Ideal cum Desirable Characteristics of Trees and Crops for Agroforestry Systems

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Agroforestry is receiving a lot of attention globally as a sustainable means of offsetting the impacts of climate change and global warming. Since the beginning of time, agroforestry has existed in some form or another. However, it is currently widely promoted as a form of climate-resilient agricultural production that will not only be able to survive changed environmental effects but also boost the amount of vegetation. Therefore, in order to increase the acceptance and larger adoption of an agroforestry system by the stakeholders, it is necessary to go into further detail about the ideal and desirable traits of tree species and crops.

Introduction

Agroforestry is an agriculture production system in which crops and woody perennials are deliberately grown together with a purpose to utilize the available resources (land, water and sunlight etc.) optimally and sensibly. As a result, agroforestry systems produce a higher yield per unit area as compared to their respective sole systems, indicating improved land productivity. Since time immemorial, agroforestry has been practiced in one or more forms. But now-a-days, as a climate-resilient agricultural production system, it is largely promoted to not only cope with the climate's adversities but also to enhance green cover. Thus, there is a need to thoroughly elaborate on the ideal cum desirable characteristics of tree species and crops for agroforestry systems for the benefit of all stakeholders. At this juncture, considering the major factors involved in agroforestry, the ideal cum desirable characteristics for trees and crops are discussed below.

About tree species

(i) Not to alter the soil moisture

One of the most significant characteristics of soil is moisture, which is extremely necessary for plants from germination to maturity. Plant performance in the field is negatively impacted by insufficient soil moisture at any stage of crop development. Soil moisture should not be hampered by the tree species used for the agroforestry. Therefore, it is believed that tree species with moderate growth, a lengthy gestation period, and a deep root system are the ideal candidates for agroforestry.

(ii) Minimal water requirement

For all plants to survive and grow, water is necessary. To prevent competition amongst the component crops in agroforestry systems, it is desirable to choose and incorporate woody perennials that use relatively less water.

(iii) No competition with agricultural crops for resources

In agroforestry systems, different plant species are simultaneously grown on the same unit of land. Inappropriate tree species selection may encourage rivalry between crop and tree

species for growing resources, such as water, nutrients, space, and sunlight, which could be harmful to both crops and trees. The best tree species for agroforestry are those with relatively shallow roots, clean and clear bole, sparse canopy, and low water requirements.

(iv) Deep tap rooted system

Most crops have shallow roots and draw water and nutrients from the top soil layer. Therefore, the introduction of woody perennials with deep tap root systems is preferred to avoid competition for growth resources between crops and tree species in agroforestry systems. The deeper soil layers supply the tap deep-rooted woody perennials with the water and minerals they need.

(v) No competition with crops for nutrients

Deep-rooted tree species typically collect nutrients from the deeper layers of the soil, which prevents crops and trees from competing for nutrients. Furthermore, by utilizing untapped nutrients found in the deeper soil layer, deep-rooted tree species not only reduce competition for nutrients but also increase the efficiency with which nutrients are used. Therefore, choosing the proper tree species could reduce competition for nutrients between crops and trees in agroforestry systems.

(vi) Non-nutrients exhaustive and soil fertility builder

The inclusion of multipurpose tree species in agroforestry reportedly enhances soil fertility. The multipurpose tree species for an agroforestry system are those that have multiple uses (food, feed, fodder and fibre) and shall have the capacity to fix nitrogen. These tree species aid in stopping soil erosion by covering the soil surface in addition to fixing atmospheric nitrogen in the soil system. Altogether, these tree species increase soil fertility over time and create a wholesome, fruitful environment for associated crops.

(vii) Sparse branching pattern

For understory crops to receive sunlight, the tree used for agroforestry needs to have a light/sparse branch pattern. Crops rely heavily on sunlight as a resource for growth. The lack of sunshine not only affects the duration of the crop by changing various developmental processes, but it also has an impact on physiological processes, which in turn reduce the yields of understory crops. Thus, tree species for agroforestry systems should be sparsely branched.

(viii) Endurance to pruning operation

Trees are regularly pruned or lopped in an agroforestry system to reduce shade on the understory crops. The pruning operation not only allows sunlight to reach understory crops but also helps in achieving clean and clear bole and fodder for animals. Therefore, tree species that have the ability to tolerate light to heavy pruning operations should be chosen for agroforestry systems.

(ix) High survival rate and easy and quick establishment

In agroforestry systems, both components (tree and crop) are equally important, but more emphasis is given to the crop component. Tree species get secondary importance and many a times left with a mercy to survive on the left over resources of crop. The management practices needed for proper survival, growth, and development of tree species are also overlooked. Thus,

tree species that have a high survival rate and easy and quick establishment should be chosen for agroforestry systems.

(x) Fast growing habit, short rotation and easy management

Fast-growing tree species that require less management are preferred for agroforestry. The establishment and management of these types of tree species require less investment and start producing income early due to their shorter gestation periods.

(xi) Wider adaptability and high palatability as a fodder

Agroforestry is largely being practiced in the arid, semi-arid, and dry regions with the sole purpose of producing something in the event of crop failure and some additional material in the case of a prevailing conducive environment. As a result, it is critical to select tree species with broad adaptability as well as high palatability as fodder. The wider adaptability of tree species could make the agroforestry system more vibrant and functional. Additionally, the availability of high-palatability fodder may be able to satisfy the livestock's need for feed.

(xii) Free from chemical exudations/allelopathy and have easily decomposable leaves

Agroforestry should use tree species that, in addition to having easily decomposable leaves, do not exudates harmful chemicals (allelo-chemicals) from their roots, leaves, or bark. Allelo-chemicals have harmful impacts on understory crops that influence the germination, growth, and development of understory crops as well as the quality and health of the soil. Additionally, tree species whose leaves are difficult to breakdown are discouraged for agroforestry because they interfere with a number of field operations, including the sowing and germination of crops by blocking sunlight.

(xiii) Numerous uses and high yield potential

For agroforestry, the multipurpose tree species with the highest yield potential are suggested. These tree species produce a variety of goods and have numerous applications, including those for feed, fodder, fiber, fertilizer, and timber. These tree species should also be able to produce more yield per unit area in addition to the aforementioned benefits.

Fig. 1. *Melia dubia* a short rotation and fast growing tree with sparse canopy, clean and clear bole

About crops

(i) Quick growing and short duration

Short-duration crops with a quick growth habit and a life cycle that lasts 45 to 60 days are best suited for agroforestry systems. These crops enable multi-cropping, reduce irrigation water, labor, and input costs, as well as avoiding competition for growing resources with tree species. These crops are also the least impacted by tree species due to their brief lifespans and quick phasic development.

(ii) Partially shade tolerant

For agroforestry, crops with enough plasticity for adaptation to shade should be used. When compared to other agricultural crops, these crops provide a yield with a minimal yield penalty by either changing their morphology or phenology to adapt to low irradiance. Thus, crops with shade tolerant are highly desirable.

(iii) Conducive to high tree density

Crops chosen for an agroforestry system must have the ability to tolerate high tree density because an agroforestry system alters light, water, nutrients, and space. Altogether, these affect the physiological processes and overall performance of the crops. Crops that can perform well in high tree densities should thus be chosen for agroforestry systems.

(iv) Capability to tolerate multiple stresses

The agroforestry system contains both annual and perennial components, and these components compete for the same resources in order to survive, grow, and develop. Crops that can partially tolerate and endure both biotic and abiotic stresses should be chosen in order to increase the functionality and compatibility of an agroforestry system.

(v) Ability to add adequate organic matter to soil

The organic component of soil is called soil organic matter. It is made up of organic matter from plants and animals as well as material that have been broken down by soil microbes at various stages of decomposition. Soil organic matter directly influences soil quality and productivity in an agroforestry system. Therefore, for an agroforestry system, it is best to use crops that can add more organic matter to the soil.

Conclusion

Agroforestry is a sustainable approach to offset climate change and global warming, promoting climate-resilient agricultural production and increased vegetation. Despite its existence, agroforestry has been promoted globally for its ability to survive environmental changes and boost vegetation. To increase stakeholder acceptance and adoption of agroforestry systems, it is crucial to discuss ideal tree species and crops, focusing on desirable traits for both tree species and crops.