing the pressure on natural forests. These systems' have important to ecological health and human wellbeing. This review was aimed at the capacity of AFS for the reduction of GHGs from the atmosphere and climate change mitigating the in tropical Africa. The AFS has been significantly sequestered of CO_2 and reduce GHGs sink from the atmosphere. Several research reports were recognized as AFS has been substantially carbon-capturing from the atmosphere compared to the mono-crops, dry woodlands, and/or pasture land. The Tropical Africa region AFS has been estimated to 2.11 × 1091 Mg C yr^{-1} of aboveground biomass carbon. The multi-strata AFS has the highest(16-36 Mgt ha^{-1} yr^{-1}) carbon sequestration were reported, The soil organic carbon (SOC) stock of Fruit-coffee, coffee-enset and Enset system agroforestry systems were estimated 186.41 Mg ha^{-1}, 178.8 Mg ha^{-1} 177.8 Mg ha^{-1} in the at 0-60 cm depth in Tropical Africa, respectively. According to IPCC and several research results, nowadays AFS as part of a climate change mitigation strategy. The important tree management of farm land and grazing land strongly recommended as increased GHG emission reduction capacity of AFS in Tropics.

***Keywords**:- Agroforestry, Carbon, Sequestration Climate Change, Mitigation, Tropics.*

I. INTRODUCTION

Climate change is a worldwide problems that has already had an practical impact on species diversity and natural as well as made ecosystems.[1] According to IPCC,[2] report, the expectation of temperatures is rise range 1.10–6.40^{0}C at the end of the twenty-first century from 1980–1999 baselines. The tropical Africa region is a vastly susceptible continent in the world to climate change. In general, the temperatures of the region have been risen by 0.7°C throughout the 20s.[3] The Africa temperature rise is predicted with a range of 0.2°C per decade to more than 0.5° by low scenario and high scenario, respectively[3,4], while the rainfall distribution of tropical Africa region is sensitive to variability.

Climate change in the tropical Africa region is also linked to changes in the frequency and intensity of extreme events such as episodes of El Niño–Southern Oscillation (ENSO), that is, El Niño and La Niña.[5,6] Climate variability and extreme events have impacts on Ecosystems in Ethiopian.

The Ethiopia precipitation patterns are contributed to agriculture production especially crop, loss of livestock, natural resource degradation, and even famines in the past. According to the National Meteorological Agency (NMA)[7], Ethiopia has known ten and elven wet and dry years over the last 55 years respectively, it has indicative of strong inter-annual variability. Between 1951 and 2006, the annual minimum temperature in Ethiopia increased by about 0.37°C every 6 decades that is 0.3 ^{0}c high lands and 0.4 ^{0}c low lands. However, the outcome of the IPCC mid-range release scenario shows that compared the 1961-1990 average, the average yearly temperature throughout the country will rise by ranging 0.90 to 1.1^{0}c in the year the 2030s and with ranging 1.70 to 2.1 90 ^{0}c in the year 2050s.

Afforestation and reafforestation activities have the potential to change 25% reduction of atmospheric CO_2 by carbon capturing and also assisted in adaptations and sustainable development.[8] Agroforestry are considering as exceptional consign to REDD+ and NAMAs strategies and also recogzied GHGs emission reductions capacity well as conserve the biodiversity and enhance livelihood benefits in different contries. Agroforestry systems have capacity to reduce the outward flux of CO_2 and mitigation studies were identified as the capacity of agroforestry systems (AFS) to have long term greenhouse gas (GHG) capturing.[9] it has been welle acknowledged as having the greatest possible for sequestration rate of carbon from atmosphere with all the land uses analyzed in the Land-Use, Land-Use Change, and Forestry report of the IPCC.[10] The integration of woody plants on farmland or pastures can raise the quantity of carbon sequestered, which has a substantial total biomass carbon stored with relative to a single crop plant or pasture lands.[11,12]

For these reasons, AFS has often more fruitful, taking up a huge quantity of CO_2 from the atmosphere and stoking the carbon in live vegetation biomass, organic matter of soil, and harvested wood products.[13] Now day AFS is expected to be experienced on 1000 to1023 Mg C ha^{-1} worldwide and to sequester from 30.0 to 322 CPgyr.[14,15] This review paper aimed to assess the AFS capacity of environmental services and mitigation reduction capacity in tropical Africa and Ethiopia.

In many African countries sustainability of agricultural and environmental is contextualized in REDD+ policies. For example in Ethiopia, agricultural systems front a serious threat to the sustainability of the environment and highly contribute to the country's GHG emissions. Hence REDD+ is anticipated to help reverse this trend.[10] Most time land-use competition, land tenure forest resources, continuous population growth, and rudimentary farming techniques are significantly affected forest resources in Ethiopia.[16] To maintain those problems, established agroforestry can aid to decrease demands on remains of natural forests from deforestation and to enhance the soil.[17] The African countries emphasized that agroforestry comes with a "triple win" of climate change mitigation, agricultural adaptation, and increased productivity as does REDD+ and also enhance to economical benefits through carbon funding to support the forestry development in the region.

II. DISCUSSION

A. Concept of Agroforestry

The Concept of Agroforestry is a land-use system that integrates trees (woody perennials), crops, people, and/or animals on the same piece of land to get higher productivity, larger financial income, and more social benefits on a sustained basis.[18] According to Nair,[19] AFs generally were categorized into three mainly as agrisilvicultural, silvopastoral, and agrosilvopastoral. The familiar conventional agroforestry practices (AFP) in the tropical region are scattered trees on crop fields, homestead tree planting and multistory home garden.[19] The Global Agroforestry systems land cover was presented (Figure 1). The agrisilvicultural with spatial diverse arrangement in Ethiopia, the explained AFP of which is largely implemented for soil richness replenishing purpose for degraded soil. According to Ashagre, [20], and Bekele,[21] also described the common AFP in various parts of the region as coffee shade based sprinkled woody plant on the cropland, homestead, pieces of a land plantation, border of plantation practices, and woody plant on pasture lands.

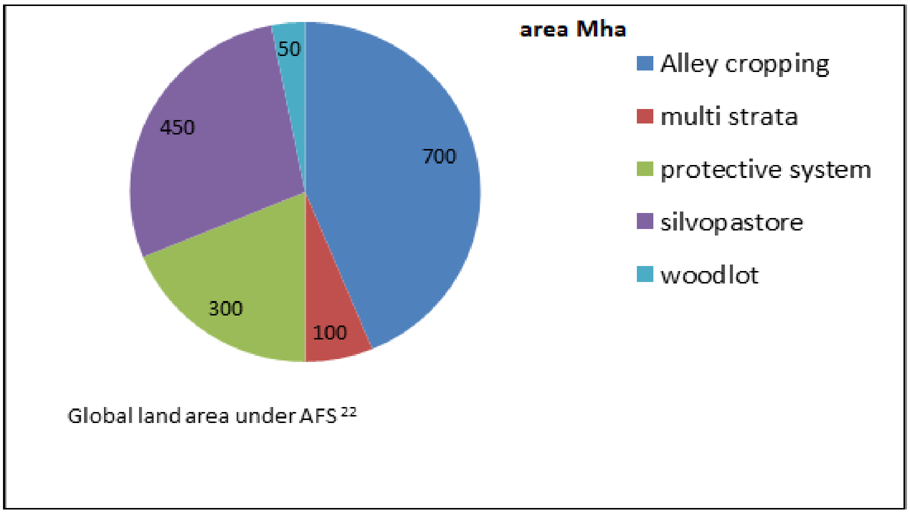

Fig 1:- common AFS land cover in the world

B. Major Agroforestry Practices in Tropical Africa

The agroforestry concept in Tropical Africa is not new. This is a very old practice whereby in the smallholder farmers maintain various woody plants on croplands. The major tropical agroforestry practices are Alley cropping (hedgerow intercropping), homestead, boundary planting, Improved fallow fast-growing, versatile woody plants on farms land and grazing land, Silvopasture, Grazing systems, Cut and carry system (protein banks), Shaded perennial–crop systems, Shelterbelts and windbreaks, and Taungya.[22]

The parkland and home gardens are the well-accepted AFS in most parts of the tropical region especially Africa (ex. Ethiopia, Kenya...). It was reported by.[23] Additionally, nine types of Profitable AFPs for ecological and socio-economic services were identified in various parts of Ethiopia. These are banana-based multi-story gardens, teff, and acacia system integrated, boundary eucalyptus and cereal crops, conservation-based vertically and horizontally packed agroforestry, multi-strata perennial crop, enset-coffee-tree-spice-based, fruit trees-bamboo combined with enset-vegetable farming and bamboo combined with cereal farming agroforestry.[24] The area coverage and production of the three cash crops Fruit, coffee, and khat in Ethiopia in 2010/ 11 were presented (Table 1).

The main Cash crop AFS are coffee, khat, and fruit-based systems in the country. According to FAO (2009), the coffee-based system is occupying over 9.80 million ha of land worldwide. Ethiopia has four coffee production systems of AFS such as forest coffee, semi forest coffee, garden coffee, and plantation coffee.[25]

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Cash Crops	**No. farmers**	**Area of cultivation**		**Production**	
		Area (ha)	**Sharing (%)**	**Ton**	**Share (%)**
Fruit	2658415	51,078	9	403459	45.6
Khat	2068262	214112.19	37	244641.96	27.1
Coffee	3049120	313608.98	54	253038.38	28.3
Total	7775797	578799.17	100	901139.34	100

Table 1: area coverage and production of the three cash crops Fruit, coffee and khat, 2010/ 11 in Ethiopia
Source: Woldu, *et al.*, [15]

C. Agroforestry for ecosystem services

Ecosystem services are defined in the different aspects, including "the benefits human populations derive, directly or indirectly, from ecosystem functions".[27] According to the millennium ecosystem assessment (MA,)[28] a worldwide program set up in 1999 to evaluate how ecosystem change would affect human well-being. The communities are benefited from the ecosystem in the form of supporting services, provisioning services, regulating services, and cultural services. The benefits community gain from ecosystems through religious enrichment, cognitive development, education, recreation, and aesthetic experiences.

Agroforestry systems can be contributed to environment function: Humans have always depended on the natural world for ecological assets like freshwater, nutrient cycling, and soil formation. Simultaneously reducing greenhouse gas concentration by sequestration of CO_2.[29] The systems have been understood as one of the incorporated forest and soil resource management interventions for addressing a variety of ecological and community challenges. The integration of woody plants, cash crops, and field crops and/or livestock into an AFS has the likelihood to improve soil productiveness, decrease soil degradation, maintain the water cycle, enrich biodiversity, increase the aesthetics and storage of carbon. The Agroforestry practices benefit in the special and temporal scales were shown (Table 2).

According to Sileshi *et al.*,[30] agroforestry practices in southern and east Africa revised results were provided three categorical services. A. *Provisioning services* such as genetic resources, food, basis of power, and feed, e.g. Over 80% of the rural society in southern Africa also depends on therapeutic plants for most of their health needs. B. *regulatory services* including microclimate stabilization, regulation of flood, alleviation of desertification, carbon sequestration and pest control, and C. *supporting services* namely, soil fertility enhancement, biodiversity maintenance, and pollination in the miombo eco-region.

Agroforestry has a great role to mitigate climate change and different sources of income in developing countries, especially during the mechanisms for accounting and compensating for carbon sequestered in agroforestry become widely available to the small-scale farmers.[31, 32, 33,34]

Ecosystem Services	**Special Scale**		
	Farmer/ Local Level	**Landscape/Regional Level**	**In the world**
Production of Net Primarily			
Control of Pest			
Pollination/Seed Dispersal			
Soil Improvement			
Soil Stabilization/ Control of Erosion			
Maintain hydrology And Air cycle			
Regulation of Flood			
Carbon Sequestration rate			
Genetic resource conservation			
Aesthetics/Cultural			

Table 2:- Agroforestry practices benefit in the special and temporal scales
Source: Jose, [35]

III. AGROFORESTRY AND CLIMATE CHANGE MITIGATION

Tropical agriculture systems vulnerable to climate change in Tropical regions, which are subsistence agriculture is substantially vulnerable to climate variability and/or change, as smallholder farmers do not have adequate resources to adapt to climate change. While AFS are recognized REDD+ strategy that has a great play of substantial function in mitigating climate change through the reduction of GHG from the atmosphere this is also contributing to play in serving human being adapt to climate change.[36]

Agroforestry is practicing annual and perennial plants and also included with livestock. The climate elements (temperature, relative humidity, and ambient CO_2) concentration affect all organisms involved in an AFS, possibly in very different ways, and climate change is projected to alter all of these factors. Climate change mitigation, woody plant-based farming systems are at present being encouraged in many parts of developing regions including tropical Africa.37 Trees management based agroforestry systems have a substantial play in the reduction of GHG concentration from the atmosphere and also direct targets of Reduced Emissions from Deforestation and Forest Degradation (REDD+) programs.

❖ *Carbon Sequestration rate capacity of Agro-forestry systems*

The sequestration rate of carbon is the subtraction of additional carbon from the atmosphere and depositing it in another reservoir principally through the change in land use (IPCC, 2000, Mandal *et.al*, 2005). And also state that sequestration rate of carbon as the progression of taking away carbon from the ambiance and then put into storage in plant. It entails the relocate of atmospheric CO_2, and its locked stock in long time storages. From the plant growth of view, it initial processes the uptake of the source of CO_2 throughout photosynthesis and also shifts of the permanent carbon accumulation into aboveground biomass, and soil carbon pools for protected (i.e. long-term) stock. Different studies are encouraging widely implemented AFS as a strategy of carbon sequestration rate that is focused on carbon-rich multistory AFS in the moist tropical forest.[38,39] Though drylands tropics have a shortage of information on the capacity of carbon sequestration [38] and also in meticulous about AFS carbon sequestration rate in sub-Saharan Africa[40] and Eastern Zambia.[41]

The agroforestry system offer opportunities for the creation mitigation that have the potential of carbon accumulation from 391,000 Mg C yr^{-1} by 2010 to 586,000 Mg C yr^{-1} 630 million ha of marginal crop and grasslands could be converted to AFS by 2040 in the tropics.[35] Estimation of the capacity of sequestration rate of carbon from aboveground biomass to be 2.1×10^9 Mg C yr-1 from AFS in tropics,[42] as well as agroforestry systems, were practiced by individual farmers have potential to C sequestration rate ranged from 1.50 to 3.50 Mg C ha-1 yr-1 in the tropics.[43] However, the net carbon balance in all carbon pools varies based on the kind of AFS, with reported C changing from a range of 0.31 up to 7.71 Mg C ha^{-1} y^{-1} in biomass and 1.01 up to 7.40 Mg C ha^{-1} y^{-1} in soil.[45] It has indirect that effect of systems structure, composition, and management on carbon-capturing ability in each component.

Agroforestry systems are an alternative of resource to reducing natural forests overutilization and also it is one of the largest sinks of terrestrial carbon, enhance carbon storage in woody (tree) and soil. However, estimating the carbon sink capacity of AFS in the drylands is important for carbon accounting purposes. Due to low vegetation growing and cover, naturally, poor soil C levels and then these areas have poor carbon storage performance.[29] However, these dryland areas transformed into agroforestry land use seem to possess a massive capacity to capture carbon from the ambiance. Moreover, the scope to which woody plans uncultivated land-use systems like as woodlots as rotational practices, decreasing illegal cutting pressure of the conserved natural grower forests in semiarid regions and thereby counterbalance CO_2 emissions has been minimally investigated.

A. Biomass Carbon Stock Potential of Agroforestry Systems

According to the Kyoto protocol, according to the action of afforestation and reforestation (A & R), AFS was accepted as one of action and it is paying attention to special recognition as a C sequestration policy. This recognition was the reason for the growing structure that accumulating the highest amount of aboveground biomass (AGB) and root development process of the woody plant in the AFS. So far, several types of research outputs were indicated AFS under different ecological regions have C sequestration potential become obtainable since the mid-1990s starting. Most of these available reports on biomass carbon sequestration rates and stocks in tropics were presented (table 3). In AFS are estimates of carbon stocks in above ground biomass- and belowground(root biomass plus soil) compartments, quantified amount of carbon is, or potentially could be, capturing and preserves AFS under different ecological situations and management. The estimates ranging from 0.29 up to 15.210 Mg C ha^{-1} yr^{-1}.[31] The Cocoa-based agroforestry systems are recognized for storing a substantial quantity of carbon in the systems.[33] For this reason, it has possible to mitigate climate change. Besides, shaded agroforestry systems with perennial crops like coffee (*Coffea arabica* L.), rubber (*Hevea brasiliensis*) (Muell.-Arg.) could help to mitigate climate change and cocoa-may vary between 12 and 228 Mg C ha^{-1}.[22] Similarly, Negash & Starra[32] fruit-coffee, coffee-Enset and Enset systems of carbons stock vary within 22 and 122 Mg ha^{-1} in Refit valley Ethiopia.

Major Agroforestry systems of biomass carbon stock in the tropical regions have in a locked large quantity of carbon, and their reduction capacity of CO_2 through improved by changing appropriate woody plant and annual crop species in presented AFS.[46]

AF System	Sub systems	Location	Mg C ha -1	citation
Multi strata	Inga-coffee, pines-coffee, coffee	Humid tropics	60.6,124 &107	Lenka *et al*., [47]
Multi strata	Home garden	Tropics	101-126	
Silvopasture	Browsing system	Sami tropics	6.55 yr	Shreshtha & Alavalupati[12]
Woodlot	Fodder (acacia. Spp.)	Tropics	180	
Parkland	*Faidherbia albida*	West African Sahel	54	Takimoto[40]
Parkland	*Vitellaria paradoxa*	West African Sahel	22.4	Takimoto[40]
Live fence	*Acacia nilotica*	West African Sahel	8.3	Takimoto[40]
Fodder bank	*Gliricidia sepium*	West African Sahel	4.1	Takimoto[40]

Table 3:- Mean Biomass carbon stock potential Agroforestry systems in some tropical regions.
Source: Nair *et al*., [22]

Many factors are affecting biomass carbon accumulation, including the species growing nature, land suitability, age, application and type of managing carry out and their interface within the woody plant and cash crops of the understory in an AFS.[5] The total (above + below ground) biomass carbon stock in the specific country was indicated (Table 4). The highest of 239 MgCha $^{-1}$ from the woodlot, followed by 123 Mg C ha $^{-1}$ in Alley cropping and 77 Mg C ha $^{-1}$ in the multi strata systems total biomass carbon stocks were reported by Bajigo *et al.*,[48] Makumba, 2006 and Negash & Starra,[32] in Ethiopia, Malawi, and Ethiopia, respectively.

AF System	Subsystems	Country	Mg C ha $^{-1}$	Citation
Woodlots	*L. leucocephala species.*	Zambia	24.5 - 55.9 &74	Kaonga,[41]
Woodlots	*Fodder bank*	Mali (ST)	0.29 yr	Kumar *et al.*[49]
Woodlots	*Live fence*	Mail (T)	24	Kumar *et al.*[49]
Multi-strata	*Shade coffee system*	Togo	6.31/yr	Dossa *et al.*[50]
Multi-strata	*L. leucocephala + maize*	Nigeria (HLT)	13.6/yr	
Alley cropping	*Gliricidia sepium +maize*	Malawi(H& s hT)	123-149	Makumba,[51]
Woodlot	*Different acacia spp.*	Ethiopia	239.43	Bajigo *et al.*[48]
Multi-strata	*Fruit-coffee, Enset -coffee & Enset*	Ethiopia	77.4, 77.5 &46.	Negash & Starra,[32]
Multi-strata	*Home garden*	Ethiopia	24.83	Bajigo *et al.* [48]
Multi-strata	*Sami forest coffee*	Ethiopia	61.5	Denu *et al.* [52]

Table 4:- Mean biomass (above +below) carbon stock in humid tropics and tropical Africa countries including Ethiopia

B. Agroforestry systems and Soil Organic Carbon Stock

The soil is one of a large amount of carbon storage pool, it contains about 2,500 pg and it is four times a biotic pool (560 pg) and also it has three times higher than the full of atmospheric carbon concentration (760 pg).[53] The soil organic carbon content 58- 81% was taken up to 50cm depth. The recent studies reported a global SOC across all estimates of mean value 1460.50 Pg carbon, ranging within 504 to 3000 Pg C. [53] The soil C stock agroforestry varies based on systems 124.29, 160.42 and 84.69 Mg ha^{-1} on mixed multistory, taungay, and falcata-coffee multistory AFS respectively.[54] The different scholars, AFs Soil organic carbon stock reports were showed table 6. The soil organic carbon (SOC) stock was highest in Fruit-coffee agroforestry systems for 186.4 Mg ha^{-1}, followed by 178.8 t ha^{-1} in the coffee-enset, and 177.8 Mg ha^{-1} in the Enset system at 0-60 cm depth and the lowest amount of SOC stock was present 24 Mg ha $^{-1}$ in Live fence at 0-100 cm depth in Mali and land Agrisilviculture (*Gmelina arborea* +field crops) for 27 t ha -1 at 0-60 cm depth in central India.

The SOC amount varies based on the biomass input received from foliage, litterfall and on the recycling of fine roots.[55] The relation to the plant's carbon in the soil system recycling also influenced by available of organisms (macro and micro faunal activity), on litterfall quantity and rate of decomposition.[56] And also, climate and vegetation cover are influencing the spatial circulation of soil organic carbon, concordance with similar studies in the European countries.[57]

According to Garg Vk,[58] the carbon pool of soil depends on agroforestry practices that have been an increase by 2-3 Mg C ha^{-1}yr^{-1}. Moreover, carbon sequestration rates ranging from 16-36 Mgt ha-^{1} yr^{-1} were observed in the Tropical home gardens. The reports were shown, GHG mitigation potential of AF is 0.44- 1.89 MgCO_2-eq/ha/yr .[59]

AF systems	Countries	Depth (cm)	Soil C Mg/ha	Reference
Shade coffee	Togo	10	97.3	Dossa *et al*.,[50]
Mixed story, toungay & Falcata- coffee AFS	Philips	30	124.3, 160.4 & 84.7	Labata *et al.*,[54]
Home garden , Park land & woodlot	Ethiopia	0-30	61.57, 49.05 & 48.6	Bajigo *et al*.,[48]
Fruit –coffee, Enset-coffe & Enset	Ethiopia	0-60	178.8, 177.8 & 186.4	Negash & Starra,[32]
Live fence (A*cacia* spp. &*Ziziphus mauritania*). & Fodder bank	Mali	100	24 & 33.4	Takimoto *et al.*,[40]
Fodder plat +maize	Malawi	200	123-149	Makumba *et al*.,[51]
Leucaena leucocephala woodlots	Zambia	100	140	Kaonga,[41]
Leuceana leucocephala woodlots	Nigeria	0-10	13	

Table 5:- Mean Soil carbon stock in different soil depth in the different tropical countries

C. Tree species under agroforestry contribution to Carbon stock

Total ecosystem forest biomass and soil were shards more than 80% and 70 % of all terrestrial and all SOC carbon stores, respectively. In another way, the judicious land system and recommended agronomy practices also increase SOC stocks through another form of carbon pool[60] and Brady and Weil,[61] also trees can contribute substantially and more efficient in promoting to soil carbon sequestration. Manging trees that are integrated with grassland or pasture systems can be considerably increased carbon sequestration in the SOC content. According to several reports, the woody plant components of AFS are possible sinks from source carbon due to their fast growth and productivity, accumulation of high and long term biomass, and extensive root system. In another study, the agri-silviculture carbon sink was higher than 40% and 84% in mono-cropping of woody plants (tree) and provisions crops, respectively. It is representing that complex agroforestry practice has more capacity to carbon sequester rate from the atmosphere.[33,62,63] Considering the individual woody plants on the soil organic carbon as beneficial effects, the different arguments were indicated that increasing biomass production (above and below) depends on tree density, which could substantially influence of SOC storage through litterfall and fine root decomposition. Hence the high amount of biomass produced that would help increased total biomass production including litter and fine root activities and then trees are incorporating with cash crops is a vital issue for carbon sequestration rate in soil.[64]

The most appropriate land management systems for mitigating atmospheric CO_2 through established agroforestry, afforestation and reforestation have been suggested as woody plant-based practices and or systems in the tropical AFS.[43] The soil carbon sequestrations are significantly influenced by the litter biomass and fine root activities.[64] The quality litter biomass is higher sources of soil organic carbon stock and carbon sequestration rate through time.

The enormous quantity of root biomass carbon transfers from the root into the soil, so roots are a significant role in soil carbon balance. The below-ground biomass is a vital contribution to soil carbon sequestration through litterfall accumulation and decomposition rate, development of root, and turnover, root exudates (of organic substances). Additionally, it is influenced by rooting depth and then a substantial quantity of carbon is stored below the plow layer and better secluded from disturbance, which leads to longer dwelling times in the soil. Root carbon inputs can be substantial, although the amount declines sharply with soil depth, same reports were indicated that the rooting depths of some woody plants having greater than 60 m.[65] During photosynthesis around 50.0% of the fixed carbon is transported belowground and partitioned among root growth, rhizosphere respiration, and assimilation to soil organic matter.[66,67]

IV. FACTORS AFFECT AGROFORESTRY SYSTEMS CARBON STOCK

According to (example, Newaj & Dhyani,)[68] scholar report, the potential of agroforestry ecosystem carbon stocks are considerable varies across species and geographical location. Moreover, the quantity of C stock affected by the arrangement and purpose of various components of agroforestry within the systems put into practice. The other fact present reports have been argued AFS as a function of both the source and sink of carbon. There is also an obvious confirmation to suggest that the kind of AFS very much influences the source or sink role of the integration of woody plants. For example, agrisilvicultural systems where the woody plants incorporate in crop fields are net sinks while agro silvopastoral systems are possible sources of GHGs.[68] Besides, the unmanaged practices have significant emissions of GHGs which are Practices like the application of chemical fertilizers, manuring, frequent soil disturbances, tillage, and controlled burning. The other reports on intercropping of trees AFs reported an enhancement in SOC by greater than 50% due to leaf litter (Venkateswaralu,). The tree density, age, structure, and composition were influences of AFS storage of carbon potential in different components (biomass and soil). [5]

The carbon of Soil may preserved centuries to accumulate under normal circumstances, but it has significant direct and indirect effects related to human-induced land-use cover on soil organic carbon stocks by changing the equilibrium between carbon sequestration and carbon losses, which are extremely difficult to restore in the short term. Numerous researchers have discussed possible soil carbon changes with land use and management practices.[69,70]

V. SUMMERY

Agroforestry systems are the integration of woody plants growing with crop and tree with livestock production. The integration of trees with other land use has the highest capacity for a sequestration rate of carbon than grazing and field crops. The woody plant (trees) is incorporated in the crop field and pasture lands were indicated a total biomass and soil carbon sequestration rate. The establishment of well-managed agroforestry systems has substantially the role of reducing the external change of CO_2 and similarly importance of the significantly long term to GHG sink and mitigation. According to different reports, the Agroforestry system has been predictable as having the largest capacity for sequestration rate carbon than all other lands. The integration of woody plants on cropland or pasture areas can enlarge the quantity of carbon sequestered related to single crop field or grassland. Although some estimates of the so-called "C-sequestration potential" of AFS are obtainable, these are mostly predicting of storage of net carbon. According to different research reports, the estimation of biomass and soil carbon sequestrations as methodological difficulties under AFS are several confines in exploiting this cheapest environmental advantages of agroforestry. Now a day the financing or trading of carbon is quickly increasing in the world. So far, the Kyoto Protocol clean development mechanisms propose a smart economic opportunity for subsistence farmers the major practitioners of agroforestry in developing countries.

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