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Assessing Land Suitability for Agroforestry

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Background

Agroforestry is the integration of forest trees, orchard species and shrubs with farmlands, and also includes adaptation of grazing animals and edible crops under the forest canopy. Agroforestry combines agriculture and forestry, garnering benefits to the land such as higher carbon sequestration, protection against erosion and multi-use options. Agroforestry plays a crucial role in mitigating climate change on a global scale by enhancing carbon sequestration and improving ecosystem services, which help reduce CO_2 emissions in the atmosphere. From a combined perspective, agroforestry can be defined as a sustainable land management system that intentionally integrates agricultural crops, tree crops, and livestock to enhance overall production. This approach leverages beneficial ecological and economic interactions among these components while respecting and aligning with the cultural practices and needs of the local community (Bene et al. 1997; Nair et al. 2009).

The USDA defines agroforestry through five major methods, which are classified into two primary systems: (i) Non-linear agroforestry farming systems, including alley cropping, forest farming, and silvopasture, and (ii) The linear agroforestry system included practices such as establishing riparian forest buffers and windbreaks (USDA, n.d.). Although agroforestry methods can be combined to amplify and enhance their benefits.

Agroforestry has various advantages for the landowners and environment. Based on the application, agroforestry practices can: (i) provide protection for valuable topsoil, livestock, wildlife and crops, (ii) increase productivity of agricultural and horticultural crops, (iii) improve water quality, (iv) increase and diversify on-farm income, (v) reduce inputs of energy and chemicals.

Land Assessment for Appropriate Agroforestry Implementation

The land assessment for any kind or combination of agroforestry is mostly based on the objectives of the landowners and capabilities and potential of the land. Therefore, the potential opportunities of the land should be in coherence with the goals of the landowner. Overall, the climatic conditions and soil quality of a given area are the most significant factors in determining the evaluation (Mercer and Pattanayak 2003). Although the soil and climate in Tennessee enable landowners to implement various agroforestry practices, land located in high elevations, bottomlands, or along riversides may have unique microclimatic conditions that provide specific advantages. The soil productivity is another factor that should be included in decision-making process. The soil depth, amount of soil organic matter, soil protection status, historic background, presence of excess nutrients, pollution, or erosion are some of

the top properties that determine the land use type for a given soil.

How to Choose Agroforestry Practices

Agroforestry blends agricultural and forestry methods, so the lands involved are classified under either land use, along with their respective subcategories. Those can include meadows, farms growing cash crops, cattle grazing or sheep grazing lands, poultry farms, or Christmas tree groves or orchards. The forest lands can be fully stocked, include forests with openings, be mixed or single species forests, with deciduous tree species or coniferous tree species.

In addition to land characteristics, factors such as location, distance to market, topography, and exposure also play a crucial role in determining land suitability for various agroforestry practices (Table 1).

Table 1. Decision guide and related outcomes and expectations for different agroforestry practices. Users can identify their site constraints using the first three rows, then identify outcomes and expectations of each practice in the remaining rows.

Conditions and requirements	Alley cropping	Forest farming	Silvopasture	Riparian forest buffer	Windbreak
Existing land use status ↓	Agricultural land	Forest	Pastureland with trees	Riparian areas	Agricultural land or pasture
Soil requirement ↓	Well-drained soil, nutrient-rich	Fertile, deep soil, adequate moisture	Well-drained, nutrient-rich soil	Moist, nutrient-rich soil	Well-drained, sandy loam
Site properties ↓	Full sun, moderate slope	Partial shade, diverse microhabitats	Open areas with trees	Adjacent to water bodies, diverse species	Open fields, flat or gently sloping land
Outcomes and expectations					
Introduced treatments	Fast growing or fruit producing trees, leguminous cover crops	Selective thinning, understory planting, fencing for protection of the introduced species	Managed grazing, tree planting	Native species planting, erosion control	Shelterbelt planting, wind-resistant species
Expectation	Improved soil utilization, better nutrient uptake, soil amendment, revenue generation, increased yields	Sustainable timber and non-timber products, better soil protection, suppressed unwanted understory	Enhanced livestock productivity, improved soil quality	Improved water quality, wildlife habitat	Reduced wind erosion, improved crop yields
Benefits	Erosion control, higher CO_2 seq., wildlife introduction, better nutrient utilization, less water pollution	Biodiversity enhancement, income generation, higher CO_2 seq.	Dual income from livestock and timber	Habitat for wildlife, flood control	Increased crop resilience, reduced evaporation
Unwanted results	Competition for nutrients in initial years, unintended rodents	Overcrowding, invasive species	Soil compaction, overgrazing	Sedimentation, invasive species	Pest attraction, maintenance costs
Recommendations	Tree species can be chosen from orchard species with less shade, regular soil testing, manage competition	Monitor growth, manage species diversity	Rotate grazing, control livestock density	Regular monitoring, manage invasive species	Regular pruning, plan for maintenance

Depending on the landowner's needs and plans, as well as the land's potential, different practices can be selected. For example, if the land has well-drained soil, a

gentle slope, and receives full sunlight, it is suitable for both alley cropping and windbreak practices. If wind is not a concern, but the land is still used for pasture and weed harvesting, then a windbreak can be beneficial, as it creates a favorable microclimate for weed growth. If the land is designated for agricultural use, it is likely to be well-suited for alley cropping. The table can be evaluated by considering the land's potential alongside the landowner's needs and objectives.

Application of the practices

Alley cropping (Fig. 1) is a plantation of orchard or other valuable perennial trees in between agricultural crops on agricultural lands. It has specific benefits to improve the soil health by increasing organic matter, providing better infiltration, increasing water holding capacity, soil microbial and faunal diversity and controlling erosion.

Fig. 1: Alley cropping system consisting of pine trees and cotton. (Photo by courtesy of Shibu Jose)

Trees can be chosen from valuable hardwood species for veneer or lumber, fruit and nut trees or shrubs, specialty crop trees, or desirable softwood species for wood fiber production and fast-growing varieties. The planted trees can benefit from crop growth

practices such as irrigation and fertilization, while ultimately gaining growth independence over the long term without requiring further support.

Forest farming practices include establishing shade tolerant crops and other species under the forest tree canopy which is generally referred to as multi-layer cropping. Even the crops designated to grow in the understory do not require full sunlight. This application is suitable for forest species that allow moderate sunlight to penetrate beneath the canopy cover. Intentional thinning for light penetration could be applied to provide higher light for productive photosynthetic radiation. As the wildlife is a threatening factor for the maintenance of the understory farm, fencing protection could be useful for securing the forest farming system. Most berries, medicinal herbs and nut species can be considered as optional plants that can be grown under a forest canopy (Fig. 2) (USDA 2012).

Fig. 2: Non-timber specialty products like goldenseal can be cultivated beneath a tree canopy. (Photo by courtesy of Katie Trozzo)

Both ***riparian forest buffer*** and ***windbreak*** applications are under linear agroforestry treatments and are useful for protection of soil from wind and water erosion. Riparian forest buffers are well suited for river banks to retain the nutrient elements and soil particles (Fig. 3).

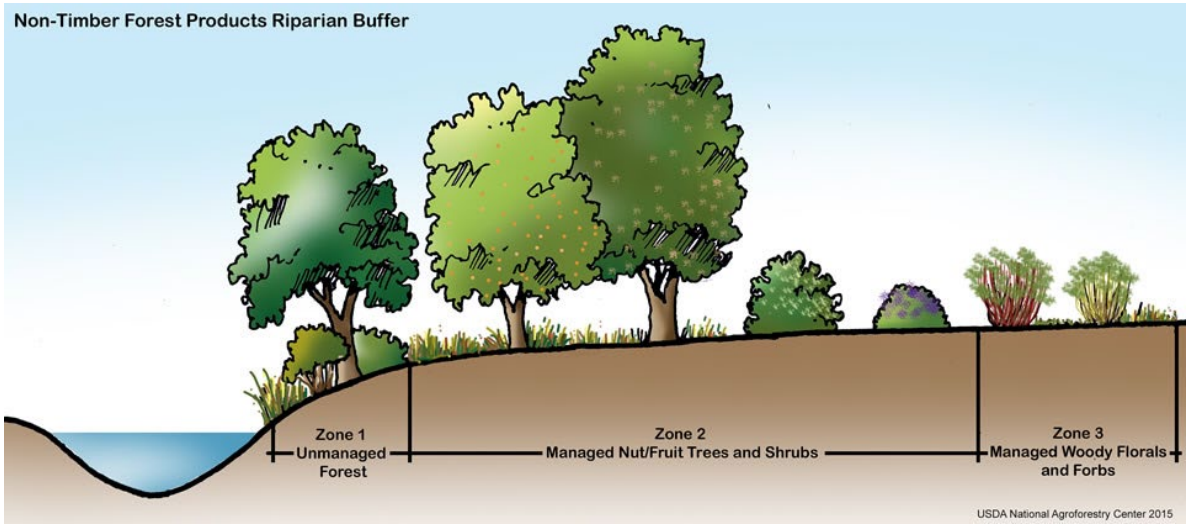

Fig. 3. Zoning and management options for the riparian buffer treatments (USDA Agroforestry Center).

On the other hand, windbreaks are barriers to prevent wind erosion, capture dust particles, wind, snow and odor, and provide shelter for crops and livestock (Trozzo et al. 2014).

In the ***silvopasture*** application (Fig. 4), the land is planted with shade producing trees and shared with the grazing livestock. Trees also provide other food sources for livestock that support their body weight (Pezo et al. 2018). In silvopasture, the focus is on using the land mainly for grazing livestock, but it is important to also care for the trees growing there. This means regular tree maintenance, ensuring they thrive alongside the livestock. By combining these two uses, silvopasture creates a harmonious environment where both livestock and trees can benefit, leading to a healthier ecosystem overall. To protect the trees from being consumed by the livestock it can be useful to fence them until they reach a certain height. Rehabilitation of overgrazed pastureland can be supported by trees through canopy protection, root stabilization against soil erosion, and sustainable microbial populations in the soil supported by root exudates.

Fig. 4: Silvopasture can help reduce heat-stress, which improves animal performance and well-being. (USDA National Agroforestry Center Photo)

Conclusion

Based on the benefits that the practices provide, the conditions of the lands, and needs and expectations of the landowners, many suitable agroforestry practices can be incorporated. Extension agents and USDA local offices in your area can also help provide additional information:

USDA Service Center Locator: https://offices.sc.egov.usda.gov/locator/app

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