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Fruit Based System- A viable alternative for carbon sequestration

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ABSTRACT

Fruit trees, which have received little attention in the context of climate change, can act as a carbon sink. There are certain management approaches to build carbon reservoirs in tree biomass and soil within a fruit orchard. However, the potential of fruit trees in carbon sequestration remains untapped. There have been few studies that have quantified the carbon sequestration abilities of various fruit tree species. This adds to fruit tree species having a low profile in carbon trading. Proper orchard management strategies and propagation methods are expected to promote carbon sequestration and also providing socioeconomic benefits. This offers a variety of development options within the context of climate change, mitigation and adaptation. A major present issue is rising CO_2 levels in the atmosphere, which may be responsible for global warming or climate change. Fruit trees can grow for years and continue to sequester carbon as they add biomass. We examined several studies on carbon storage by fruit tree species and the various benefits derived from them.

Key words- *Carbon, Sequestration, Fruits, Climate change,* CO_2

Introduction

The process by which agricultural and forestry practices remove carbon from the atmosphere is known as carbon sequestration. By increasing carbon storage in trees and soils, sequestration helps to mitigate climate change. It lowers CO_2(carbon dioxide) levels in the atmosphere and serves as the foundation for carbon credits for growers. The crop sequesters carbon, but only for a limited period until the fruit is consumed. We can estimate how much carbon is trapped in the structure of trees, but trees are frequently burned, releasing all of the trapped carbon. Carbon will be fixed less in sparse orchards with a little light interception, but more in alleyways. Planting trees has remained the most cost-effective, efficient, and useful method of removingCO_2 from the environment (Williams *et al*., 2008). Fruit trees also extract CO_2 from the environment and assimilate it into their cellulose, lowering CO_2 accumulation in the atmosphere.

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Fruit tree orchards can contribute to carbon sequestration and play an important part in the carbon (C) cycle of terrestrial ecosystems (Quiones *et al*., 2013). Because of their propensity to function as carbon sinks, fruit tree orchards have received a lot of attention in recent years. Perennial fruit trees such as cashew, mango, guava etc. have the same carbon-sink capacity as forest trees (Arulsevi *et al*., 2011). This capability arises from a variety of factors, including tree lifespan, year-round activity in maintaining living roots, deeper and more widespread root systems; high leaf area index and delayed leaf turnover (Liguori *et al*., 2009). Researchers have demonstrated the total net carbon sink in China's terrestrial ecosystems was 4.5 % of the total net carbon sink in apple orchards and hence promote carbon sequestration. They discovered that in 2000, carbon deposition in apple orchards might have offset 1.6–3.0% of China's CO_2 emissions from fossil fuels (Wu *et al*., 2012). Similarly, authors have established that apple orchards in New York had a positive impact, with one acre of orchard removing around 20 tonnes of CO_2 and releasing 15 tonnes of oxygen per season (Lakso, 2010). Unlike annual plants, which can sequestrate more C than forest systems, but for shorter periods evergreen tree species can bring about a sustainable ecosystem based on their high C fixation potential (Perez-Piqueres *et al*., 2020). This assertion is in line with a model estimate in Californian agriculture, where land switched from annual crops to vineyards produced the most carbon sequestration. Furthermore, employing all of California's orchard and vineyard wood in biomass power plants would cut carbon emissions by 0.3 Tg C/yr (Karoodsma *et al*., 2006). In addition to perennials, large annual herbaceous plants like banana, have a remarkable capability for carbon storage and CO_2 sequestration. The bulk of the C fixed by banana plants was disseminated throughout the fruit development stage (Zhao *et al*., 2014).

Elevated CO_2 has been shown in several studies to boost the photosynthetic rates of fruiting trees, which should result in greater biomass production. As a result, greater amounts of carbon will likely be trapped in woody trunks and branches of such species. In agreement with this Schaffer *et al*. (1997) observed atmospheric CO_2 enrichment boost net photosynthetic rates in avocado, banana, citrus, mango, and mangosteen. Similar findings have been also reported in citrus species by Idso and Kimbal (2001).

Carbon storage

Carbon is stored in the trunks, branches, leaves, flowers, fruits and roots of plants. Elevated CO_2 levels either enhanced fruit yield and weight in certain trees or enhanced carbon allocation to roots in others. This suggests that fruit trees could play an important role in removing CO_2 from the atmosphere. Trees with abundant flowering and fruiting ability remove more carbon from the atmosphere and store a significant amount of carbon. In this context, a study was conducted on oil palm farms in the Philippines. According to the findings, the average carbon stock in oil palm farms is 40.33 tC/ha. The oil palm plant structure contains the majority of the carbon stock (53 %). Oil palm plants are predicted to sequester 4.55 tonnes of carbon per hectare per year (Borboun *et al*., 2020). Similarly, in an Italian orchard including citrus, wine grape, apple, olive, peach, and orange trees, research indicated a considerable sink for atmospheric C (Liguori *et al*., 2009). Comparative research shows the maximum above-ground biomass (18.51 t/ha) and carbon stock (8.33 t/ha) in mango plantation than other fruit crops (Ernesto *et al*., 2016).

When CO_2 levels are high, plants improve their CO_2 sink capacity by producing a large number of flowers and fruits. Fruit trees with exceptional flowering and fruiting capacity can remove considerable amounts of CO_2 from the atmosphere. Carbon stored in leaves, flowers, and pruning materials (unwanted branches) may contribute to C storage because CO_2 can be converted into soil organic carbon, which may not be mobilised. Many fruit trees developed from seedlings are expected to have a vigorous growth stature, which necessitates the removal of useless branches.

Propagation protocols

Propagation techniques may have an impact on the effectiveness of carbon sequestration since it has a significant impact on tree and biomass development. The biomass of marcots and cuttings of *Dacryodes edulis* was found to be greater than that of seedlings Grafted fruit trees are another intriguing aspect of carbon storage. The rootstock may have an impact on the quantity of biomass accumulated in grafts. If they don't have dwarfing characteristics, seedling-derived trees can accumulate more biomass than grafts. However, vigorously growing grafts can match the outcomes of seedlings. Grafts with slow-growing rootstocks (dwarfing features) are likely to have low biomass. Hence, to boost carbon storage, rootstocks that optimise tree biomass must be used. Alternatively, a model for a single tree species may be required. For example, the santol plantation has the highest carbon sequestration value among the tree plantings, followed by mango and rambutan. The understory, with rambutan, mango, and santol plantations, is the least among the carbon pools (Janiola and Marin, 2016).

Carbon Markets

There are many carbon markets, including voluntary exchanges for the carbon stored in trees. Fruit orchards and specialised management techniques should be addressed if carbon trading is based on woody tree biomass, as tree management has a considerable influence on tree biomass development. Certain woody fruit tree species may be eligible for carbon credits. Carbon credit trading enables industries unable to limit CO_2 emissions to purchase credits (each worth one metric tonne, or tonne, of CO_2) from industries that have decreased their emissions more than the required level. A study of the carbon sequestration capability of fruit-bearing trees was undertaken in the Nubra valley where the orchards of apricot, apple, and walnut were discovered to sequester roughly 22,300 MT of carbon, with the apricot orchards sequestering the most carbon (18,000 MT). As a result of the findings, it may be deduced that certain temperate fruit crop species may be more appropriate for carbon markets (Kumar *et al*., 2010).

Conclusion

Fruit trees have the potential to mitigate some CO_2 emissions. By understanding tree morphology, propagation methods, physiology (growth rate), appropriate tree management practices for fruit yield and carbon sink expansion, can aid in the long-term development of carbon sequestration capacity. Propagation methods also influence tree development and structure, and it must be investigated since it influences total tree biomass and thus carbon sequestration. Hence, more research investigations are needed to increase our understanding.

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