American Journal of Environment and Climate (AJEC)

ISSN: 2832-403X (ONLINE

VOLUME 5 ISSUE 3 (2026)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of
Environment and Climate (AJEC)

Volume 5 Issue 3, Year 2026
ISSN: 2832-403X (Online)
DOI: https://doi.org/10.54536/ajec.v5i3.7208
https://journals.e-palli.com/home/index.php/ajec

Carbon Sequestration Services of Fruit Trees in Institutional Landscapes: Implications for Urban Greening and Sustainable Home Garden Management

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Article Information

Received: December 25, 2025
Accepted: March 03, 2026
Published: September 08, 2026

Keywords

Carbon Sequestration, Climate Mitigation, Fruit Trees, Institutional Landscaping

ABSTRACT

This research was conducted to assess the carbon sequestration services of fruit trees within the Rivers State University campus, as a guide for institutional landscaping and home garden management. The random sampling technique was used to collect data on tree height and DBH using D-tape and clinometer. The allometric method was used to calculate the carbon sequestered from the above and below ground biomass estimated from tree height and DBH. Terminalia catappa, and Persea gratissima had the highest mean height of 35.14m, and 31.60m respectively, while Cocos nucifera and Citrus sinensis had the least height of 25.40m and 11.70m respectively. Terminalia catappa, Persea gratissima, and Mangifera indica had the highest mean diameters of 124.38cm, 106.26cm, and 106.42cm, respectively, while Cocos nucifera and Citrus sinensis recorded DBH of 63.44cm and 33.46cm. Terminalia catappa, Persea gratissima and Mangifera indica recorded below ground biomass of 16304.37 tons, 10801.56 tons and 10517.47 tons respectively. The above ground biomass was highest for Terminalia catappa (81521.87 tons), Persea gratissima (54007.79 tons) and Mangifera indica (52587.33 tons), while Cocos nucifera and Citrus sinensis recorded the lowest of 15740.22 tons and 2158.01 tons respectively. Terminalia catappa, Persea gratissima, and Mangifera indica sequestered the highest carbon (108454.65 tons, 71850.61 tons, and 69960.87 tons), respectively. This research has provided information on the mean height and diameter at breast height of fruit trees, and evidence of the fruit tree with the highest carbon sequestration potential on the Rivers State University Campus Hence, it is recommended that Terminalia catappa, Persea gratissima and Mangifera indica be incorporated into campus home gardens to sustain the livelihood of residents as well as provide climate mitigation and beautification services.

INTRODUCTION

Increasing carbon emissions is of major global concern, as addressed in the Kyoto protocol (Chavan & Rasal 2010). Atmospheric carbon dioxide (CO2) has affected the global climate and has stirred the interest of researchers to carbon capture and sequestration technology (Anwar *et al.*, 2018). One of the best carbon capture systems exist in the forests as forests sequester or store carbon mainly in trees and soil. Forests capture and store different amounts of carbon at different speeds depending on several factors including age of trees. Young trees growing rapidly can sequester carbon quickly. Trees are regarded as one of the best carbon capture technologies available as during the process of photosynthesis, trees absorb carbon dioxide from the atmosphere and converts it to sugar necessary for wood growth and other physiological functions. About 50% of the wood in trees are composed of carbon and are locked up in the standing tree for several years (Stephenson, 2014). Annual rates of carbon sequestration largely depend on the tree size at maturity, life span and their growth rates (Nowak & Crane, 2002).

Carbon sequestration in terrestrial ecosystem is referred to as the absorption of CO2 from the atmosphere by photosynthesis. Carbon sequestration is a mechanism for the removal of carbon from the atmosphere and storing in the biosphere (Chavan & Rasal, 2012). Carbon sequestration in growing forests is known to be a cost-effective option for the mitigation of global warming and global climatic change (Green & Aklilu., 2016). Terrestrial vegetation and soil represent important sources and sinks of atmospheric carbon (Watson *et al.*, 2000).

Rising urbanization trends combined with the continuous increase in population have put pressure on cities, resulting in a continuous deterioration of air quality through the release of excessive greenhouse gas of which carbon dioxide is more predominant and is the primary cause of global temperature rise (WHO, 2019; Millennium Ecosystem Assessment, 2005).

The environmental benefits of trees in campus ecosystems are numerous and well acknowledged in forestry benefit account (Nowak *et al.*, 2014; Nowak *et al.*, 2008; McPherson *et al.*, 2003). Campus trees improve air quality, cool local air temperatures, filter and retain storm water, functions as phytoremediation agent, sequester carbon, and provide food, fruit, vegetables, medicine for the inhabitants, improves social, cultural, and physical health as well as enhance mental health (Nowak *et al.*, 2008). According to Berto, (2005) exposure to nature and restorative environments increases sustained attentive capacity for learners. Easy access to green outdoor environments from workplaces has been found to significantly reduce work stress (Lottrup *et al.*, 2013).

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More importantly, academic institutions and hospitals have noted that nature and trees result in quantifiably positive impacts on students' and patients' well-being (Alvarsson *et al.*, 2014).

The term urban forest and urban green space includes trees in gardens, parks, and along the streets, roads, canal, etc., which contribute to verdancy in the city (Ugle, et al, 2010). These spaces provide a variety of ecosystem services such as improving air quality (Singh, *et al.*, 2017), buffering of noise pollution, biodiversity conservation, mitigating urban heat island effect, micro-climate regulation, stabilization of soil, ground water recharge, prevention of soil erosion, and carbon sequestration (Sharma, 2020). Studies conducted by several scientists have claimed that urban green spaces can play a very important role in limiting the city's carbon footprint (Strohbach, 2012). Such areas also provide an array of cultural services, including spiritual and religious, recreational, ecotourism, and aesthetic (Chang *et al.*, 2017). The maximum benefit of these spaces largely depends on judicious selection of an appropriate and diverse mix of tree species and their proper management in the urban areas (Bala, *et al.,* 2015, Singh, *et al.*, 2017). According to the Intergovernmental Panel on Climate Change (2006), the major five carbon pools of a terrestrial ecosystem involving biomass are above-ground biomass, below-ground biomass, dead wood, litter, and soil organic matter (IPCC, 2006).

University campuses provide extensive spaces for urban trees, offering significant potential for mitigating climate change impacts. Understanding the carbon sequestration capacity of urban tree species is essential for institutions and organizations to make informed decisions regarding climate mitigation and sustainable land-use planning. This study therefore aims to quantify the biomass and carbon sequestered by selected home-garden fruit trees on the Rivers State University campus, with the objective of generating evidence that can be integrated into campus planning, landscape beautification, urban greening strategies, and sustainable home management practices.

MATERIALS AND METHODS

The study was conducted in the Rivers State University Campus, Rivers State University is in Nkpolu-Oroworukwo, Port Harcourt, the capital city of Rivers State and a major oil-producing hub in the Niger Delta. It is situated in a highly urbanized and industrial environment with latitude 4.51ºN and longitude 7.01ºE at an altitude of 223 above sea level (Uko & Tamunobereton-Ari, 1991). The average rainfall of the area ranges between 200mm and 2600mm per annum. The area is marked with two distinct seasons: the wet and dry seasons. The wet season begins in March and ends in November while the dry season begins in December and ends in February. Five fruit tree species (Persea gratissma, Mangifera indica, cocus nucifera, citrus sinensis and Psidium guajava) were selected for the study using simple random sampling technique, data were collected in five replicates. Tree diameter at breast height (1.3m above ground level) were taken in centimetres using 800-647-5368 diameter/Linear tape by Forestry Suppliers Inc. On trees with buttress, bulge, canker or branch whorl, diameter measurements were taken above the deformity where it occurs at 1.3m above ground level. Tree terminal height measurements were taken in meters using digital clinometer by Haglof Sweden. The GPS coordinates of each tree location was taken using the GPS test App.

A non-destructive approach using the allometric equation by Brown (1997) was used for above-ground biomass (AGB) and below-ground biomass (BGB) estimation. BGB was estimated from AGB as developed by Ponce-Hernandez *et al.* (2004) for non-destructive below-ground biomass value of vegetation as 20% of the AGB. Biomass data was used to quantify carbon stock which was used to estimate the amount of carbon sequestrated with field measurements of height and diameter at breast height. The algorithm functions of Clark *et al.* (1986) was used to determine the above-ground green weight of the trees expressed as:

AGW= 0.25D2H: For trees with D≤28cm

AGW=0.15 D2H: For trees with D≥28cm

Where AGW=Above-ground green weight(ton)

D=Stem diameter(cm), H =Total height of tree (m)

The root system weight was estimated at 20% of the above-ground weight. Therefore, the total green weight of the tree was determined by multiplying the above ground weight by 1.2

The above-ground biomass of each standing tree was determined using the functions of Chavan and Rasal (2010) which states that the average tree is 72.5% dry matter and 27.5% moisture. The function therefore was expressed as:

DW= AGW x 0.725 = 0.25D2H x 0.725 for trees with D≤28cm

DW=AGW x 0.15D2H=0.15 D2H x 0.725 for trees with D≥28cm

Where DW=Above ground dry weight(ton), D=Stem diameter(cm), H =Total height of tree (m)

The content of carbon in woody biomass is generally 50% of the dry weight (Paladinic, *et al.*, 2009; Afzal and Akhtar, 2013; Eneji, *et al.*, 2014). Therefore, the weight of carbon in sampled trees was determined by multiplying the dry weights by the factor of 0.5.

The atomic weight of carbon is 12, the atomic weight of oxygen is 16. The weight of carbon dioxide in a tree is determined by the ratio of CO2 to C (44/12 = 3.67). The weight of carbon dioxide in the sampled trees was therefore, determined by multiplying the weight of carbon in the trees by 3.67.

Data collected were subjected to descriptive statistical analysis. The one-way analysis of variance was used to test the significant differences of carbon sequestered by different tree species using IBM SPSS statistics 27. Means were separated using the Turkey B at a probability of 0.05%.

RESULTS AND DISCUSSION

Results on tree height and diameter at breast height of fruit trees within the Rivers State University Campus are presented in Table 1. The result showed that Terminalia catappa had the highest mean height (35.14m) followed by Persea gratissima (31.60m), while Cocos nucifera and Citrus sinensis recorded the least mean heights of 25.40m and 11.70.49m respectively at P≤0.05 using Turkey B. Significant differences in mean DBH sizes were observed as Terminalia catappa recorded the highest mean DBH (124.38cm) followed by Persea gratissima and Mangifera indica (106.26cm and 106.42cm) respectively. The least DBH was observed in Cocos nucifera and Citrus sinensis (63.44cm and 33.46cm) respectively.

Results on Table 2 shows Terminalia catappa had the highest mean above ground biomass (81521.87 tons) followed by Persea gratissima and Mangifera indica (54007.79 ton and 52587.33 tons) respectively, while Cocos nucifera and Citrus sinensis recorded the least AGB (15740.22 tons and 2158.01 tons) respectively. Terminalia catappa also recorded the highest mean BGB (16304.37 tons) while Cocos nucifera and Citrus sinensis recorded the least (3148.04 tons and 431.60 tons) respectively at P≤0.05 using Turkey B.

Table 1: Mean Height and Diameter at Breast Height

Species	**Mean Height (m) ±SD**	**Mean DBH (cm) ±SD**
Citrus sinensis	11.70d ± 1.22	33.46 d ± 5.36
Cocos nucifera	25.40 c ± 2.31	63.44 c ± 7.83
Mangifera indica	30.58 b ± 2.59	106.42 b ± 7.82
Persea gratissima	31.60 ab ± 3.17	106.26 b ± 7.19
Terminalia catappa	35.14 a ± 1.76	124.38 a ± 8.21

Within columns means with different superscript are significantly different at P≤0.05 using Turkey B

Table 2: Mean Above and Below Ground Biomass

Species	**Mean AGB (tons) ±SD**	**Mean BGB (tons) ±SD**
Citrus sinensis	2158.01 c ± 461.16	431.60 c ± 92.23
Cocos nucifera	15740.22 c ± 5147.13	3148.04 c ± 1029.42
Mangifera indica	52587.33 b ± 11917.10	10517.47 b ± 2383.60
Persea gratissima	54007.79 b ± 11081.49	10801.56 b ± 2216.29
Terminalia catappa	81521.87 a ± 8414.69	16304.37 a ± 1682.94

Within columns means with different superscript are significantly different at P≤0.05 using Turkey B

Terminalia catappa had the highest carbon stock (29551.68 ton) and sequestered the highest CO2 (108454.65 tons), followed by Persea gratissima and Mangifera indica having carbon stock of (19577.82 tons and 19062.91 tons) respectively and sequestered CO2 (71850.61 ton and 69960.87 tons) respectively. Cocos nucifera and Citrus sinensis ((5705.83 tons and 782.28 tons) recorded the least carbon stock and least CO2 sequestered (20940.39 tons and 2870.95 tons) respectively at P≤0.05 using Turkey B (Fig 1 and 2).

Terminalia catappa recorded the highest mean height among the species studied. This agrees with documented botanical descriptions that identify T. catappa as a fast-growing deciduous or semi-evergreen tree commonly attaining about 15 m in height, with some individuals reaching up to 40 m (Useful Tropical Plants, 2024). Persea gratissima and Mangifera indica also exhibited relatively high mean heights in the study area. The growth pattern of P. gratissima is consistent with reports describing the species as characterised by rapid vertical and canopy expansion (Elena *et al.*, 2018). Similarly, M. indica is widely recognised as a large and fast-growing tropical tree capable of attaining heights of approximately 30 m (≈100 ft) under favourable conditions (Mango Tree Information, 2013).

The estimation of above-ground biomass (AGB), below-ground biomass (BGB), carbon stock and carbon dioxide sequestration revealed substantial variation among the tree species sampled. The observed differences were primarily influenced by stem diameter (DBH) and tree height, which are recognised as the most reliable predictors of tree biomass in tropical ecosystems (Brown, 1997; Chave

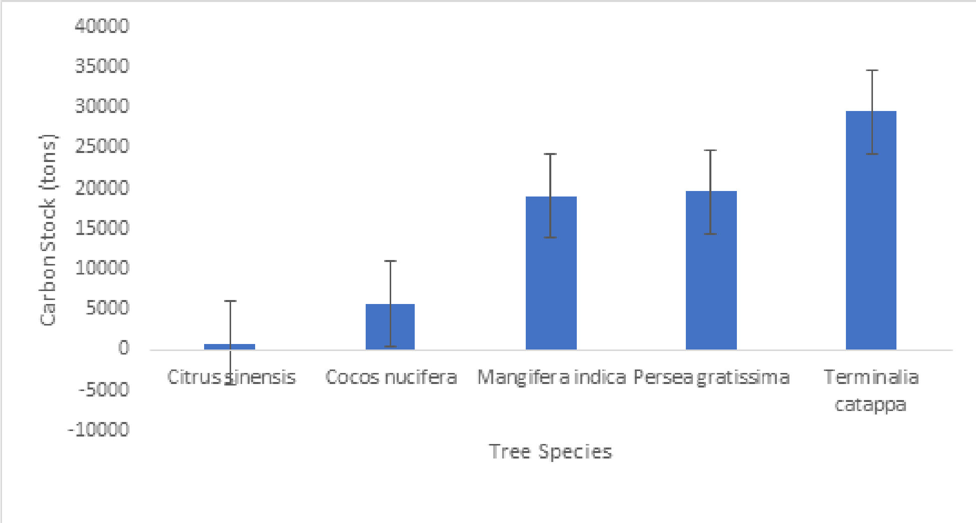

Figure 1: Mean carbon Stock

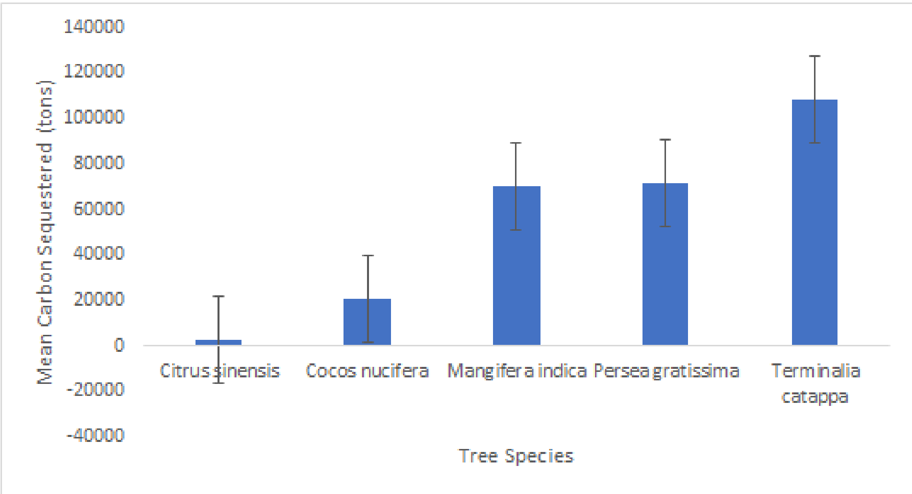

Figure 2: Mean carbon Sequestered

et al., 2005). Because biomass is proportional to the diameter squared multiplied by height (D²H), trees with larger diameters contributed disproportionately greater biomass and carbon storage than smaller individuals (IPCC, 2006). This supports the principle that biomass accumulation determines carbon sequestration potential (Simbi-Wellington, *et al.*, 2025); Aladesanmi & Jonathan, 2020).

The very high above-ground green weight recorded in Terminalia catappa and Mangifera indica indicates that large canopy perennial tree species function as dominant carbon pools within urban vegetation. Mature hardwood trees accumulate biomass rapidly due to extensive secondary woody growth and larger stem volume (Brown, 1997; Chave *et al.*, 2014). This observation agrees with Eneji *et al.* (2014), who reported that trees with dense foliage, broad crowns and clustered leaves generally possess higher carbon sequestration capacity. Similarly, Terminalia catappa has been identified as one of the tree species with high biomass and carbon content. Ramanan, (2024) indicated that terminalia catappa is a large tropical tree species with significant biomass and ecosystem function potential, commonly included in assessments of carbon sequestration and urban forestry planning due to its size and growth characteristics.

In contrast, Cocos nucifera showed comparatively lower biomass values. This agrees with findings that palms typically possess lower wood density and smaller bole volume than hardwood shade trees (Hairiah *et al.*, 2011). Palms store less biomass because they lack true secondary thickening and therefore accumulate less structural carbon compared to dicotyledonous woody species (Tomlinson, 2006).

Terminalia catappa recorded the highest carbon sequestration value, followed by Persea gratissima and Mangifera indica. This agrees with Eneji *et al.* (2014), who reported that Persea gratissima exhibited the highest CO_2 sequestration potential (125,916.7 kg) among selected urban trees in Benue State, Nigeria. The higher sequestration capacity may be attributed to the plant morphology, particularly dense foliage and wide canopy structure which enhance photosynthetic carbon fixation.

Furthermore, Mangifera indica has been recognised as an effective carbon-sequestering species in urban environments (Jasmin & Brundage, 2011). Similarly, Ishaq *et al.* (2014) reported that species such as Azadirachta indica, Elaeis guineensis and Mangifera indica accumulated substantial carbon stocks within township areas, with Mangifera indica recording the highest carbon storage along Gboko Road, Benue State.

CONCLUSION

Overall, the findings confirm that tree size, species morphology and wood structure strongly influence biomass accumulation and carbon sequestration potential. Large-diameter hardwood trees contribute more significantly to atmospheric carbon removal than smaller or monocotyledonous species, highlighting the importance of conserving mature trees in urban climate-mitigation strategies.

The CO_2 sequestration values obtained demonstrate that urban and peri-urban trees act as significant climate regulation agents. The study demonstrates that tree diameter and species type significantly influence biomass accumulation and carbon sequestration capacity. Large, mature hardwood species serve as major carbon reservoirs and should be prioritized in environmental management and urban planning programs aimed at climate change mitigation.

Large trees such as Terminalia catappa contributed the highest CO_2 removal capacity, highlighting their significance in climate change mitigation strategies. Smaller species like Citrus sinensis contributed less carbon per individual but may provide meaningful cumulative sequestration when planted in large numbers (Nowak & Crane, 2002).

The study confirms that tree diameter and species composition significantly influence biomass accumulation and carbon sequestration capacity. Mature hardwood species act as major carbon reservoirs and should be prioritised in environmental management strategies aimed at mitigating climate change.

REFERENCES

Afzal, M., & Akhtar, A. M. (2013). Factors affecting carbon sequestration in trees. *Journal of Agricultural Research, 51*(1), 61-69.

Aladesanmi, D. A. & Jonathan C. O. (2020). Tree species diversity, volume yield, biomass and carbon sequestration in urban forests in two Nigerian cities. *Springer Science+Business Media, LLC, part of Springer Nature (23) 23,* 957-970. DOI: 10.1007/s11252-020-00994

Alvarsson, J. J., Wiens, S., & Nilsson, M. E. (2010). Stress recovery during exposure to nature sound and environmental noise. *International Journal of Environmental Research and Public Health, 7*(3), 1036–1046. https://doi.org/10.3390/ijerph7031036.

Anwar, M. N., Fayyaz, A., Sohail, N. F., Khokhar, M. F., Baqar, M., & Khan, W. D., (2018). CO_2 capture and storage: a way forward for sustainable environment. *Journal of Environmental Management, 226*, 131–144.

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25*(3), 249–259. https://doi.org/10.1016/j.jenvp.2005.07.001

Bhalla, P., & Bhattacharya, P. (2015). Urban biodiversity and green spaces in Delhi: A case study of new settlement and Lutyens' Delhi. *Journal of Human Ecology, 51*(1–2), 83–96. https://doi.org/10.1080/09709274.2015.11906933

Brown, S. (1997). Estimating biomass and biomass change of tropical forests: A primer. *FAO Forestry Paper 134.*

Chang, C. R., Li, M. H., & Chang, S. D. (2017). A preliminary study on the local cool-island intensity of Taipei city parks. *Landscape and Urban Planning, 80*(4), 386–395. https://doi.org/10.1016/j.landurbplan.2006.09.005

Chavan, B. L., & Rasal, G. B. (2010). Sequestered Standing Carbon Stock in Selective Tree Species Grown in University Campus at Aurangabad, Maharashtra, India. *International Journal of Engineering Science and Technology. 2*, 3003-3007.

Chavan, B., & Rasal, G. (2012). Total Sequestered Carbon Stock of Mangifera indica. *Journal of Environment and Earth Science, 2.*

Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., Fölster, H., Fromard, F., Higuchi, N., Kira, T., Lescure, J.-P., Nelson, B. W., Ogawa, H., Puig, H., Riéra, B., & Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia, 145*(1), 87–99. https://doi.org/10.1007/s00442-005-0100-

Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M. S., Delitti, W. B., Duque, A., Eid, T., Fearnside, P. M., Goodman, R. C., (2014). Improved allometric models to estimate the aboveground biomass of tropical trees. *Global Change Biology, 20*(10), 3177–3190. https://doi.org/10.1111/gcb.12629

Clark, A. (Alexander) III, Saucier, J. R., & McNab, W. H. (1986). Total-tree weight, stem weight, and volume tables for hardwood species in the Southeast. *Georgia Forestry Commission, Research Division.*

Eneji, I. S., Ofoegbu O., & Emmanuel T. A. (2014). Sequestration and Carbon Storage Potential of Tropical Forest Reserve and Tree Species Located Within Benue State of Nigeria. *Journal of Geoscience and Environment Protection. 2*, 157-166.

Elena, H.F., Alberto, C.P. & Alegria C, P (2018) Avocado Fruit-Persea americana, Direct Science .com accessed at https://doi.org/100.1016/8978-0.12803138.4.00001.0

Green, M., & Aklilu, A. (2016). Policy design for forest carbon sequestration: A review of economics and cost-effectiveness. *Environmental Science & Policy, 60*, 51-60.

Hairiah, K., Ekadinata, A., Sari, R. R., & Rahayu, S. (2011). Measuring carbon stock in land use systems. *World Agroforestry Centre.*

IPCC. (2006). Guidelines for national greenhouse gas inventories. *Intergovernmental Panel on Climate Change.*

Ishaq, M. A., Kolawole, A., & Adeola, J. (2014). Growth performance and carbon sequestration potential of different tree species in Nigeria. *Journal of Agricultural and Environmental Science, 9*(2), 102-110.

Jasmin, S.K.S. & Birundha, V.D (2017). Urban Forestry and Pollution Mitigation. *International Journal of Research in Commerce & Management, 1*(8), 36-40.

Lottrup, L., Grahn, P., & Stigsdotter, U. K. (2013). Workplace greenery and perceived level of stress: Benefits of access to a green outdoor environment at the workplace. *Landscape and Urban Planning, 110*, 5–11. https://doi.org/10.1016/j.landurbplan.2012.09.002.

Mango Tree Information (2013). The Amazing Mango Tree. *National Mango Board.* Accessed at https://www.mango.org>mango-tree

McPherson, E. G., & Simpson, J. R. (2003). Potential energy savings in buildings by an urban tree planting programme in California. *Urban Forestry & Urban Greening, 2*(2), 73–86. https://doi.org/10.1078/1618-8667-00025

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Synthesis.* Island Press.

Nowak, D.J., Crane, D.E., Stevens, J.C., Hoehn, R.E., Walton, J.T., & Bond, J., (2008). A ground-based method of assessing urban forest structure and ecosystem services. *Arboriculture and Urban Forestry. 34*(6):347358.

Nowak, D. J., & Crane, D. E. (2002). Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution, 116*(3), 381–389. https://doi.org/10.1016/S0269-7491(01)00214-7

Nowak, D. J., Hirabayashi, S., Bodine, A., & Greenfield, E. (2014). Tree and forest effects on air quality and human health in the United States. *Environmental Pollution, 193*, 119–129. https://doi.org/10.1016/j.envpol.2014.05.028

Paladinić, E., Vuletić, D., Martinic, I., Marjanović, H., Indir, K., Benko, M., & Novotny, V. (2009). Forest Biomass and Sequestrated Carbon Estimation According to Main Tree Components on the Forest Stand Scale. *Periodicum Biologorum, 111*, 459-466

Ponce-Hernandez, R., Koohafkan, P., & Antoine, J. (2004). Assessing Carbon Stocks and Modelling Win-win Scenarios of Carbon Sequestration Through Land-use Changes. *Food and Agricultural Organization of the United Nations (FAO), Rome, Italy.* ISBN 92-5-105168-5

Ramanan, S., Arunachalam, A., Singh, R., & Verdiya, A. (2024). Tropical almond (Terminalia catappa): A holistic review. *Heliyon, 10*, e41115. https://doi.org/10.1016/j.heliyon.2024.e41115

Sharma, R. (2020). Assessment of Carbon Sequestration Potential of Tree and Urban Green Spaces. *Atmosphere, 3*(1), 52.

Singh, S., Gupta, N. C., & Bhattacharya, P. (2017). Assessment of air pollution responses through biochemical and physical traits observed for four plant species in an urban area. *In Climate Change, Resource Conservation and Sustainability Strategies* (pp. 32–40). DBH Publishers, Delhi, India

Stephenson, N. L., Das, A. J., Condit, R., Russo, S. E., Baker, P. J., Beckman, N. G., Costa, F. R. C., & Martinez-Ramos, M. (2014). Rate of tree carbon accumulation increases continuously with tree size. *Nature, 507*(7490), 90–93.

Strohbach, M. W., & Haase, D. (2012). Above-ground carbon storage by urban trees in Leipzig, Germany: Patterns of carbon storage in trees in a central *European city. Landscape and Urban Planning, 104*(1), 95–104. https://doi.org/10.1016/j.landurbplan.2011.10.010

Tomlinson, P. B. (2006). The uniqueness of palms. *Botanical Journal of the Linnean Society.*

Ugle, P., Rao, S., & Ramachandra, T. V. (2010). *Carbon sequestration potential of urban trees. Proceedings of Lake 2010: Wetlands, Biodiversity and Climate Change* (conference paper), December 2010, pp. 1–12. (Proceedings; PDF available from conference pages / IISc related sites).

Uko, E. D., & Tamunobereton-Ari, I. V. (2013). Variability of climatic parameters in Port Harcourt, Nigeria. *Journal of Emerging Trends in Engineering and Applied Sciences, 4*(5), 727-730.

Ulolo, M. B., Simbi-Wellington, W. S., & Nnadi, P. C. (2025). Carbon sequestration potential of selected ornamental trees in Isaac Boro Park, Port Harcourt. *International Journal of Agriculture and Environmental Research (IJAER), 11*(1), 142–152. Available at: https://ijaer.in/carbon-sequestration-potential-of-selected-ornamental-trees-in-isaac-boropark-portharcourt

Useful Tropical Plants. (2024). *Terminalia catappa.* Retrieved from https://tropical.theferns.info/viewtropical.php?id=Terminalia+catappa

Watson, R. T., Noble, I. R., Bolin, B., Ravindranath, N. H., Verardo, D. J., & Dokken, D. J. (Eds.). (2000). *Land Use, Land-Use Change, and Forestry.* Cambridge University Press.

World Health Organization. (2019). *Climate change and health* (Fact sheet). World Health Organization. Retrieved from https://www.who.int/health-topics/climate-change