Journal of Environment and Earth Science www.iiste.org
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) DOI: 10.7176/JEES
Vol.9, No.4, 2019

Roles of Agroforesty on Climate Resilient Green Economy of Ethiopia: Review

Alefu Chinasho[1] Bobe Bedadi[2]
1.Wolaita Sodo University, Department of Environmental Science, P.O.Box 138, Wolaita Sodo, Ethiopia
2.College of Agriculture and Environmental Sciences, Haramaya University, Ethiopia

Abstract
Agriculture is the backbone of Ethiopian economy, which is both the cause for and the one at hardest hit to negative impacts of climate change. The country has annual greenhouse gas emission of 150 Mt CO 2 equivalents, of which 50 percent comes from agriculture sector. On the other hand, the real GDP growth of the country has been decreasing due to climate change. The county's sustainable development goals will not be achieved without the achievement of Climate Resilient Green Economy (CRGE) goals. Because, the aim of CRGE is to increase agricultural productivity, resilience to climate change, and reduce greenhouse gases emission, to become middle income country by 2025. Fortunately, agroforestry has the potentials to do this, even though little attention has been given to it. For instance, agroforestry enhances crop production by improving soil health, livestock production being as source of fodder, biodiversity conservation by having more biota than monoculture and habitat for wildlife, supplements staple food, fruits and hones are source of income, and reduces risks of climate change and other environmental problems. Keywords: Biodiversity, CRGE, Economy, Monoculture
DOI: 10.7176/JEES/9-4-03
Publication date: April 30th 2019

INTRODCTION

Agriculture is the mainstay of Ethiopian economy. It is both the cause and the one at the hardest hit to negative impacts of climate change. The country has annual greenhouse gas emission of 150 Mt CO_2 equivalents, of which 50 percent comes from agriculture sector (FAO, 2010; FAO, 2016). However, the emission will be increased in future years due to increased deforestation and land degradation caused by increased population growth, political instability, and climate change. For instance, the real GDP growth of the country has decreased from 10.4 percent in 2015 to 8 percent in 2016 (Yared et al., 2016; Sennoga et al., 2017; FAO, 2016), as a result of which more than 8.7 million are food insecure and need external food support (Gray and Muller, 2012; IPCC, 2014).

The county's sustainable development goals will not be achieved without the achievement of Climate Resilient Green Economy (CRGE) goals. Because, the aim of CRGE is to increase agricultural productivity, resilience to climate change, and reduce greenhouse gases emission, to become middle income country by 2025. Fortunately, agroforestry has the potentials to do this, even though little attention has been given to it. So, this review paper is needed to figure out the roles of agroforestry in the achievement of three pillars of CRGE so that policy makers, different sectors and non-governmental organizations can take actions to increase the number of adopters of agroforestry in Ethiopia. So, the country will obtain better development.

AGROFORESTRY

Agroforestry is a term used to express agriculture and forestry in combination. Its practices and systems are classified based on the way of application and components included, respectively. Agroforestry systems in Ethiopia are silvo-pastoral (scattered perennial plants on grazing land), agro-silvicultural (agricultural crops with scattered trees or shrubs) and agro-silvo-pastoral (if agricultural crops, perennial plants scattered in agricultural land, and livestock production, are included). Whereas, agroforestry practices of the country are home garden (around houses), live fences, alley cropping, planting at boundary lines, fodder plants windbreak, and planting trees at erosion control structures.

ROLES OF AGROFORESTRY ON CARBON SEQUESTRATION

The amount of carbon sequestered depends on the kind of agroforestry system applied (Prasad et al., 2012), which range from 0.29-15.21 Mg/ha/year (Nair et al., 2010). About 80 percent of the terrestrial carbon pool is in the soil (Srinivasarao *et al*., 2012), which is sequestered by a rate of 0.05 to 1.5 t/ha/year depending on climatic conditions (Lal, 2004; Lal, 2008). The carbon stored in soils under agroforestry is higher than that under annual crops. Because, the quantum of biomass addition to the soil is much higher in tree systems (Nair et al., 2010) and soil erosion hazard is lower in this system (EPA 2012). Likewise, the Coffee agroforestry systems of Ethiopia store four times more carbon stock than maize mono crop systems (Mesele 2013; Namirembe *et al*., 2015), and stores more than 50 percent of the aboveground biomass (Tadesse et al., 2014; Vanderhaegen et al. 2015).

Besides, leguminous trees enhance nitrogen fixation (Mehari, 2012) which improves soil nitrogen level by 231 kg N/ha/year (Franco and Balieiro, 2017). The fast growth and ease of sprouting after cuttings are two important characteristics for the selection of leguminous trees (FAO, 2010). Since soils of Ethiopia are nitrogen deficient (Tesfaye, 2005), legumes can be incorporated to improve its level (Gray and Muller, 2012) which is the most important indicators of organic matter quality (Mesele, 2013). Enhanced soil organic carbon content of soils results in improved nutrient supply to crops which is responsible for crop yield. All in all, agroforestry trees sequester atmospheric carbon dioxide during photosynthetic process and tied up the carbon. On the other hands, carbon sored in annual crops is emitted to atmosphere in the form of carbon dioxide during crop harvest.

ROLES OF AGROFORESTRY ON AGRICULTURAL PRODUCTIVITY

Increasing the SOC pool by one Mg C/ha/year can enhance agronomic production in developing countries by 32 and 11 million tons per year in case of cereals and food legumes, respectively (Lal, 2011; Srinivasarao et al., 2012). (Mulatu *et al.*, 1990). The coffee with *Desmodium intortum* yielded 5.2-19.2 percent more berries over the control plot (Lazier, 1987). Acacia tree foliage species (Mokoboki *et al*., 2005; Diriba et al., 2013), *Dichrostachys cinerea* fruits, *Combretum mole, Combretum Mopani*, *Ficus sycomorus* (Ezeagu, *et al*., 2002; Smith *et al*., 2005; Ogunbosoye and Babayemi, 2010), have adequate crude proteins to support the requirements of cattle, sheep and goats at low to medium production levels. So, agro-forestry systems have potentials to enhance crop and livestock productivity.

ROLES OF AGROFORESTRY ON BIODIVERSITY CONSERVATION

The plants composition (species richness), invertebrate species, arthropods, and birds are larger in silvopastoral agroforestry system than in open pasture land (McAdam, 1998; Crowe and McAdam, 1993; Dennis et al., 1996; McAdam, 1998). The enset-coffee home garden agroforestry has 120 species of trees and shrubs (Tesfaye 2005), which is more diverse than monocropping and pleasant to observe. Agroforestry trees serve as habitat for birds, used to hang beehives so that bees can be attracted and conserved, live fences at borders and windbreaks can be used as corridors for wildlife movement and reproduction, increase soil microorganisms by improving microclimate and soil health. So, agroforestry systems play great role in biodiversity conservation.

ROLES OF AGROFORESTRY ON RISK REDUCTION

Since agroforestry improves crop and livestock production, reduces soil erosion, supplements income source due to products like fruits and honey, it reduces risks to environment and farmers. Besides, it enhances resilience of farmers to climate variability and change ensuring food escurity (Méndez *et al*., 2010. For instance, in coffee agroforestry systems, crops grown under heavy shade (60-80%) were kept 2-3°C cooler during the hottest times of the day than crops under light shading (10-30%) (Lin, 2007) and lost 41% less water through soil evaporation and 32% less water through plant transpiration (Lin, 2010). Windbreaks reduce wind speeds by 80-95%, reducing wind damage up to two times the distance of windbreak height (Tamang *et al*., 2010). There are other naturally occurring co-benefits that occur in agroforestry systems including enhanced nutrient cycling, integrated pest management, and increased resistance to diseases, which will additionally protect farm production (Beer, 1998). Above all, agroforestry systems play a great role on the overall stability of the environment.

CONCLUSION

Agroforestry improves the resilience of agricultural production to climate variability and change using trees for intensification and diversification of faming systems. It helps to increase sustained yield and make a farm as solution to climate change rather than being part of the problem, which is basic requirement of CRGE. Agroforestry based production systems often produce crops of higher value than mono crops. Thus, diversifying the production system to include as significant tree component may buffer against income risk associated with climate variability. Generally, different sectors should work together to enhance the adoption of feasible agroforestry systems in small holder farmers of the country, so as to achieve the goals of CRGE at the end of the day.

REFERENCES

Beer, J., Muschler, R., Kass, D., Somarriba, E. (1998). Shade management in coffee and cacao plantations. *Agroforestry Systems* 38, 134-164.

Crowe, S. R., and McAdam, J. H. (1993). Factors affecting herbage biomass production in a mature tree silvopastoral system. Agroforestry Forum 4 (3): 14-18.

Dennis, P., Shellard, L. J. F., and Agnew, R. D. M. (1996). Shifts in arthropod species assemblages in relation to silvopastoral establishment in upland pastures. Agroforestry Forum 7 (3): 14-17.

Diriba Geleti, Mekonnen Hailemariam, Ashenafi Mengistu, and Adugna Tolera (2013). Nutritive Value of Selected Browse and Herbaceous Forage Legumes Adapted to Medium Altitude Subhumid Areas of

Western Oromia, Ethiopia. *Global Veterinaria* 11 (6), ISSN: 1992-6197.
EPA (2012). National Report of Ethiopia, the United Nations Conference on Sustainable Development (Rio+20). Federal Democratic Republic of Ethiopia, Addis Ababa.
Ezeagu, I.E, Metges, C.C, Proll, J., Petzke, K.J, and Akinsoyi, A.O. (2002). Chemical composition and nutritive value of some wild-gathered tropical plant seeds. Food and *Nutrition Bulletin* 17 (3): 104.
Franco, A.A., and Balieiro, F.D.C. (2017). The Role Of Biological Nitrogen Fixation In Land Reclamation, Agroecology and Sustainability of Tropical Agriculture
Gray, C., and Mueller, V. (2012). Drought and Population Mobility in Rural Ethiopia. World Dev. 40(1): 134–145. doi: 10.1016/j.worlddev.2011.05.023.
Lal, R. (2004). Soil Carbon Sequestration impact on global climate change and food security. Science, 304: 1623–1627.
Lal, R. (2008). Sequestration of atmospheric CO2 into global carbon pool. Energy Environmental Science, 1:86-100.
Lal, R. (2011). Sequestering carbon in soils of agro-ecosystems. Food Policy, 36:33–39.
Lazier, J. (1987). The effects of Desmodium intortum under sown in coffee on coffee yields. Forage Network in Ethiopia Newsletter. 17: 16 18
Lin, B. (2010). The role of agroforestry in reducing water loss through soil evaporation and crop transpiration in coffee agroecosystems. *Agricultural and Forest Meteorology*, 150, 510-518.
Lin, B.(2007). Agroforestry management as an adaptive strategy against potential microclimate extremes in coffee agriculture. Agricultural and Forest Meteorology, 144, 85-94.
McAdam, J. H. (1998). Environmental impacts. In: Agroforestry in the UK (ed. M. Hislop), Forestry Commission.
Mehari Alebachew (2012). Traditional Agroforestry Practices, Opportunities, Threats and Research Needs in the Highlands of Oromia, Central Ethiopia. *International Research Journal of Agricultural Sciences and Soil Science*. ISSN:2251-0044, 2(5).
Méndez, V.E, Bacon, C.M., Olson, M., Morris, K.S, Shattuck, A.K.(2010). Agrobiodiversity and shade coffee smallholder livelihoods: A review and synthesis of ten years of research in Central America. Special Focus Section on Geographic Contributions to Agrobiodiversity Research, 62, 357-376.
Mesele Negash (2013). The indigenous agroforestry systems of the south-eastern Rift Valley escarpment, Ethiopia: Their biodiversity, carbon stocks, and litter fall. Academic dissertation for the degree of Doctor of Science (DSc) in Agriculture and Forestry, University of Helsinki, Helsinki.
Mokoboki, H. K., Ndlovu, L.R., Ng'ambi, J.W., Malatje, M.M., and Nikolova, R.V. (2005). Nutritive value ofAcacia tree foliage growing in the Limpopo Province of SA. South *African Journal of Animal Science*, 35: 221-228.
Mulatu, T., Regasa, T., and Franzel, S. (1990). On Farm Research in Nazret Area: Experiences in Developing Technologies for Smallholders. Research report No. 8. Institute of Agricultural Research. Addis Ababa, Ethiopia. 57 pp.
Nair, PKR., Nair, VD., Mohan, KB., and Showalter, JM. (2010). Carbon sequestration in agroforestry systems.Advances inAgronomy, 108:237-307
Namirembe,S., McFatridge, S., Lalisa Duguma., Bernard,F., Minag, P., Sassen, M., Soersbergen, A., Eyerusalem Akalu (2015). Agroforestry: an attractive REDD+ policy option.
Ogunbosoye, D. O., and Babayemi, O. J.(2010). Potential values of some non-leguminous browse plants as dry season feed for ruminants in Nigeria. African Journal of Biotechnology Vol. 9 (18), pp. 2720-2726.
Sennoga, E.B., Admit Wondifraw, and Wakiaga, J., and Haile Kibret (2017). Ethiopia.
Smith, T., Mlambo, V., Sikosana, J. L. N., Maphosa, V., Mueller, H. I., and Owen, E. (2005). *Dichrostachys cinerea* and *Acacia nilotica* fruits as dry season feed supplements for goats in a semi-arid environment. Animal Feed Science and Technology 122: 149-157.
Srinivasarao Ch, Venkateswarlu B, Singh AK, Vittal KPR, Sumanta Kundu, Gajanan GN and Ramachandrappa B. (2012). Yield sustainability and carbon sequestration potential of groundnut-fingermillet rotation in Alfisols under semi arid tropical India. International Journal of Agricultural Sustainability, 10 (3): 1-15.
Tadesse, G., Zavaleta, E., Shennan, C.(2014). Effects of land-use changes on woody species distribution and aboveground carbon storage of forest-coffee systems. Agriculture, Ecosystems and Environment: 197, 21–30.
Tamang, B., Andreu, M.G., Rockwood, D.L. (2010). Microclimate patters on the leeside of single row tree windbreaks during different weather conditions in Florida farms: implications for improved crop production. *Agroforestry Systems*, 79, 111-122.
Tesfaye Abebe (2005). Diversity in homegarden agroforestry systems of Southern Ethiopia, Tropical Resource Management Papers, Wageningen University and Research Center, Department of Environmental Science, ISSN 0926-9495.

Vanderhaegen, K., Verbist, B., Hundera, K., Muys, B. (2015). Carbon and biodiversity in the Afromontane landscapes of SW Ethiopia. For. Ecol. Manage. 343, 22–33. doi: 10.1016/j.foreco.2015.01.016.