Journal of Equity in Science and Sustainable Development

Vol. 2(1), 44-53, January 2018
Article Number: JESSD 30.10.2017
ISSN 2523-1901(Online)
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URL: http://www.mwu.edu.et/journal-sites
Email: jessd@mwu.edu.et

Full Length Review Paper

Sustainable Agriculture: Agroforestry for Soil Fertility and Food Security

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Received 30 October, 2017; Accepted 27 December, 2017; Published 1 January, 2018

ABSTRACT

Agricultural practices determine the level of food production, sustainability and largely the state of the global environment. The present agricultural practices that have greatly increased global food supply have had adverse impacts on the environment and on ecosystem services are calling for the need for more sustainable agricultural system. Sustainability implies maintain high yields in the face of major shocks, and agricultural practices that have acceptable environmental impacts. This review paper aimed to examines how and why agro-forestry would be the best requirement for sustainable agriculture and food security. Different researches which have reviewed in this paper explain that agro-forestry is highly efficient to insure agricultural sustainability through enhancement of soil fertility, plant nutrients, organic matter, soil carbon sequestration, retention of soil moisture, regulate soil temperature, increase productivity and improve dietary value. It also help for food security via increased crop productivity, ensuring nutrition security and balanced diet, diversified crop production, boost income generation, and other multi functional value. In short agro forestry is an efficient agricultural practices for sustainable agriculture system which offer increased productivity, economic benefits, and more diversity in the ecological goods and services provided with two or more interacting plant species in a given land area, it creates a more complex habitat that can support a wider variety of birds, insects, and other animals. To achieve such a scenario particularly in the developing countries understanding the multiple benefits of agro-forestry and expanding the system is not only an important for enhanced soil fertility and food security, but it is the question of sustaining life on the earth.

Key words: *Sustainable Agriculture, Agroforestry, Soil fertility, Food security*

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INTRODUCTION

Agricultural revolution is the foundation of civilization which is changing rapidly especially since the end of World War two, with the advancements of science, shifting consumer preferences, globalization, environmental impacts, population growth and frictions in subsidy regimes (IISD, 2007). Green agricultural revolution caused for the increment of food production in the world by 145%, in Africa by 140%, Latin America by almost 200% and in Asia by 280%. During this time the total agricultural area has expanded by 11% from this the industrialized countries, agricultural area has fallen by 3% and the developing countries has risen by 21% (FAO, 2005).

In many developing countries, agriculture is still the most backbone of the economy but its sustainability fall in threat due to inefficient use of input such as chemical fertilizer, machinery, insecticides and herbicides which led to considerable environmental harm, loss of habitats, loss of biodiversity and their valuable environmental services (UNEP/ CBD/SBSTTA, 2010). The idea of sustainability came to public attention after a 1972 report on environment and development held in Rio Janerio (Anja Yli-Viikari, 1999).Universally accepted definition of sustainable agriculture is proved unclear in relation with the question such as; can anything be sustainable in quickly changing world?. How on earth are we going to feed 2 billion more people by 2050 as climate change depletes the land and water available?, Can human activity successfully maintain itself and its goals without exhausting the resources on which it depends (UNEP/ CBD/SBSTTA, 2010).

There is a growing evidence to suggest that the modern agricultural approach to agricultural growth has reached critical environmental limits and that the aggregate costs in terms of lost or necessary benefits from environmental services are too great for the world to bear (Ruttan, 1999; MEA, 2005; Kitzes *et al.*, 2008). It is crucial in helping to lift people out of poverty and hunger in rural areas by any alternative form of sustainable agriculture, not only at national level, but also globally (European Union, 2012). According to Preston Sullivan (2003) sustainability can be observed and measured interims of the three pillars of sustainability which are environmental sustainability (there is no bare ground, clean water flows, wildlife is abundant, fish are abundant, the farm landscape is diverse in vegetation), social sustainability (the farm supports other businesses and families in the community, the number of rural families is going up, young people take over their parents' farms and continue farming and economic sustainability. The family savings or net worth is consistently going up, the family debt is consistently going down, the farm enterprises are consistently profitable from year to year, and reliance on government payments is decreasing.

The effort that has been implementing in the pillars of sustainability is failing to solve the problem, because most effort is focused on only one or two pillar at a time. For example, the United Nations Environmental Programme (UNEP), the environmental protection agency's (EPA) of many nations and environmental NGOs focus on the environmental pillar. The World Trade Organization (WTO) and the Organization for Economic Cooperation and Development (OECD) focus mostly on economic growth, and to some extent gives attention to social sustainability, like war reduction and justice (Thwink.org on Voice America, 2016).

At the end of the 1990s, increased international concern about environmental issues has made Kyoto Protocol and emphasis on the environmental service functions of alternative land uses. Therefore sustainable agriculture via agro-forestry is very significant alternative land use system and the timely response to the decline in the quality of the natural resource base associated with modern agriculture and has prompted major adjustments in conventional agriculture to make it more environmentally, socially and economically viable (Pinho Rachel *et al.*, 2012). Agro forestry practices have existed since the very beginning of plant domestication and it is practiced by more than 1.2 billion people worldwide (FAO, 2013a). The system has characterized by intentional, intensive, interactive, integrated, productive, sustainable and adoptive production due to the capacity of its various forms to offer multiple alternatives and opportunities to enhance farm production and income, promote environmental services, aesthetic values and agro-ecotourism (Beer *et al., 2003; Hosny* El-Lakany, 2004 and World Agro-forestry Centre, 2014). As stated above the issue of un sustainable agriculture is the major question and challenge for the agricultural sector, which are enforcing to look for efficient agricultural practices for sustainable product and productivity, among those efficient agricultural practices agro forestry is the best example which initiated the authors to review different scientific out puts regarding sustainable agriculture.

AGROFORESTRY AND ITS IMPORTANCE

Because of problems related to overpopulation, lack of sustainable and arable land, decrease in plot sizes, depleted natural resources and urbanization, the current condition of agricultural systems, people particularly small-scale farmers lack the necessary resources to use for farming and develop sustainable crops (Joneydi, 2012). The World Agroforestry Centre points out the importance of agroforestry innovation in the development of the agricultural sector for the livelihood. Over the past two decades, various studies have been carried out to investigate the viability of agro forestry, most them has highlighted that agro forestry can have immense benefits environmentally, socially and economically, producing more output and proving to be more sustainable than forestry or agricultural monocultures (Robbins, 2011).

Soil fertility enhancement through agroforestry

Soil is the thin coat covering the whole earth's surface, except for open water surfaces and rock outcrops, which interrelates dynamically with the lithosphere, atmosphere, hydrosphere, and biosphere, collectively forming pedosphere. The soil is not only seen as an important layer for crops but also as a key-component of the ecosystem services supply chain. In organic farming systems, soil fertility is defined as the "ability of a soil to provide the conditions required for plant growth" (Stockdale *et al*, 2002). The purpose and significance of soils in agro ecosystems has been recognized in the context of sustainable management, soil quality, soil conservation, and protection of local or regional agro ecosystems (Stockdale et al., 2002). Thus, Larson and Pierce (1994) suggest the concept of soil quality, "represented by a range of physical, chemical and biological properties of the soil within its particular environment that together provide a medium for plant growth and biological activity, control and divider of water flow and storage in the environment, and serve as a buffer in the formation and destruction of environmental hazardous compounds".

Fertile soil has an abundance of plant nutrients including nitrogen, phosphorus and potassium, zinc, manganese, boron, iron, sulfur, cobalt, copper, magnesium, molybdenum, chlorine and also organic matter, Therefore restoring the productive capacity and life support processes of soil via sustainable natural resource management using agro forestry system is very necessary (Patiram and Choudhury, 2000).

Table 1: Soil properties beneath trees and open field

Available Nutrients (mg/kg)	Under Prosopis Glandulosa	Beyond canopy
NO-N	195	62
PO_4	7.7	0.8

Source Virginia, 1986 cited in Young: (1988)

Table 1 reveals that how trees in agro forestry system ensures sustainable agriculture via increment of soil nutrient (Young,1988).The tree roots serve for fertility and nutrient cycling by enriching the soil with organic matter and nitrogen under the canopy,maintaining the soil biomass and improving nutrient cycling through root production and turnover; reducing leaching losses through the uptake of mobile nutrients; pumping up nutrients from subsoil layers to the top soil; improving soil penetrability for crop roots; creating appropriate conditions for the development of mycorrhizal and rhizospheric microorganisms (N-fixing and P-solubilising) (Felker, 1978; Schroth , 1999; Jelte van 't *et al.*, 2012).

Retention of soil moisture

Changes of soil water may greatly affect vegetation development, tree species diversity and forest canopy structure. The water storage capacity of soil depends on its depth and capacity to retain water under gravitational drainage, vegetation type, and evapo-transpiration. Getting a better understanding of the interactions between vegetation, soil and water flux is central to environmental management for more water yield in water-limited environments (Chao Wang *et al.,* 2013).The soil water retention capacity is closely related to soil properties such as texture, bulk density, porosity, soil organic carbon content, and so on. Especially, there is a positive correlation between averaged soil water content and soil organic matter content (Chao Wang *et al.*, 2013). Thus, agro forestry influences the water retention capacity in forest sites, and in turn increases the overall water storage capacity (Luscher and Zurcher, 2003).

Sarah (2002) found that shrubs affect soil properties through soil-vegetation interaction that resulted in higher infiltration rate and greater soil water retention capacity than in inter- shrub areas after rain. Wang *et al.* (2008) showed that the top soil layer under high vegetation cover, as with the highly organic fine-grained soils and litter layer reduced the thermal conductivity and increased the water infiltration and water hold capacity, altering the active soil-water-heat relationship. Similar results were found by Zhang *et al.* (2011) forested ecosystems had greater soil water retention capacity than shrub ecosystems because of the thick humus. Agro forests play a crucial role in runoff generation, on the one hand by affecting hydrological processes such as precipitation interception and evapo-transpiration and reduce runoff and soil losses (Sundriya and Sharna, 1996; Eagleson, 2002).

Table.2: Annual runoff and soil loss under different land use systems

Land use	Runoff (L/ha)	Soil loss (kg/ha)
Agricultural field of maize	6427	122
Large cardamom plantation with shade trees	6989	66
Natural forest	5581	12
Barren land	8097	166

Source Sharma *et al.,* (1992)

Table 2 shows how agro forestry checks soil erosion through the cover effect, where hedge pruning are laid along cropped alleys reduce runoff, increase infiltration and reduce soil loss through their barrier effect. Dense ground forest vegetation (grass, cardamom, herbs, shrubs) under large cardamom plantation with shade trees on hill slopes more than 35%, arrests the flow of water, reduce the soil erosion and soil remains almost undisturbed (Sharma *et al.,* 1992 and Patiram *et al*.,1996).

Reduction of excessive soil temperature

The temperature of soil is one of the important factors affecting plant growth. These are air temperature, amount and intensity of precipitation reaching the soil depth and duration, shade of living cover, depth of litter, water content of the soil, humus content of the soil, snow cover, wind velocity, color and structure of the soil (MacKinney, 1929). Forest shade of the crowns and partly from the filling of the forest floor usually reduces the maximum soil temperature and increase the minimum soil temperature with the depth of the soil (Ibid). The influences of forest vegetation on freezing of soil are of great importance because soil under a forest usually remains soft when that in the open is frozen to considerable depth. The distance beyond the edge of the forest's influence on the soil temperature is about the same as the distance of the influence on radiation (Breman and Kessler, 1995).

Studies in the agro forestry system suggest the tree shade increases understory herbaceous productivity because of the reduction of temperature and evapo-transpiration. There is some evidence that extreme heat negatively affects crop establishment and subsequent growth (Peacock *et al*., 1990; McIntyre *et al.,* 1993).Solar irradiance was reduced by 45 to 65 percent under Acacia tortilis and Adansonia digitata and only about 20% of total radiation reached the understory of Acacia tortilis and Balanites aegyptiaca at mid-day in a Sahelan savanna (Belsky *et al.,* 1989; Akpo and Grouzis, 1996).

In semi-arid Kenya, soil temperatures 5 cm below the surface were at least 5–9°C lower under trees than in the open grassland, both at the beginning of the growing season and when grass cover was at a maximum (Belsky *et al.,* 1989; Jonson, 1995). An almost leafless crown of albida resulted in a soil temperature decrease of up to 10°C at 2 cm depth (Van den Beldt and Williams, 1992). Also in northern Senegal air temperatures under and outside tree canopies differed by 6°C at maximum temperatures (Akpo and Grouzis, 1996).

Maximum and minimum air temperatures are moderated by tree crowns because of reduced solar radiation during daytime and reduced reflection of infrared radiation at night (Dancette and Poulain, 1969). According to Van den Beldt and Williams (1992) at the international crops research institute for the Semi-Arid Tropics (ICRISAT) using vertical artificial screens showed that the effect of shade on soil temperatures contributed to better millet growth during seedling establishment. Therefore agro forestry contributes on soil temperature in reducing solar radiation, runoff and wind velocity positively contribute for soil temperature (Dancette, 1966).

Improvement of organic matter (OM)

Of all the effects of trees, that of maintaining soil organic matter levels through the supply of litter and root residues is the major cause of soil fertility improvement. Soil improvement under trees and agro-forestry systems is in great part related to increases in organic matter, whether in the form of surface litter fall, soil carbon or roots exudates in the rhizosphere which substrate for a vast range of organisms involved in soil biological activity and interactions, with important effects on soil nutrients and fertility (Rachel *et al.*, 2012). Trees in agro-ecosystems can be present in an infinite number of arrangements and species, greater diversity of species is more favorable of space above and below the soil, and the variation in the characteristics of the litter produced can maintain a greater level of soil biodiversity, with positive effects on fertility (Sharma *et al.,* 1997).

Management of pruning and relative synchronizations of timing of release to nutrients from litter with demand for their uptake by crops and trees producing litter rich in Ca were associated with soils with greater pH, exchangeable Ca, and percent base saturation, as well as greater rates of forest floor turnover and greater diversity and abundance of earthworms, also trees contribute to carbon accumulation in soils, but in some type of trees species such as Pinus lower PH that produce acidifying litter (Tian, 1997; Young, 2000 and Rachel *et al.,* 2012).

Table 3: Soil organic carbon, nitrogen and N-mineralization rate in different agro forestry

Agro forestry systems	Org. C (%)	Nitrogen (%)	N-mineralization rate (N/g /14 days
Albizzia + cropland	1.13 ± 0.03	0.25 ± 0.02	19.0 ± 6.7
Non-N-fixing trees+ cropland	0.90 ± 0.07	0.20 ± 0.01	8.0 ± 2.8
Alnus + large cardamom	2.01 ± 0.10	0.30 ± 0.02	35.5 ± 4.0
Natural forest + large cardamom	3.56 ± 0.46	0.51 ± 0.03	54.0 ± 8.9

Source Sharma *et al.,* (1992)

The table 3 above shows the N2-fixing species conserves fewer nutrients compared to non-N2-fixing species and hence, contributes more of these elements in their litter which results greater cycling. This provides better production potential for associate crops in the stands with N fixers (Sharma *et al*., 1997). In short the soil organic content, microbial biomass, respiration rate, and light fraction are greater under the canopy than outside the canopy (MUN OZ *et al.,* 2007).

Enhance soil carbon sequestration through agroforestry

Carbon sequestration is the process of removing Carbon from the atmosphere and depositing it in a reservoir. It is well known that tree based systems contribute to reductions in atmospheric CO2 and offset CO2 emissions through three main mechanisms, namely: C sequestration, C conservation, C substitution (UNFCCC; Nair *et al.* 2009). The role of trees reduces the global carbon accumulation adversely affects the climate and contributes to the soil fertility by supporting vegetation growth. Besides the above benefit carbon sequestration role of plants has economic value via payments for mitigation of greenhouse gas emissions to reduce climate change (Rachel, 2012).

Based on the above functions the role of land use systems in stabilizing the CO2 levels and increasing the carbon sink potential has attracted considerable scientific attention particularly after the Kyoto Protocol. Agro forestry practices have been approved as a strategy for soil C sequestration under afforestation and reforestation programs and under the Clean Development Mechanisms of the Kyoto Protocol (Nobel, 2000; IPCC, 2007; Bondeau, 2007). The systems have spread over one billion ha in diverse eco regions around the world. These woody perennial-based land use systems have relatively high capacities for capturing and storing atmospheric CO2 in vegetation, soils, and biomass products. According to the intergovernmental panel on climate change, agro forestry system has important opportunities of creating synergies between both adaptation and mitigation actions with a technical mitigation potential of 1.1–2.2 Pg C in terrestrial ecosystems over the next 50 years. The total C storage in the aboveground and belowground biomass in an agro forestry system is generally much higher than that in land use without tree-less croplands under comparable conditions (Julianna White, 2016).

Adoption of agro-forestry practices has greater potential to increase C sequestration of predominantly agriculture dominated landscapes than mono crop agriculture (Lee and Jose 2003; Nair 2003; Morgan *et al*., 2010). Within agro forestry systems C can be stored in above and below-ground biomass, soil, living and dead organisms. The quantity and quality of residue supplied by trees/shrubs/grass in agro-forestry systems enhance soil C concentration (Oelbermann *et al*., 2006). The amount of carbon fixed in silvopastoral systems is determined by the tree/shrub species, density and spatial distribution of trees, and shade tolerance of herbaceous species (Nyberg and Hogberg, 1995; Jackson and Ash, 1998).

In addition to C sequestered by trees, windbreaks provide additional C sequestration due to improved crop and livestock production and energy savings (Kort and Turnock, 1999). Indirectly, windbreaks reduce fuel use for heating and thereby reduce CO_2 emissions. Various literatures reveals incorporation of agro-forestry by introducing improved plant stock and implementing improved and intensive management techniques could be enhanced C sequestration on the land base in a short period. Well designed and managed agro forestry system can be effective CO2 sinks, especially with the use of perennial crops and fast growing tree species (Nair *et al,2009).*

Enhancement of plant nutrients (N, P, K, Mg, Ca)

Plant nutrient is concerned with the cycling of plant material; agro forestry is necessarily concerned with the complete range of plant nutrients: the primary soil nutrients are nitrogen, phosphorus and potassium and the secondary nutrients are calcium, magnesium and sulphur; and the trace elements or micronutrients are required for plant growth. There is much current interest in the potential role of agro forestry in the mitigation of nutrient depletion. One of the main tenets of agro forestry is that trees enhance soil fertility, the capacity of the soil to provide essential nutrients for plant growth (Young, 1990; Patiram and Choudhury, 2000).

Table 4: Agroforestry systems for nutrient exchange

Agroforestry systems	Nutrients (me/100 g)					
Tree + crop	Total N (%)	C/N	Ca2+	Mg2+	K+	Avail P (ppm)
Alder	0.23	7.1	2.91	2.05	0.41	12.1
Albizia	0.20	8.0	3.02	4.46	0.39	18.1
Cherry	0.15	9.6	2.11	1.90	0.23	10.5
Mandarin	0.17	9.2	2.52	2.00	0.27	11.8
Sole crop	0.11	12.2	0.53	0.51	0.19	5.8
Mean	0.19	8.6	2.51	2.46	0.29	11.67
Sd (±)	0.04	1.61	0.83	1.28	0.08	3.39
CV (%)	23.2	18.63	33.23	51.90	27.02	31.80

Source: - Patiram and Choudhury (2000)

Ensuring food security

One of the most serious challenges faced by policy and decision-makers in many developing countries is food security. Food security may have different meanings for different people. The International Conference on Nutrition held in Rome in 1992, defined food security as "access by all people at all times to the food needed for a healthy life" and a country must achieve the three basic aims 1, Ensure adequacy of food supplies in terms of quantity, quality and variety 2. Optimize stability in the flow of supplies 3. Secure sustainable access to available supplies by all who need them (FAO/WHO, 1992).

Table 5: Estimates and projections of chronic under nutrition in developing regions

Region/year (three- year average)	Total population (millions)	Undernourished	
Sub-Saharan Africa		Percentage of total population	Person millions
1969-1971	268	38	103
1979-1981	357	41	148
1990-1992	500	43	215
2010	874	30	264

Source: FAO (1996)

The table 5 shows that, the, rising chronically undernourished people from 38 to 43 percent between 1969 and 1992 and people with inadequate access to food doubled, rising from 103 million to 215 million in the same period. In recent decades, agricultural land that was formerly productive has been lost to urbanization and other human uses, as well as to desertification, salinization, soil erosion, and other consequences of unsustainable land management (Nellemann *et al.,* 2009). The most likely scenario is that more food will need to be produced from the same amount of, or even less land. Indeed for the last three consecutive years the record shows that total global agricultural land area has actually diminished (Nellemann *et al*., 2009).

Beginning in 2006, international prices for basic agricultural commodities rose to levels not experienced in nearly three decades. The remarkable progress in global agricultural production in the second half of the last century has helped to break cycles of crop failures, food deficits and famines. However, as we move into the 21st century, the decline of food production in developing countries has been so worsening; for instance nearly 840 million people in the world suffer from under-nourishment most of them live in Asia and Africa. In general in the last four decades, agricultural production has come under increasing threat, due to the worsening climatic and environmental conditions, land, biodiversity, and forest and soil degradation, enhanced by a huge population pressure on limited resources. Therefore investment in agriculture and rural development to boost food production and nutrition is a priority for the World (World Bank Group Agriculture Action Plan 2013–2015).

Also the growing food insecurity and deteriorating livelihood situations call for intensive actions at national and international levels to take advantage of the high potential of agro-forestry, among other systems for promoting best land use practices. In this regard agro-forestry has multiple socio-economic and environmental advantages in solving the problem of food and nutritional security requires a range of interconnected agricultural approaches, which includes improvements in staple crop productivity, ensure ecosystem services, enhance cultivation of a wider range of edible plants that provide fruits, nuts, vegetables, reduced insect pests and associated diseases, etc, for more diverse diets (David Pimentel *et al.,*1997 and Frison *et al*., 2011). But little attention has been paid to the beneficial influence of integrating trees with the production of crops, livestock or a mixture of both in farming systems. The result has been the meaningless destruction of forests and trees with their negative consequences on food production in particular and environmental degradation in general (Aju, 2014).

Increased crop productivity

During the past 50 years, the earth's population doubled to reach its current level of 7 billion and it is projected to exceed nine billion by 2050. Today world population is increasing by more than 80 million annually, at the same time 795 million people go hungry every day. Global agricultural productivity must increase by an estimated 60 percent to meet global food needs (FAO, 2016). Agricultural productivity is the amount of a single output per unit of a single input or in terms of an index of multiple outputs divided by an index of multiple inputs (Barrett *et al.,* 2010).

In the past growth in agricultural production in Sub-Saharan Africa was achieved by spreading out the amount of cultivated land, but today there is a very small scope for increasing the area for cultivation. Scholars in the field (Venkatesan & Kampen, 1998) suggest that raising agricultural production in the fixed land could only be achieved by raising the yield and productivity of farm labor, yet this obliges the innovation and adoption of appropriate farming system and technologies for developing countries. The realization that trees can improve agricultural production and the development of farming systems that take advantage of this are still far from being widespread.

But agro forestry has contributing significantly to the increment of productivity. Example maize yields have been proven to increase more than 200% in some cases when grown with nitrogen-fixing acacia species Faidherbia in Africa (Garrity *et al.*, 2010). Here the argument is that the soil and water conservation use of agro forestry is the joint between conservation and production which is essential for sustainable land use (Young, 1989). In Kenya alone, about 400 documented indigenous fruit tree species contribute much to food and nutritional security and livelihoods of rural communities, particularly during the periods of food shortage (De Leeuw *et al*., 2014). Indeed, in small scale agricultural production systems, trees outside forests management seems to hold a high promise as a bridge between food productivity and environmental protection, due to its capacity to restore the ecosystems and improve soil fertility (FAO, 2001).

Diversified crop production

Fluctuating markets, unpredictable weather patterns and international competition are all a part of today's modern agricultural world (National Agro forestry Center, 1994). Diversification reduces risk and can make the difference between success and failure for farming or ranching enterprise. As production and consumption decisions, there is also non separation between crop choice decisions in production and access to inputs for short or long-term investment by the farm household. In developing countries, like Ethiopia farmers usually try to fill their income gap by diversifying agriculture from merely food crop farming to other tree and cash crop planting practices (Geremew, 2016).

In addition of diversifies crop production options provision of rural employment and income, protective environmental functions and maintenance of biodiversity agroforestry system is rich in vitamins and sometimes even minerals, enhancing the food and nutritional security of rural communities and can bring significant health, ecological and economic revenues (Hosny El-Lakany, 2007 and De Leeuw *et al.,* 2014). When soil becomes poor in plant nutrients, food production is impaired (AJU, 2014 and De Leeuw *et al.,* 2014). Appropriate combinations of crops, animals and trees in agro-forestry systems can not only increase farm yields ,ensure food security, they can promote ecological and social resilience to change, because the various components of a system, and the interactions between them, will respond in differing ways to disturbances (FAO, 2013b).

Ensuring nutrition security and balanced diet

Forests and tree-based agricultural systems make essential contributions to human livelihoods and well-being through both the provision of direct and indirect ecosystem services (Arnold *et al*., 2011). More than a billion of the world's poorest people rely on forests and trees to provide food, fuel and cash income and many components of the daily diet of rural families come directly from forest fruits, tubers, vines, mushrooms and leafy legumes, insects and animals harvested from forests. These provide important nutritional supplements that are a vital for food security (FAO, 2012).

Among the major uses of forest farming, NTFPs (none timber forest product) are a very important component of subsistence and livelihood activities throughout the world which are plants, parts of plants, fungi, and other biological materials harvested from within and on the edges of natural, manipulated, or disturbed forests. Shade-loving plants that are naturally adapted to grow under forest conditions are candidates for agro forestry. Examples of crops are gourmet, mushrooms like shiitakes (*Lentinula edodes*), berries, other fruits such as pawpaw (*Asimina triloba*), ramps (*Allium tricoccum*), and tree nuts such as walnuts and hickories (*Carya spp*) decorative pine straw (Community Resources 2000; Gold *et al.*, 2000; Jump up 2013).

Trees found in homesteads or farmlands are also frequently considered a living savings to be left to grow when not required but to be cut in times of need, thereby offering a more secure livelihood (Chambers and Leach, 1986). Recently a collection of scholars published the results of a cross-sectional study that examined the role of forest foods in dietary intake and food security for forest-dependent households, report from South Africa showed that a large portion of the population utilizes forest foods to sustain their livelihoods and alleviate poverty (Chambers and Leach, 1986).

Boost income generation

Most research on agro forestry has been conducted from the biophysical perspective, but nowadays economic and social aspects are gaining attention (Mercer and Miller, 1998). There are many opportunities for agro-forestry to generating income. For instance in Eastern Africa's dry lands various tree species are serving as source of incomes (De Leeuw *et al*., 2014). Also in the United Kingdom, a range of timber/cereal and timber/pasture systems has been profitable to farmers (State of the World's Forests, 2005). Agro forestry participants in semi-arid areas of Misungwi district of Tanzania annually had extra income than non-agro forestry system participants at average of 760 US$ (Stephen Manoni Maduka (2007). A study of coconut farmers in an area in Sri Lanka, for example, showed that intercropping increases net returns (Karunanayake, 1982). The growth in markets for some agro forestry products has recently been very rapid notably for fuel wood, charcoal and poles. All the above functions of agro-forestry classified as provision of non-wood products, timber provision, energy needs, water/hydrological cycle, air quality and environmental services, soil conservation and fertility amelioration (WAC, 2014).

CONCLUSION AND THE WAY FORWARDED

Conclusion

From the previous works/reviewed materials the reviewers are understand sustainable agricultural systems depend on agro-ecological processes can be advantageous over conventional agricultural via promoting soil fertility and pest resistance through biologically acquired inputs, and social processes that generate knowledge and incentives for producing a variety of foods and fibers within locally affordable means, such as agro forestry system. Also agro-forestry systems have been indicated as one of the more promising and efficient practices to achieve a more sustainable agriculture, in greater equilibrium with the environment because the practices are characterized by the coexistence or succession of trees and crops or production and conservation which are particularly dependent on human action to remain stable. In short agro forestry is an efficient agricultural practices for sustainable agriculture system which offer increased productivity, economic benefits, and more diversity in the ecological goods and services provided with two or more interacting plant species in a given land area, it creates a more complex habitat that can support a wider variety of birds, insects, and other animals.

The way forwarded

The reviewers advocate that it is a needed to realizing the potential role of agro forestay in sustainability of agriculture, enhancement of soil fertility and food security and also how agro-forestry practice affects soil, water, plant, animal and atmospheric relations, and the roles of management in bringing about desirable outcomes for the present hotspot issues of sustainability and food security. Thus, human action is central to regulate these interactions and enhance the productivity toward selected goals by converting physical, chemical and biological processes into beneficial inputs for wood, crops production and food security.

CONFLICT OF INTEREST

Authors of this review paper have no conflict of interest. And we need to ensure that we are responsible for any conflict of interest that may arise. Also we have not received any fee for patents for the manuscript. Concerning non-financial computing interest the authors encourage the manuscript has significant value for intellectual and/or academic purposes.

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