review paper
Ratar. Povrt. 2022, 59(3): xx
doi: 10.5937/ratpov59-39353
Manuscript submitted: 25 July 2022
Manuscript accepted: 29 August 2022

Agroforestry: A review of its importance, problems and prospects in crop production

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Current title: Orji, K.O. et al. The potentials of agroforestry in crop production

Summary: Currently, the whole world is confronted with a geometric increase in the human population without a corresponding increase in the agricultural land resource to meet the human demands for food and clothing which are primarily sourced from agricultural industry. Therefore, it is needful for every country to search the importance of agroforestry and make haste to adopt it as it is the only option and panacea with which to combat the world ever increasing human population with limited and dwindling agricultural land resource. Agroforestry is more intentional, intensive, interactive and integrated than agriculture per se. Improved agro-forestry practice is eco-friendly, job creative and lucrative. It also promotes wider biodiversity and high yields of crops and livestock through proper soil management. Agroforestry is a multidisciplinary science encompassing agronomy, physiology, horticulture, apiculture, soil management, ecology, agrisilviculture, silvopasture, agrosilvopasture, and apisilvoculture have made it more comprehensive than other farming systems. The most glaring importance of agroforestry is centered on its ability to adapt to climate change, especially now it has become a case study in the world as its adverse effects on both living and non-living things cannot be neglected. So, this review paper is aimed at sensitizing and encouraging worldwide farmers and non-farmers to adopt the modern agro-forestry practices as improved means for promoting food security and checking deforestation with its associated adverse effects in the world. However, there are numerous challenges confronting the establishment of agroforestry and basically among them are – scarcity of land, improved seeds/seedlings, and conservative attitudes of the farmers.
Keywords: agroforestry, importance, problems, prospects, trees

1. Introduction - The Historical Background of Agroforestry

Agroforestry started as far back as when man initially changed from a hunting and livestock collection to embrace civilization. In this farming system, integration of arable crops and trees forms the major aim of cropping at subsistence level although they were not intentionally combined (Winrock, 1995). Historically, Nair (1979) stated that integration of crops with trees on the same piece of farm has been an old method of farming practiced by farmers all over the world. It was a generally accepted custom in Europe until the Middle Ages to cut down unfertile areas and burn the rubbish. The agricultural crops and trees were planted together at various times of the season or trees grown after the crops had been planted (King, 1989). This method of farming is rarely practiced in the countries of Europe.

It was a norm for farmers in the countries of Central America to practice agroforestry on land less than a hectare with an average of 24 plant species grown on it. However, the Philippines in Asia practiced difficult and somehow sophisticated types of "shifting cultivation" (King, 1989).

In Africa, agroforestry was a little distinct. For example, in Southern Nigeria, yams, maize, pumpkins and beans were typically grown together under a cover of scattered trees. There are numerous instances of traditional land–use systems involving combined production of trees with food crops on the same piece of land in many parts of the world which are nowadays known as agroforestry (Nair, 1993).

However, by late 19th century, Myanmar established teak (*Tectona grandis*) plantation known as "Taungya" which later became the best system of planting trees which was introduced to South Africa in 1857 and was taken to India from Burma in 1890 (Hailey, 1957). The guiding principle of Taungya system was to establish forest plantation where possible with available unemployed or landless labourers. The labourers could be permitted to cultivate the land between the rows of tree seedlings to grow food crops as reward for their hard labour. This was a simple system and its practices differed from one country or locality to another (Nair, 1993).

Contemporary agroforestry came into existence as a result of the problems of deforestation and environmental degradation confronting the world in the tropical regions. So, individuals and institutions increased their search for approaches for appropriate land-use. One of the approaches was generally field experimentation on intercropping which was borne out of more scientific approach. It was opined that greater efforts would be channeled to agronomy, biological nitrogen fixation, crop physiology, plant protection and yield stability (Naira, 1979).

Consequently, the International Institute of Tropical Agriculture (IITA) expanded its programmes to cover combination of trees and shrubs with crop production. The most important idea that led to the development of agroforestry was initiated by International Development Research Centre (IDRC) of Canada. The IDRC Project Report suggested the establishment of an internal organization which would support, plan and coordinate research combining the land management systems of agriculture and forestry throughout the whole world. Hence, the International Council for Research in Agroforestry (ICRF) was established in 1977. In 1991, it was renamed the International Centre for Research in Agroforestry (ICRAF) and mandated to play a key role in collecting information, conducting research, disseminating research results and pioneering new approaches and systems (Nair, 1993).

2. Definitions and Explanations of Agroforestry

2.1 Biological Definition

Biologically, agroforestry is defined as an intensive land management approach that maximizes the importance produced when trees and/or shrubs are intentionally integrated with crops and/or livestock from the biological interactions (AFTA, 1994).

2.2 Ecological Definition

Ecologically, agroforestry can be defined as dynamic, ecologically based natural resources management system that through the interaction of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (Leakey, 1996).

2.3 Socio-economic Definition

Socio-economically, agroforestry is defined as a combination of rural land resources management predicated upon the deliberate integration of trees or shrubs with crops or livestock, which interactions produce economic, environmental and social benefits (Cornell, 2014).

2.4 Extension Definition

By extension, agroforestry is defined as the process of teaching people about agroforestry technologies to enable them make wise decisions on applying agroforestry practices (Fergus, 1999).

Bene et al. (1977) defined agroforestry as a sustainable management system for land that improves total production, integrates agricultural crops, and forest plants and/or animals simultaneously or sequentially and applies management approaches that are compatible with the cultural pattern of the local population.

Nair (1984) defined agroforestry as a sustainable use of land that involves intentional introduction or mixture of trees or other woody plants in crop/animal production fields to benefit from the result of ecological and economic interactions. Okigbo (1983) defined agroforestry as a combination of compatible components of forestry and agricultural production. Lundgren and Raintree (1982) defined agroforestry as a general name for land – use systems and technologies where woody plants such as trees, shrubs, palms, bamboos, etc. are intentionally applied on the same land management area as agricultural crops and/ or animals, in some form of spatial arrangement or temporal sequence.

2.5 Explanation of Agroforestry

Agroforestry is a specific land-use approach which involves a combination of agricultural, forestry, horticultural and animal management components and practices. It is a means of managing land that integrates trees or shrubs with agricultural or horticultural crops or livestock (Cornell, 2014). Agroforestry combines trees with crops and/or animals with the purpose of mitigating risk and improving total productivity. For example, farmers historically used local multiple cropping to risk off total crop failure (Cornell, 2014). Agroforestry systems are both stable and sustainable under normal conditions. It is a general name for multiple land–use approaches involving trees combined with crops and/or animals on the same piece of land (Cornell, 2014). It can integrate production of multiple outputs with protection of resource base. It is usually good for low input condition and fragile environments. It often applies more of socio-cultural values than in most other land-use approaches. It is structurally and functionally more difficult to practice than monoculture (Patish, 2008), and it provides regular income more with increased cash flow stability due to its greater diversity than monoculture practices do and capable of distributing production for a long period of time (TNAU, 2014).

Scientifically, agroforestry comes from from ecology, "agro-ecology" (Wojtkowski, 1998) and is one of the three major land-use systems; the other two being agriculture and forestry. Agroforestry differs from agriculture and forestry by putting an emphasis on integration and interaction among the component resources rather than focusing only on each individual component (Wojtkowski, 2002).

Agroforestry is similar to intercropping with both systems emphasizing on interaction between distinct crop species. Generally, both agroforestry and intercropping can produce higher overall yields and decrease costs of operation (Wojtkowski, 2002).

2.6 Characteristics of Agroforestry Practices

Agro-ecosystem is an integrated and intentional combination of trees with crops and/or livestock which involves intensive management of the interactions between the components. These four key characteristics – intentional, intensive, interactive and integrated are the essence of agroforestry and are what differentiates it from agriculture or forestry practices. Land-use practices must satisfy all of the following four criteria in order to be called agroforestry (Cornell, 2014):

a. Intentional: Combinations of trees, crops and/or animals are planned and managed as a whole system, rather than as individual components which might take place in close proximity but are controlled separately.

b. Intensive: Agroforestry systems are intensively managed to maintain their productive and protective perspectives which usually involve annual operations such as cultivation, fertilization and irrigation.

c. Interactive: Agroforestry management attempts to actively manipulate the biological and physical interactions among the tree, crop and animal components. The objective is to increase the production of more than one harvestable component at a time and simultaneously providing conservation benefits such as control of non-point source water pollution or wildlife habitat.
d. Integrated: The tree, crop and/or animal subunits are structurally and functionally combined into a single, integrated management system which may be horizontal or vertical, and above or below ground. A single, integrated management system uses more of the productive capacity of the land and assists to balance economic production with resource conservation.

3. Classification of Agroforestry Systems

Agroforestry systems may be classified on the basis of the following four criteria (FAO, 2022):
a. *Structural Basis*: This criterion refers to the composition and the spatial and temporal arrangements of the system. Addition of woody plants can greatly affect the horizontal and vertical arrangement of plants in a system which often increases the diversity of the system and typically increases the length of time that the system is in use.
b. *Functional Basis*: This refers to the function of the woody component. Specifically, the addition of woody plant species increases the number of products generated by the system.
c. *Socio-Economic Basis*: This refers to the purpose of the system which often splits into subsistence, commercial, or intermediate. In addition, agroforestry may be managed to meet specific social objectives such as reduction of poverty (social forestry) or to increase accessibility of community to resources on communal lands (community forestry).
d. *Ecological Basis*: This refers to the suitability of the agroforestry system for a given environment. Hence, there are various types of agroforestry for tropical, temperate arid environments which consider the biological, environmental, and ecological conditions of each place.

3.1 Classification of Agroforestry Systems on Structural Basis

Nair (1991) grouped agroforestry systems on the basis of their component units. Hence, there are three basic types of agroforestry practices, namely:
i. *Agrisilviculture:* This is a combination of arable crops with tree crops on the same site.
ii. *Silvopasture:* This involves an integration of forage crops and livestock with tree crop production.

Source: TNAU (2014).

Source: TNAU (2014).

3.2 Management of Silvopasture

Silvopasture thrives when the following management practices for the trees, forage and livestock are compatible:

a. Tree component. Selection of tree species is determined by the soil and climate of the area as well as readily available markets for wood products. Conifers are generally better chosen than hardwoods to silvopastoral systems, nevertheless grazing is successful in pecan orchards. Spot or strip spraying around the trees during the first few years after planting will minimize competition from forage grasses and improve tree growth. Occasional thinning and pruning of the trees are important not only to improving wood quality, but also to providing more sunlight for forage growth.

b. Forage component. A variety of perennial warm or cool season grasses and legumes can be applied in silvopastures. They tolerate shade and prevent competition with the trees by growing in varying seasons or rooting at different depths. Simple grass/legume mixture can be over-seeded with other species to extend the grazing period. Forage can be mechanically harvested until the trees are tall enough not to be harmed by some livestock browsing or rubbing by designing tree row spacing to accommodate haying equipment.

c. Livestock component. Cattle and sheep are the most common animals used in silvopasture, although other breeds also have potential. They may be less likely to browse trees although cattle can easily trample young trees or compact wet soils more than sheep. Diligent observation of herd behavior is vital to detect and correct potential problems with browsing or rubbing of trees. Electric fencing or individual tree guards could be important to protect trees if animals are introduced when they are still small. Fencing is also applied in rotational grazing methods to better control forage consumption.

3.3 Importance of Silvopasture

Silvopasture has the following advantages over timber or pasture alone:

a. Return on investment. Addition of a livestock production component to silvopasture creates a stable source of cash flow prior to nut or timber harvest (e.g. pine, poplar or pecan) and diversifies the forestry enterprise. Addition of a long-term timber while maintaining forage production provides more income than grazing alone for livestock grazers. Pine straw harvest can also provide supplemental income in some places.

b. Increased soil fertility. Nitrogen-fixing forage plants, pasture fertilization and animal manure will assist in the improvement of the soil and tree nutrition. Grazing controls competing brushy species and minimizes fire hazard. Competition between trees is lower at the wider spacings within silvopasture. It also produces greater timber yield.

c. Livestock benefits. Trees create a sheltered microclimate to protect animals from heat and cold. Shelter also improves forage quality and lengthens its growing season. The pruning of some trees can also be used as fodder, e.g. poplar. The result is better livestock growth.

d. Creation of Wildlife habitat. Wildlife habitat is also created by creating a more biologically diverse system.

iii. **Agrosilvopasture**: This type involves a combination of arable and forage crops with tree crop production.

iv. **Taungya system**: Food crops are combined with trees in one piece of land for 2-3 years. Production of food crops stops on the land when the tree crops close canopy. The practice has proved effective in providing food for forestry workers and forage for cutting by cattle rearers (Amonum et al., 2009).

v. **Integrated Taungya**: This is similar to Taungya farming. However, in this case, when the tree canopy closes, livestock grazing replaces arable crop production. This integrated method aims at introducing the idea of land use system whereby the farm operation is carried out all year round (Rander, 1988).

vi. **Improved Fallow in Shifting Cultivation:** This involves the introduction of cover crops on the farmland in order to reduce soil degradation linked to agriculture. The major objective of this practice is to maintain soil conservation and improvement which results in increased crop yields during the cropping season (Amonum et al., 2009).

vii. **Alley-cropping (hedge row intercropping):** Alley-cropping involves cultivation of arable crops between hedgerows of planted shrubs and trees, preferably leguminous species that are occasionally pruned to avoid shading of the companion crops and the pruned materials used as mulch for the crops. It is a comparatively novel technique developed at IITA and ICRAF. The leguminous species fix nitrogen from atmosphere and recycle nutrients from the depth of soil. This practice also suppresses weeds and increases soil organic matter content (ICRAF, 1997).

viii. **Alley farming**. This practice integrates trees, shrubs and other perennials planted with arable crops to supplement the woody trees in the rows. It focuses on livestock production. Alley farming was introduced mainly for sheep and goat grazing. The merits are that the land provides crop residues and controls soil erosion through windbreak. Its main demerit is the competition of hedgerows with crops for soil water, which usually limits crop productivity (Singh et al., 1989).

ix. **Home Garden**. Tropical home gardens comprise an assemblage of plants which may include trees, shrubs, vines and herbaceous plants growing in or adjacent to a homestead or home compound. In this practice, Okafor and Fernandes (1989) reported that multipurpose trees and shrubs in a multi-storey association with arable crops are grown with small livestock in homesteads. Home garden is not a formal practice of agroforestry, but a traditional farming practice with agroforestry (Baumer, 1990).

x**. Multipurpose Trees on Cropland (Trees on farmland or farm forestry)**. In this practice, farmers intentionally leave few economic trees on farms when clearing the land. There is also deliberate planting of fruit trees on farmlands where the density of the natural tree is low. Other involvements of this system are community forestry, a form of social forestry which involves tree planting activities undertaken by a community on communal lands or direct participation of poor resource farmers in the process, either by growing trees themselves or by local processing of the tree products (Baumer, 1990).

xi. **Social Forestry**. In this case, woody plants, whether in hedges or not, are planted to stabilize the soil on terrace edges and other conservation. Woody plants can greatly help infiltration and mitigate surface water runoff, although a wrong choice of species or poor planting technique can affect the objectives (Baumer, 1990).

xii. **Aqua-forestry**. This is a system that integrates trees production with aquaculture. Here, trees are grown around fishponds to provide fodder for herbivorous fish. The trees serve as shelter and shade which create a conducive microclimate for the pond. This system is widely practiced by traditional farmers in inland watercourses where the farmers have full rights to the land (Baumer, 1990).

Source: TNAU (2014).

Source: TNAU (2014).

xiii. **Apisilvoculture/beekeeping plantation**. This practice involves careful selection of woody plants grown for their nectar-producing flowers and pollen that can attract bees to boost wax and honey production. It is also known as apisilviculture. Allowing the bees to work as long as there are flowers instead of only working for a few months in a year if flowering is staggered is recommended (Amonum et al., 2009).
xiv. **Protein Bank.** This is a system of agroforestry in which woody plants wisely applied assist to provide fodder to our livestock during dry seasons or years of low rainfall (Amonum et al., 2009).
xv. **Riparian Forest Buffers**. Riparian forest buffers are strips of trees, shrubs and grass planted between cropland or pasture and surface water courses. Buffers protect water quality, reduce erosion and flooding. Riparian forest buffers can offer important opportunities for row crop farmers, ranchers, horticulturists, and dairy and livestock producers.

3.4 Importance of Riparian Forest Buffers

Riparian forest buffers provide economic, social and environmental benefits as discussed below:
a. **Water quality.** Buffers mitigate non-point source pollution by absorbing and filtering animal wastes, sediments, nutrients and pesticides from crop and rangelands.
b. **Erosion and flood control.** Riparian buffers involve bioengineering practices which aid to stabilize stream banks, slow out-of-bank flood flows, and protect cropland from flooding.
c. **Extra Income.** Multi-row riparian buffers can be managed to permit the intermittent harvest of timber or non-timber products while still maintaining buffering capacity. This practice aids offset the loss of productive crop or pasture land to buffers.
d. **Wildlife habitat**. Riparian forest buffers offer shade, shelter and food for fish and aquatic organisms, as well as terrestrial wildlife.
xvi. **Forest farming**. This system involves an intentional cultivation of edible, medicinal or decorative specialty crops under traditional or planted woodlands that are controlled for both wood and understory crop production. It does not embrace the gathering of naturally-occurring plants from native forests (wild crafting). Forest farming can give profitable avenues to forest and woodland owners, nut growers, sugar maple growers, and herb growers.

3.5 Importance of Forest Farming

a. Extra income and diversification. Cultivation of specialty crops in a forest setting provides new sources of annual or occasion income before or instead of timber harvests.
b. High value products. A good number of plants can be grown in a forest to produce natural or processed edible, herbal, medicinal, decorative and craft products.
c. Ecologically responsible. Careful management of cultivated forest plants that are endangered in the wild due to over-harvesting is the responsible alternative to wild crafting.
xvii. Parklands. These are visually defined by the presence of trees widely scattered over a large agricultural land or pasture. The trees are often of a single species with clear regional favourites. The benefits of parklands include the following – provision of shade by the trees to grazing animals, protection of crops against strong wind outbreaks, provision of firewood from pruning of trees, and the trees acting as a roost for insect or rodent-eating birds. Research with *Faidherbia albida* in Zambia showed that mature trees can sustain maize yields of 4.1 tonnes per hectare compared to 1.3 tonnes per hectare without these trees. *Faidherbia albida* unlike other trees sheds its nitrogen-rich leaves during the rainy season and does not compete with the crop for light, nutrients and water. The regrowth of leaves during the dry season provides land cover and shade for crops.

3.6 Classification of Agroforestry Systems on Functional Basis

There are two major functions of all agroforestry system. They include the following:

3.6.1 Protective functions. These are as follows:

a. **Windbreaks**. Windbreaks involve linear cultivation of trees and shrubs aimed at increasing crop and livestock production as well as protection of people. It also improves soil and water conservation. Windbreaks can offer valuable chances for vine and tree fruit farmers, row crop farmers, livestock farmers, and rural homeowners. Here, double rows of trees are planted around the border of an arable crop farm on the windward side. Each windbreak is 150 m long with 100 trees planted at escapement of 3 m × 3 m. (Kort, 1988; Baumer, 1990).

3.6.1.1 Importance of Windbreaks

i. Boost crop yield and quality

Windbreaks increase the yield and quality of many different crops through microclimate modification of field and orchard. Windbreak protection can be especially valuable in orchards and vineyards of high-value horticultural crops. Windbreaks can also serve to increase biological control of crop insect pests by integrating plants that attract beneficial insects. Windbreaks can provide extra income from non-timber products by using trees and shrubs that produce specialty food or decorative products, e.g. chokecherry or corkscrew willow.

ii. Improvement of animal survival and weight gain

Tree-sheltered havens, or living barns, within pastures can make the difference between death and survival for livestock subject to harsh weather conditions, e.g. newborn and newly-horn sheep. Windbreaks around feedlots have been indicated to improve the health and weight gain of cattle and sheep in cold climates.

iii. Production of timber

Multi-row windbreaks of rapid-growing plant species such as poplar can be sequentially pruned for timber products while maintaining continuity of shelter.

iv. Control of wind erosion

Windbreaks are proven effective in mitigating wind erosion of light-textured soils. Windbreaks also aids produce more moisture available for crops by dispersing snow evenly across fields.

v. Management of snow dispersal

Windbreaks prevent snow buildup around buildings and on roadways when the trees are properly placed.

vi. Reduction of energy costs and improvement of comfort

Rural homes protected by windbreaks need 10-20% less energy for heating and cooling compared to unsheltered homes. Windbreaks around farm dwellings and rural communities improve quality of life for the inhabitants by reducing wind speed along with noise and dust. Established windbreaks increase property values and enhance aesthetic benefits.

vii. Wildlife habitat

Trees and shrubs provide much-needed food and habitat for game birds and other wildlife.

viii. Carbon sequestration

It has been estimated that for each acre planted in field windbreaks, over 21 metric tonnes of carbon dioxide will be stored in the trees by age 20.

b. Soil conservation
c. Soil improvement

3.6.2 Productive functions. These include the following:

a. Fodder
b. Cloths
c. Shelter
d. Food
e. Wood

3.6.2.1 Importance of wood in agroforestry

The use of fire wood in the future might not reduce where it is abundantly produced although it is less extensively used for fuel on farms now than formerly. The development of wood burning stoves and furnaces nowadays can increase the use of wood for fuel in future. Also, use of home ground fuel offers the farmers a chance to direct to some other use the cash that would otherwise be spent for fuel (Anwar et al., 2017).

3.7 Classification of Agroforestry Systems on Ecological Basis

This type grouped agroforestry systems into three major zones, namely:

a. **Humid/ sub-humid.** These zones are known by the production of trees and arable crops.

b. **Arid/semi-arid.** These zones are characterized by the practices of silvopasture and windbreaks.

c. **Highlands.** These zones are characterized by the practices involving plantation crops such as tea, coffee, use of woody perennials in soil conservation and improved fallow systems.

3.8 Classification of Agroforestry Systems on Socio-Economic Basis

This category classified agroforestry systems into three based on scale of production and level of technology input and management. These three forms are:

a. **Subsistence agroforestry**. This system involves those land-use practices directed towards production of basic needs and are managed by the land owner and his family.

b. **Commercial agroforestry**. This system involves large scale production of forestry products such as oil palm, rubber and coconut with permanent under-planting of food crops and pastures.

c. **Intermediate agroforestry**. This agroforestry practice falls between subsistence and commercial systems which shares the attributes of them in production. For instance, production of perennial cash crops and subsistence food crops undertaken on farms whereby the cash crops fulfill the cash needs and the food crops meet the food needs of the family.

4. Problems of Agroforestry

Agroforestry is relevant to almost all environments and is a potential response to common problems around the globe. It can be advantageous compared to conventional agriculture or forestry (USDA, 2014). A survey of extension programmes in the United States suggested some of the following obstacles to agroforestry adoption (Jacobson and Shiba, 2013):

i. Lack of developed markets for products.
ii. Unfamiliarity with technologies
iii. Lack of awareness of successful agroforestry examples
iv. Competition between trees, crops and animals
v. Lack of apparent profit potentials
vi. Lack of demonstration sites
vii. Lack of training or expertise
viii. Lack of technical assistance
ix. Unavailability of information about agroforestry
x. Apparent inconvenience
xi. Lack of infrastructure
xii. Lack of equipment
xiii. Insufficient land
xiv. Lack of seed/seedling sources
xv. Inability to afford adoption or set up cost, including costs of time.

5. Prospects of Agroforestry

5.1 Adaptation to Climate Change

Nowadays, resource poor farmers are adopting agroforestry as a means of mitigating the impacts of climate change. For example, a study from the Consultative Group on International Agricultural Research (CGIAR) programme and Agriculture and Food Security (AFS) on climate change observed from a survey of over 700 households in east Africa that at least 50% of those households had commenced planting trees on

their farms in a change from their conventional farming practices some decades ago (Kristjanson et al., 2012). The trees reduce the effects of climate change through carbon sequestration. Cropping fields can act as a carbon sink through sequestering, i.e. binding the greenhouse gasses such as carbon dioxide. This is achieved as crops photosynthesize to produce their food, they remove carbon dioxide from the atmosphere and produce the oxygen we need to breathe. Through this chemical process, carbon is sequestered in the soil. The planted trees also help to stabilize erosion, improve water and soil quality as well as providing yields of fruit, tea, coffee, oil, fodder and medicinal products in addition to their harvest all year round.

5.2 Encouragement of Carbon Credit

A carbon credit is a tradable permit or certificate that offers the holder of the credit the right to emit one tonne of carbon dioxide or an equivalent of another greenhouse gas. In otherwise, it is mainly an offset for producers of such gases. The primary objective for creating carbon credits is to mitigate the emissions of carbon dioxide and other greenhouse gases from industrial activities in order to reduce the adverse effects of global warming. So, if agroforestry is adopted by every farmer the increased production of CO_2 arising from global warming will be minimized because there will be adequate trees to content with it naturally. The practice of agroforestry will also provide an opportunity to harness CO_2 from urban areas and sell it to agroforestry farmers that can apply it to their plants for maximum photosynthesis which directly reduce the effect of climate change due to increased CO_2 in the atmosphere.

Conclusion

Agroforestry dates as far back as the origin of human civilization when man started integrating food crops with tree crops on the same piece of land. Therefore, agroforestry can be summarized with these three agroforestry applications:

(i). Agrisilviculture: This involves a combination of arable crops with tree crops on the same site which can be expressed arithmetically as: arable crops + tree crops.

(ii). Silvopasture: This involves an integration of forage crops and livestock with tree crop production. This can also be expressed arithmetically as: arable crops + livestock + tree crops.

(iii). Agrosilvopasture: This type is a combination of arable and forage crops with tree crop production which can be modelled arithmetically as: arable crops + forage crops + tree crops. So, agroforestry is a comprehensive system of farming which encompasses all the spheres of food production such as food crops, tree crops, livestock and api-silviculture.

Recommendations

i. There is a need for proper collaboration and synergy between farmers and forest extension services to boost agroforestry practices in the world through proper education of resource poor farmers by the extension agents.

ii. Governments should also establish forestry centers across states to raise forestry seedling nurseries from which farmers can source healthy and improved seedlings at subsidized rates.

iii. Governments should also introduce forestry and agroforestry as a course into the primary and secondary school curricular as it is in the tertiary institutions to enable pupils/students to have broad knowledge of it in life.

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Agrošumarstvo: Pregled značaja, problema i perspektiva u biljnoj proizvodnji

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Sažetak: Trenutno se svet suočava sa geometrijskim povećanjem ljudske populacije bez odgovarajućeg povećanja resursa poljoprivrednog zemljišta kako bi se zadovoljili ljudski zahtevi za hranom i odećom. Stoga je potrebno da svaka zemlja preispita značaj agrošumarstva. Agrošumarstvo je promišljenije, intenzivnije, interaktivnije i integrisanije od same poljoprivrede. Unapređena agrošumarska praksa je ekološki prihvatljiva, otvara radna mesta i unosna je. Takođe promoviše širi biodiverzitet i veću proizvodnju useva i stoke kroz pravilno upravljanje zemljištem. Agrošumarstvo je multidisciplinarna nauka koja obuhvata agronomiju,

fiziologiju, hortikulturu, pčelarstvo, upravljanje zemljištem, ekologiju, šumopoljoprivredu, šumopašnjarstvo i šumopčelarstvo, što ga čini sveobuhvatnijim od drugih poljoprivrednih sistema. Najočigledniji značaj agrošumarstva je usredsređenost na prilagodljivost klimatskim promenama, posebno sada kada se nepovoljni efekti klimatskih promena na živa bića i neživu prirodu ne mogu zanemariti. Dakle, ovaj pregledni rad ima za cilj da podigne svest i podstakne svetskih poljoprivrednike i ostale zainteresovane strane širom sveta da usvoje savremene agrošumarske prakse kao unapređena sredstva za promovisanje bezbednosti hrane i kontrolu krčenja šuma u svetu.

Ključne reči: agrošumarstvo, značaj, problemi, perspektive, drveće