Division 1 Silviculture,
Agroforestry Research Group (1.04.00)

Online Conference

26-27 March 2024

Agroforestry and mitigation of climate change

Abstract Book

Preface

The agroforestry systems are integrative systems with multiple productions, including forest, agriculture grazing, and several other products and services. These forest systems have ecological and economical interactions among their components; are a source of food supply, income and health, especially for smallholder farmers; may provide a wide range of economic, sociocultural, and environmental benefits. They also have a decisive role in the mitigation of climate change. These systems can be used to tackle the effects of variability in climate, including the increase of temperature and decrease of precipitations, as well as their annual and interannual variability while maintaining or increasing productivity, biomass storage, and carbon sequestration.

The IUFRO Agroforestry Research Group's goal are the promotion of activities that enable a worldwide discussion forum for all the researchers that study these systems. This group has organised and participated in various international events focused on forestry and agroforestry.

The online conference ***Agroforestry and Mitigation of Climate Change*** held on 26-27 March 2024 comes in the continuation of the former research group events. Its goals are the analysis and discussion of the current state of knowledge on the mitigation of climate change through concepts, models, risk, vulnerabilities, resilience, and resistance both at the conceptual and practical levels:

- Are agroforestry systems resilient to climate change?
- Can agroforestry systems maintain sustainable biomass and carbon stocks?
- Can multiple productions reduce the vulnerabilities of these systems?
- How can management contribute to mitigate the impacts of climate change in these systems?

This book of abstracts has been put together as a reference knowledge product for those who are interested in this disciplinary area. This online meeting had more than 350 registrations and 90 participants from thirty-seven countries of the five continents of the world, which is promising for attaining the research group's goals. Unfortunately, due to internet failures, some of our participants were unable to attend and present their studies.

Ana Cristina Gonçalves
MED– Mediterranean Institute for Agriculture, Environment and Development, CHANGE, University of Évora, Portugal;
Swoyambhu Man Amatya
Coordinator, Agroforestry Research Group, IUFRO/ Nepal;
Sanjeev K. Chauhan
University of Horticulture and Forestry, Nauni, Solan, India
28 March 2024

Index

Program

26th of March of 2024 (14:00-17:30 UTC)

14:00-14:20	Opening session **Swoyambhu Man Amatya**, Coordinator, IUFRO Agroforestry Research Group
Session 1	Moderator: **Swoyambhu Man Amatya**, Coordinator, IUFRO Agroforestry Research Group.
14:20	Agroforestry policies and performance with respect to mitigation of climate change *Presenter*: Harpal Singh (India)
14:30	Economics of provisional ecosystem services of traditional agroforestry systems practiced in the Vindhya range of Uttar Pradesh *Presenter*: Mayank Shukla (India)
14:40	Agroforestry for climate change adaptation and improving gate-gate life cycle of wood-based Industries in Gujarat, India *Presenter*: Swati Mishra (India)
14:50	Agroforestry: the way forward to mitigate climate change *Presenter*: Garvika Malani (India)
15:00	Impact of climate change on agroforestry and temperate forest vegetation *Presenter*: Ghanshyam Singh (India)
15:10	Toward optimizing agroforestry system for rural development in Nigeria *Presenter*: Faisal Muazu Hasheem (Nigeria)
15:20	Silviculture of planted native trees in Brazil: unveiling knowledge and cutting-edge technologies for sustainable productive systems and climate resilience *Presenter*: Silvio Brienza Junior (Brazil)
15:30-15:50	Discussion
15:50-16:00	Break
Session 2	Moderator: **Sanjeev K. Chauhan**, University of Horticulture and Forestry, Nauni, Solan, India
16:00	Plant diversity, carbon sequestration, and economy of home garden agroforestry in the coastal areas of southeastern Bangladesh *Presenter*: Tapan Kumar Nath (Malaysia)
16:10	Agroforestry systems as sustainable carbon stocks in Northeast India *Presenter*: Ishita Mathur (India)
16:20	Potential of *Ficus thonningii* Blume based agroforestry for mitigating impacts of climate change *Presenter*: Daniel Hagos Berhe (Ethiopia)
16:30	Emergy and nitrogen footprint calculator approach to the sustainable management of *montado* systems *Presenter*: Joana Marinheiro (Portugal)
16:40	Resilience analysis of Ancestral Amazonian Production Systems (AAPS) in the face of climate change considering its mitigation potential and reducing vulnerability through regenerative agriculture practices - Ininkis River watershed Landscape – Ecuadorian Amazon *Presenter*: Adriana Cárdenas (Ecuador)
16:50	Aboveground carbon stocks in home gardens and tea plantations a Sri Lankan village *Presenter*: Ryan Smith (Sri Lanka)
17:00-17:20	Discussion
17:20-17:30	Closing session **Ana Cristina Gonçalves**, MED &Change, University of Évora, Portugal;

27th of March of 2024 (14:00-17:00 UTC)

Session 1	Moderator: **Sheila Ward**, International Society of Tropical Foresters
14:00	Bangladesh's future green: using agroforestry as a primary climate mitigation strategy *Presenter*: Sakib Imran Ali (Bangladesh)
14:10	The role of soil and plant traits in shaping soil moisture levels in Sal forests *Presenter*: Kumari Anandita (India)
14:20	Family homegardens and diet of coffee producers in Sierra Madre de Chiapas, Mexico *Presenter*: Marina Benitez-Kanter (The Netherlands/Mexico)
14:30	Strengthening resilience: agroforestry approaches to wetland restoration and climate adaptation *Presenter*: Sheetal Thakur (India)
14:40	Sustainable agroforestry model: *Perilla frutescens* and apple cultivation in Himalayan Regions *Presenter*: Ankita Chauhan (India)
14:50	Magnitude of Retranslocation of N, P, K in *Populus deltoides* Intercropped with Aromatic Crop *Presenter*: Afreen Mohsin (India)
15:00-15:20	Discussion
15:20-15:30	Break
Session 2	Moderator: **Pramod Kumar Jha**, Professor Emeritus: Tribhuvan University, Nepal.
15:30	The role of rehabilitation of green dam in climate mitigation in Algeria *Presenter*: Sara Hezil (Algeria)
15:40	Sustaining resilience: agroforestry in the Western Himalayan Region as a climate change mitigator *Presenter*: Vijay Kumar (India)
15:50	Stand structure classification with STRUX index *Presenter*: Eva Barrocas (Portugal)
16:00	Impact of cattle grazing on soil compaction: case study in the *montado* Mediterranean ecosystem *Presenter*: João Horta Marques (Portugal)
16:10	Integration of *Melaleuca alternifolia* (tea tree) as a versatile agroforestry species in Kenya and its potential contribution to climate change mitigation effort *Presenter*: Dorcas Njoroge (Kenya)
16:20-16:40	Discussion
16:40-16:50	Closing session **Ana Cristina Gonçalves**, MED, University of Évora, Portugal; **Sanjeev K. Chauhan**, University of Horticulture and Forestry, Nauni, Solan, India; **Swoyambhu Man Amatya**, Faculty of Forestry, Agriculture and Forestry University, Nepal;

Presentations

Agroforestry policies and performance with respect to mitigation of climate change

Harpal Singh[1], Parmeet Kour[2]

[1]Department of Academic Affairs Chandigarh University, Mohali, Punjab, India, [2]Associate Professor Genetics and Plant Breeding UIAS Chandigarh University Mohali Punjab India; harpal.e11881@cumail.in

Abstract

Indeed, agriculture is widely recognized as one of the human enterprises most vulnerable to climate change. There are several reasons for this vulnerability: Agroforestry is recognized as a sustainable land-use practice that combines the cultivation of crops or livestock with the simultaneous management of trees on the same piece of land. This integrated approach has the potential to contribute significantly to climate change mitigation by sequestering carbon, enhancing biodiversity, conserving soil and water, and providing multiple economic and social benefits. The effectiveness of agroforestry in mitigating climate change depends on various factors, including the specific policies in place and the local context. Agroforestry systems can sequester carbon through photosynthesis, helping to offset greenhouse gas emissions. Policies that incentivize and support the establishment of agroforestry systems for carbon sequestration are crucial for success. Agroforestry practices can enhance biodiversity. Moreover, agroforestry practices can enhance biodiversity by providing habitat for various plant and animal species. Policies promoting the integration of native tree species and diverse crops in agroforestry systems contribute to biodiversity conservation. Besides that, preventing soil erosion, improving soil structure, and enhancing nutrient cycling. Policies supporting sustainable land management practices within agroforestry systems are essential for maintaining soil health. Integration of all the components will lead to improve water retention, reduced runoff, and enhanced water quality. Policies that promote water-efficient agroforestry practices are crucial for adapting to climate change impacts on water resources. Here are some key points regarding agroforestry policies and performance in the context of climate change mitigation viz., economic, social, research and intellectual property rights.

Keywords: Integrated approaches, Agroforestry practices, Land Tenure and Property Rights

Economics of provisional ecosystem services of traditional agroforestry systems practiced in the Vindhya range of Uttar Pradesh

Mayank Shukla, Sunil Kumar, Kaushal Singh

Department of Forestry & Environmental Science, Manipur University, Imphal- 795003, Manipur, India; College of Forestry, Banda University of Agriculture & Technology, Banda, Uttar Pradesh, India, 210001; mayankshukla153@gmail.com

Abstract

Economic evaluation of agroforestry systems often lacks valuation of provisional ecosystem services such as producing fruit, fuelwood, seed, and other harvestable goods. An economic evaluation of these services helps to determine their market value for green credit schemes. Hence, the present study was conducted in ten villages of Hamirpur district of Uttar Pradesh (India) in 2022-2023, assessing yield and market prices of fruit, fuelwood, and seeds produced by tree species grown in traditional agroforestry systems. Questionnaire-based methods were used to survey the farmers cultivating agroforestry crops to determine the yield and local markets selling the produce to assess their commercial cost. The per-year yield of fuelwood was 274 kg, fruit was 875 kg, and seed was 315 kg. The total value of these services was ₹571,650 per year. Among the fruit crops, *Tamarindus indica* L. generated the highest value of ₹112000 per year, and *Psidium guajava* L. generated the lowest value of ₹5250 per year. For fuelwood, *Tamarindus indica* L. was the tree with the highest value of ₹3500 per year, while *Mangifera indica* was the lowest (₹3000 per year) in income generation. The study recommends the most profitable agroforestry systems suitable in the Vindhya range of the state with the determination of their economic models.

Keywords: Ecosystem services, traditional Agroforestry system, fuelwood, fruit, seed

Agroforestry for climate change adaptation and improving gate-gate life cycle of wood-based industries in Gujarat, India

Swati Mishra

Institute of Wood Science and Technology (IWST), Indian Council of Forestry Research and Education (ICFRE), F-18, Institute of Wood Science and Technology, 18 Cross Road Malleshwaram, Bengaluru, India- 560003; swathi.mishra04@gmail.com

Abstract

India is one of the largest producers of tropical logs but cannot meet its own demand for the wood products and along with the legal restriction in the use of forest resources and low supply of wood from the agroforestry systems, the country has to largely depend on the import of the raw materials to sustain its wood-based industries (ITTO, 2017; Prasad, R., et al., 2023). Considering the shortages of raw material in the internal market, agroforestry is one of the best alternatives to fulfil the demands. It is a sustainable practice that can provide the raw material to the wood-based industries as well as the non-timber forest products in a shorter period and can also improve the nutrient status of soil, socio-economic conditions and improve micro-climate (Quandt, A. et al., 2023). The research assessed the gate-gate life cycle of the selected wood-based industries in Gujarat, India and the result showed that the agroforestry in the nearby wastelands and contract agricultural farms would reduce the vehicular emissions and economic costs of these industries while raising the profits of the industries and the farmers. Also, the environmental toxicity and GHG emissions would vastly improve and result in a resilient climate through carbon sequestration. The relevant agroforestry system in addition to the infrastructure availability, capacity building and better access to markets promise the regulation of climate extremes and risk for uncertainty.

Keywords: Gate-Gate Life Cycle Assessment, Wood-based Industries, Agroforestry, Climate Change Adaptation

Agroforestry: The way forward to mitigate climate change

Garvika Malani

Chanakya University, Bengaluru, Malani X-ray Clinic, Chirawa, Rajasthan, 333026, India,
malanigarvika@gmail.com

Abstract

Agroforestry has been widely practised in most of the continents, but India is the first nation in the world to adopt an inter-sectoral National Agroforestry Policy (NAP), 2014. It is undertaken throughout the country in all climatic regions in different localized forms. Through its physical and intangible benefits, agroforestry plays a crucial part in the Indian economy. Apart from that, the policy is majorly seen crucial to India's goal of achieving 33% tree cover. While achieving this will be victorious for India, growing tree plantations which are not native to the region can threaten rural livelihoods as well as the biodiversity of the region. The aim of this study is to understand if India's strategy to mitigate climate change and help the livelihoods of farmers, through agroforestry, can be done through the involvement of more niche specific approach. This can be used to examine how agroforestry increases adaptive capacity and reduces vulnerability.

Keywords: Agroforestry policy, India, decentralized, Mitigating climate change

Impact of climate change on agroforestry and temperate forest vegetation

Ghanshyam Singh

Dr. Yashwant Singh Parmar University of Horticulture and Forestry Solan, Village – Baragran, P.O. Panihar, Tehsil - Banjar, District -Kullu, H.P. 175106, India, ghanshyamgt8387@gmail.com

Abstract

IPCC defines climate change broadly as “any change in climate over time whether due to natural variability or as a result of human activity”. Throughout history, agroforestry has evolved significantly and remains a cornerstone of human civilization, yet it faces threats from climate change, which impacts crop yields, livestock and food security. Changes in temperature, precipitation patterns and CO_2 levels affect crop productivity, with some crops benefiting from warmer temperatures while others suffer from heat stress or water scarcity. The direct consequences of climate change on productivity disrupt ecosystems and endanger global food security. According to the FAO's "State of Food Security and Nutrition Report" 2023, over 3.1 billion people globally, representing 42 percent, were unable to afford a nutritious diet in 2021. Man has affected the environment throughout his stay on earth; the impact has been most intense in the relatively short era. Concern has been expressed by a number of researchers that greenhouse-gas induced climatic changes will severely impact the mountain regions of the world. Climate change is caused both by natural variability (continental drift, volcanic eruption, solar output) as well as anthropogenic activities (green house gases and land use change). More than 90% global warming is caused due to human interference than natural variability. Temperate forest Occur in the mid-latitudes, typically from the Tropic of Cancer (23½º north latitude) to about 50º north latitude, and south of the Tropic of Capricorn (23½º south latitude). These forests constitute both broadleaves as well coniferous tree species. Climate change has number of impact on temperate forest like vegetation shifts, habitat loss, insect pest outbreaks, affects on natural regeneration etc. Climate change is a worldwide problem and therefore it requires a response from the entire international community to overcome these impacts.

Keywords: Climate change, agroforestry, Food security, temperate forest

Toward optimizing agroforestry system for rural development in Nigeria

Faisal Muazu Hasheem

Hassan Usman Katsina Polytechnic Katsina, Katsina State, Department of Forestry Technology, Nigeria, faisalmuazuhasheem@gmail.com

Abstract

Agroforestry can be utilized on sustainable basis as a rural development strategy. Apart from responding to farmers' needs for food, wood fodder and environment protection, agroforestry also aims at improving the income and quality of life of the rural dwellers, thereby solving the problems caused by population pressure and deforestation. Unfortunately, not much attention has been paid to optimizing the immerse potential of the various agroforestry system in Nigeria for grater rural development. This paper discusses the goals and benefits of the various system for the environmental, socio-economic and industrial needs of the rural community

Keywords: Agroforestry, Taungya system, rural community, Sylvopastoral, Agrosylvopastoral

Silviculture of planted native trees in Brazil: unveiling knowledge and cutting-edge technologies for sustainable productive systems and climate resilience

Silvio Brienza Junior[1] , Fátima C. M. Piña-Rodrigues[2], Miguel Calmon[3], Samir G. Rolim[4], Miguel L. M. Freitas[5], Daniel Piotto[6], Luciano M. Verdade[7], Marcelo F. Arco-Verde[8], Ricardo A. G. Viani[9], Renata E. de Oliveira[10], Tatiana M. Amaral[11], Carlos E. S. da Silva[12]

[1]Embrapa Florestas, Colombo (Paraná state), Brazil, silvio.brienza@embrapa.br, [2]Universidade Federal de São Carlos, Sorocaba (São Paulo state), Brazil, fpina@ufscar.br, [3]WRI Brasil, São Paulo (São Paulo state), miguel.calmon.5@wri.org, [4]Amplo Engenharia, Belo Horizonte (Minas Gerais state), Brazil, sgrolim@gmail.com, [5]Instituto de Pesquisas Ambientais, São Paulo (São Paulo state), Brazil, miguel.freitas@sp.gov.br, [6]Universidade Federal do Sul da Bahia, Ilhéus (Bahia state), Brazil, daniel.piotto@ufsb.edu.br, [7]Universidade de São Paulo, Piracicaba (São paulo state), Brazil, lmverdade@gmail.com, [8]Embrapa Florestas, Colombo (Paraná state), Brazil, marcelo.arco-verde@embrapa.br, [9]Universidade Federal de São Carlos, Araras (São Paulo state), Brazil, viani@ufscar.br, [10]Universidade Federal de São Carlos, Araras (São Paulo state), Brazil, reolivei@ufscar.br, [11]Parque Científico e Tecnológico do Sul da Bahia, Ilhéus (Bahia state), Brazil, tatiana_amaral@pctsb.org, [12]Parque Científico e Tecnológico do Sul da Bahia, Ilhéus (Bahia state) Brazil, carlos_silveira@pctsb.org

Abstract

The economic silviculture of native species in Brazil has the potential to meet the demand for tropical sawn wood, reduce deforestation, maintain, and improve environmental services and biodiversity conservation, generate green jobs, increase producer income, and catalyse public and private financing. The challenge is to find suitable native species and production systems adapted to the socioeconomic conditions of the target audience. However, some questions must be answered such as: which species to plant, growth rate, time to harvest, product quality, and potential market. An initiative stimulated by the Coalition Brazil, Climate, Agriculture and Forests and the World Resources Institute (WRI) in 2018 reviewed 3,303 studies on Brazilian native forest species. After analysis by 50 experts from Brazil, 15 species were prioritised for the Amazon biome and 15 for the Atlantic Forest biome. The synthesis of this work resulted in a Research and Development Program (R&D) for native species, inspired by the success of Brazil's forestry and agribusiness sectors, which together represent over 20% of the Brazilian GDP. The selection of many species was intentional because in Brazil, silvicultural systems for native species, such as mixed plantations and agroforestry systems, demand more species than those traditionally used for exotic species, and they should cover different climatic conditions present in the biomes. In general, more than 50% of the species used in agroforestry systems in the field are included in the selection. Diverse systems with a balance of ecological and social goals can play a relevant role in improving local livelihoods, increasing forest productivity, strengthening the resilience of tree plantations to adverse climatic conditions, and, when appropriate, complying with Brazilian Environmental Law.

Keywords: agroforestry systems, native trees species, amazon region, Atlantic forest biome, silviculture.

Plant diversity, carbon sequestration, and economy of home garden agroforestry in the coastal areas of southeastern Bangladesh

Tapan Kumar Nath

School of Environmental and Geographical Sciences, University of Nottingham Malaysia, Jalan Broga, Semenyih 43500, Selangor, Malaysia, Tapan.Nath@nottingham.edu.my

Abstract

Home garden agroforestry in coastal rural areas offers a diverse range of benefits and services to the locals. This study investigated the plant diversity, biomass, carbon stock, and economic impact of home garden agroforestry. A survey was conducted in the ecologically critical area of Cox's Bazar in Bangladesh. Data was gathered by interviewing 140 households and through a series of vegetation surveys of 70 home gardens. We have found a total of 73 plant species, with an average density of 4,000 plants per hectare. The average values of the species diversity index, Shannon-Wiener diversity index, and species richness were 1.4, 2.22, and 5.72, respectively. The estimated above-ground biomass was 235.45 megagrams per hectare, which is equivalent to 117.73 megagrams of carbon per hectare. The villagers annually plant seedlings, so ensuring the presence of many diameter and height classes that demonstrate the long-term viability of their home gardens. Agroforestry significantly enhances household income, provides fuelwood and timber for household use and trade, and safeguards communities during storms. These gardens effectively contribute to the reduction of climate change, preservation of biodiversity, and enhancement of the household economy. In an effort to encourage the farmers for sustainable conservation practices in home gardens, they can be offered financial incentives through climate change mitigation initiatives.

Keywords: Home gardens, diversity, biomass, carbon stock, economy

Agroforestry systems as sustainable carbon stocks in Northeast India

Ishita Mathur, Prodyut Bhattacharya

Guru Gobind Singh Indraprastha University, Dwarka Sec 16C, Delhi-110078, India, ishitamthr@gmail.com

Abstract

Agroforestry systems in various regions, including Northeast India, play a significant role in carbon sequestration and biomass production. Across India, agroforestry practices vary from basic monoculture to complex home gardens, impacting biomass production and carbon sequestration potential across agro-climatic zones. Agrosilvopastoral systems stand out for their higher biomass carbon (C) and Soil Organic carbon (SOC) stocks compared to other systems. In humid zones, including the North-Eastern region, total biomass C and SOC stocks are significantly higher. SOC stocks were also significantly higher in medium altitudes compared to high and low altitudes. The North-Eastern Hill region of India has a rich tradition of agroforestry systems and is estimated to store between 85.34 and 121.87 Mg C ha-1 of carbon. However, within the region, carbon accumulation varies due to factors such as climate, rainfall pattern, vegetation, topography, land use, ethnicity, and cultural diversity. Tree diversity's role in carbon storage is crucial, suggesting strategic species management for optimal sequestration. The intricate relationship between tree diversity and carbon storage underscores the complexity of managing carbon sinks effectively. While traditional agroforestry practices show promise as carbon sinks when managed sustainably, their efficacy is contingent upon factors such as species composition and stand density. Notably, oil palm agroforestry proves effective in boosting crop yield and ecosystem carbon stock, especially in northeast India's degraded jhum land. Yet, anthropogenic activities near the Himalayas disrupt carbon sequestration, exacerbating climate change concerns. These findings advocate for land degradation neutrality and Sustainable Development Goals alignment.

Keywords: Agroforestry Systems, Carbon Stocks, Biomass production, tree diversity, traditional agroforestry

Potential of *Ficus thonningii* Blume based agroforestry for mitigating impacts of climate change

Daniel Hagos Berhe

Adigrat University, P. O. B0x 123, Adigrat, Tigai, Ethiopia, danielhgs829@gmail.com

Abstract

A study was conducted on the biomass production and fodder quality of *F*. *thonningii* (Blume) and its effect on soil physico-chemical properties in Ahferom district of Tigray, Ethiopia. Biomass estimation was carried out on randomly selected mature trees. Determination of foliar macronutrients and proximate chemical compositions was undertaken using five diameter classes. For soil physico-chemical property study, two factors (distance from the tree trunk and depth from the ground level) arranged in RCBD with six replications was involved. The distance factor had three levels while the depth factor had two levels viz. surface and subsurface soil layers. All data collected were subjected to ANOVA. Results of dendrometric parameters and biomass estimation revealed that altitudinal gradient significantly affected DSH, DBH, total tree height, clean bole length, stem volume, crown diameter, crown height, crown area, leaf biomass, branch biomass, stem biomass, aboveground biomass, below ground biomass, total biomass and total biomass carbon stock while it had no effect on crown depth. The tree diameter size also had an effect on foliar N, P, K, DM, CP, DCP, EE and CF while it had no effect on ash content and NFE. Results of soil physico-chemicals also revealed that except for soil texture, the studied soil physico-chemical properties (soil bulk density, moisture content, soil N, soil P, soil K, % OC, pH, EC) were enhanced under *F*. *thonningii* canopy as compared to canopy gap. This demonstrates the potential of *F*. *thonningii* based agroforestry for mitigating the impact of climate change in the drylands. *F*. *thonningii* leaves were demonstrated to be good source of nutrients (proteins, fats, carbohydrates, fibre and minerals) and are within the recommended range for ruminant livestock growth and development. Hence, use of *F*. *thonningii* as substitute livestock feed to low quality grasses in the district, especially during the feed scarce periods has to be an alternative.

Keywords: Tree height, Biomass carbon stock, Soil texture, Soil carbon stock

Emergy and Nitrogen footprint calculator approach to the sustainable management of *montado* systems

Joana Marinheiro, Soraia Cruz, Ana Fonseca, Cláudia Marques-dos-Santos

Forest Research Centre CEF, Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Portugal; jmarinheiro@isa.ulisboa.pt

Abstract

The integrated crop-livestock system, or mixed production, confronts challenges such as rising costs, diminishing knowledge, and evolving regulations. However, it can also present synergies and socioeconomic benefits. This study assesses the *montado* system in southern Portugal—an extensive silvo-pastoral system featuring cork and holm oak production alongside animal grazing. A primary challenge for *montado* systems is soil resilience. The naturally acidic soils often exhibit low organic matter content. Past management practices in Portugal, notably the cereal campaign in the 30's depleting soil minerals, and early Common Agricultural Policy encouragement to increase the number of animals per hectare in extensive cattle grazing, have negatively impacted soil health hence I nutrients availability, such as nitrogen. Key strategies involve promoting tree regeneration to enhance soil organic matter (SOM) and water retention, as well as investing in improved pastures. Well-managed pastures not only provide more livestock feed but also shield soils from further erosion. Leguminous pastures play a crucial role, fixing high nitrogen input into the soil, contributing to environmental sustainability, and reducing the need for inorganic nitrogen input purchase.

The study uses an emergy assessment as a tool for evaluating resource management and sustainability within the *montado* system, particularly concerning various nitrogen management practices. A sheep cork oak *montado* farm was assessed and different scenarios for nitrogen input were considered.

Keywords: Emergy assessment; N footprint; *montado*; Sustainability

Resilience analysis of Ancestral Amazonian Production Systems (AAPS) in the face of climate change considering its mitigation potential and reducing vulnerability through regenerative agriculture practices - Ininkis River watershed Landscape – Ecuadorian Amazon

Adriana Cárdenas

Simón Bolivar Andean University, adricarde@gmail.com

Abstract

The Ancestral Amazonian Production System (AAPS), classified as agroforestry, is an integral system of agricultural production where crops are related to nature. It associates food crops that are produced together with medicinal and forestry plants, to guarantee food for the Amazonian indigenous peoples. The framework for action against climate change seeks to increase climate resilience. The relationships and synergies that constantly occur in ecosystems and agroecosystems, both components of a landscape (resulting from processes such as adding organic matter to the soil, increasing biodiversity, integrating different types of livestock and small animals, taking advantage of exchanges with the forest) can increase productivity and resilience. This research focuses on the Ancestral Amazonian Productive System (AAPS), with emphasis on the Aja Shuar, and seeks to analyse its potential contribution to climate change mitigation and adaptation considering its landscape context (Ininkis River watershed) and consequent resilience, also taking into account its relationship with regenerative agriculture. For this purpose, a comparative analysis was developed to know the carbon benefit in a landscape inhabited by members of the Shuar indigenous group, who prioritize the AAPS as a form of production; versus a landscape under similar biophysical and legislative conditions, but which prioritizes conventional agricultural production. In addition, the traditional and modern agro-productive practices applied in the AAPS were identified as a key to adaptation and resilience increase. It was found that the landscape in which the AAPS are embedded has a very low expansion of the agricultural border, which shows that the contribution of the AAPS to mitigation is at least 42% higher than that of conventional systems. It was also determined that the traditional and modern agro-productive practices applied in these systems are aligned with regenerative agriculture and agroecology, thus leading to adaptation and resilience to climate change by maintaining the health of the intervened soils.

Keywords: resilience, agroecological landscape, mitigation, adaptation, Ancestral Amazonian Productive System (AAPS)

Aboveground carbon stocks in home gardens and tea plantations a Sri Lankan village

Ryan Smith

The Forest School, The Yale School of the Environment. 360 Prospect St, New Haven, CT 06511, USA, ryan.tw.smith@gmail.com

Abstract

Home gardens and tea plantations are two widespread yet understudied small-holder land uses in the South Asian tropics and subtropics. We created a land-use Land Classification map of a village in the buffer zone of the Sinharaja Man and Biosphere Reserve in Sri Lanka's wet tropical zone. We sampled home gardens and tea plantation of 24 households using random fixed radius plots. We then measured the carbon storage per hectare in home garden and tea plantation land uses, using allometric equations specific to functional groups. The average household sampled had 0.18 ha of home garden and 0.29 ha of tea plantation land uses, with a mean of 2.0 tea plantations per household. Five households had two home gardens, with older, more established home gardens surrounding homes that were unoccupied due to upslope risks of landslides. Home gardens stored 59.0 Mg C ha-1 and tea agroforestry systems 11.5 Mg C ha-1. The majority of the carbon was stored in trees (48%) and palms (29%) in home gardens and tea shrubs (92%) in tea plantations. Other minor land uses in the village included riparian forest, rubber plantation, secondary forest, rice paddy, home patio, and early successional scrub. The results of this study contribute to our understanding of carbon stocks in smallholder landscapes in wet tropical South Asia.

Keywords: Carbon stocks, Home Garden, Tea, Agroforestry, Sri Lanka

Bangladesh's future green: Using agroforestry as a primary climate mitigation strategy

Sakib Imran Ali

Conservation and Land Management, Bangor University, United Kingdom, Environmental Management, Independent University, Bangladesh, sakib.bangor@gmail.com

Abstract

Agroforestry is essential for achieving biodiversity targets, supplying sustainable livelihoods, offsetting gas emissions, and localizing SDGs. Bangladesh is a highly populated nation with a quickly expanding economy. There are frequent environmental problems such as deforestation, air, and water pollution, as well as its susceptibility to the effects of climate change, such as cyclones and flooding. Due to the frequent effects of natural hazards, there is a potential mitigation strategy that can be seen in the integration of trees and shrubs into agricultural landscapes. The 2016 Resolution on Agroforestry of the South Asian Association for Regional Cooperation established a strong enabling condition to guarantee the efficacy of employing agroforestry for climate targets by drawing all regional countries to a consensus on the implementation of national agroforestry policies. As Bangladesh struggles with the impacts of climate change and environmental degradation, it is more important than ever to implement sustainable land management strategies. Some of the upcoming green initiatives that agroforestry can help support the upcoming green initiatives are carbon sequestration, resilience of soil health, biodiversity conservation, sustainable livelihood, water management, community resilience, and policy support. Bangladesh can use these initiatives to reduce the potential of greenhouse gas emissions, improve ecosystem resilience, and support sustainable rural livelihoods by utilizing agroforestry as a key component of its green development program. This might prepare the way for a future that is simultaneously greener and more resilient.

Keywords: Agroforestry, biodiversity, sustainable livelihoods, community resilience, Bangladesh

The role of soil and plant traits in shaping soil moisture levels in Sal forests

Kumari Anandita[1], Anand Kumar Sinha[2], C Jeganathan[3]

[1,2] Department of Civil and Environmental Engineering. Birla Institute of Technology, Mesra. Ranchi. Jharkhand, India; [3]Department of Remote Sensing. Birla Institute of Technology, Mesra. Ranchi. Jharkhand, India, anandita1247@gmail.com

Abstract

This study investigates the nuanced relationship between soil and plant characteristics and their influence on soil moisture content within Sal (Shorea robusta) forest ecosystems. Sal, a pivotal tree species across various Asian landscapes, significantly contributes to water cycling and enhances soil fertility. Through a multidisciplinary approach incorporating soil science, botany, and environmental physics, this paper examines the critical factors affecting soil moisture retention in Sal forests. The research methodology includes an in-depth analysis of both soil properties and plant traits, identifying a synergistic interaction that profoundly influences soil moisture levels. Such insights are vital for forest health and the development of management strategies. The findings enhance our understanding of Sal Forest ecosystems and provide valuable guidance for implementing sustainable forest management techniques in the face of climate change and increasing water scarcity challenges. This paper underscores the importance of integrating multiple scientific perspectives to address the complexities of forest ecosystems and the necessity of holistic management practices that consider the interdependence of soil and plant characteristics for ecological equilibrium.

Keywords: Sal Forest; Soil moisture; Soil and plant interaction; Principal component analysis; ANOVA

Family homegardens and diet of coffee producers in Sierra Madre de Chiapas, Mexico

Marina Benitez-Kante

Wageningen University and Research, Forest and Nature Conservation Policy (FNP), P.O. box 47, 6700 AA Wageningen, The Netherlands, marina.benitezkanter@wur.nl

Abstract

Currently, the domestic groups that live in the coffee-growing areas have a way of life based on coffee planting, a trend that has intensified in the last 30 years due to the structural reforms that have been carried out in the Mexican countryside. The objective of this work is to characterize the diet of domestic groups coffee growers, the contribution of the family garden to the diet and the changes that have occurred in last 40 years with the intensification and specialization of coffee cultivation, from the agroecological perspective. For this, socioeconomic interviews were carried out semi-structured, weekly food consumption reminders, and were characterized the family gardens of 36 domestic groups that produce organic coffee for sale in a second level organization. The study was carried out in 9 locations in the municipalities of Motozintla, Tuzantan and Huixtla in the Sierra Madre of Chiapas, Mexico. Although family gardens provide about 80 edible products to the diet of the homes studied, these are mainly made up of plants from the strata creeping and herbaceous, have three strata of plants on average, and only contribute around 3% of the caloric intake of the household diet. On the contrary, a diet was found growing and dependent on grains, seeds and industrialized foods, which have high content of sugars, fats and chemicals, and that do not meet consumer needs nor of nutritional quality for domestic units. Changes in the gardens family and food in the study area in recent decades, are related with the specialization and intensification of coffee cultivation, mainly in the groups young domestics.

Keywords: Agroforestry systems, coffee production, sustainable livelihoods, homegardens, Mexico

Strengthening resilience: Agroforestry approaches to wetland restoration and climate adaptation

Sheetal Thakur

Department of Silviculture and Agroforestry, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, India, sheetalthakur2912@gmail.com

Abstract

This abstract underscores the urgent need to address wetland degradation and mitigate climate change through agroforestry practices. Wetlands, critical ecosystems supporting over 35% of global biodiversity and storing 30% of land-based carbon, are disappearing rapidly, three times faster than forests (Global Wetland Outlook 2021). Globally, more than 64% of wetlands have been lost since 1900, exacerbated by climate change-induced temperature rises and altered precipitation patterns (Davidson et al., 2014; IPCC, 2019). Additionally, degraded wetlands contribute about 6% of global greenhouse gas emissions annually due to carbon release (Bridgham et al., 2013). Recognizing wetlands' significance as carbon sinks, restoring them is crucial, as they sequester an estimated 30% of the world's terrestrial carbon (Bridgham et al., 2013). Agroforestry, integrating trees and shrubs into agricultural landscapes, offers a multidisciplinary approach to wetland restoration and climate change mitigation. Studies demonstrate that agroforestry practices can enhance carbon sequestration by up to 30% compared to conventional agriculture, while improving soil health and biodiversity (Nair et al., 2009; Jose, 2009). Incorporating agroforestry techniques such as riparian buffers, alley cropping, and silvopasture into wetland restoration efforts can yield synergistic benefits, including improved soil stability, enhanced water quality, and increased habitat diversity (Jose, 2009; Paul et al., 2001). This abstract advocates prioritizing wetland restoration within climate change mitigation strategies and highlights agroforestry's transformative potential. Recent case studies illustrate agroforestry's effectiveness in restoring degraded wetlands while mitigating climate change impacts (Kremen et al., 2020; Pretty et al., 2021). As research on this topic is limited, further exploration is essential to understand the complex dynamics between wetland degradation, climate change, and agroforestry practices. By investigating this field, innovative approaches can be developed to address the dual challenges of wetland conservation and climate change mitigation, fostering a more sustainable future.

Keywords: Agroforestry, climate change, mitigation, wetland restoration

Sustainable agroforestry model: *Perilla frutescens* and apple cultivation in Himalayan regions

Ankita Chauhan

Dr YSPUHF, Nauni, Solan, HP, 173230, India, nancy.chauhan.a1997@gmail.com

Abstract

The Himalayan region faces significant challenges from population growth and climate change, prompting the need for innovative agricultural sustainability solutions. This study proposes a sustainable agroforestry model centered around *Perilla frutescens* (perilla) and apple cultivation in mid to high hill Himalayan areas. Rapid population growth exacerbates the demand for limited resources like land and water, necessitating efficient resource management in food production. Climate change further compounds these challenges with unpredictable weather patterns leading to crop failures. Perilla, traditionally grown in mountainous regions, emerges as a resilient crop rich in omega proteins and fats, requiring minimal inputs and thus suitable for small-scale farmers and promoting natural farming practices (requiring only 2 to 3 hoeing sessions, and without the need for pesticides or fertilizers). Its wide altitudinal range from 1200 to 3000 meters contributes to the preservation of Himalayan culture and biodiversity. This study highlights perilla's potential as an alternative crop, offering economic benefits with current market prices ranging from 500 to 600 rupees per kilogram. Cultivating perilla alongside apple trees in agroforestry systems can lead to synergistic benefits. Apple trees provide partial shade, regulating soil moisture, while underground root interactions enhance soil fertility and nutrient cycling, benefiting both species. By aligning with local food traditions and geographical suitability, perilla cultivation presents a promising opportunity for Himalayan farmers. Moreover, its cultivation supports natural farming principles, addressing the urgent need for sustainable agricultural practices in the region. As society reevaluates the importance of traditional crops, perilla emerges as an asset, connecting cultural heritage with contemporary agricultural needs.

Keywords: Agroforestry, Himalayan, natural farming, climate change, cultural heritage

Magnitude of retranslocation of N, P, K in *Populus deltoides* intercropped with aromatic crop

Afreen Mohsin

Forest Research Institute, Kaulagarh, Dehradun, India, aafreenmohsin@gmail.com

Abstract

The annual litter production with increasing age of *Populus deltoides* plantations both in the pure and intercropped stands with *Mentha* spp. (*Mentha arvensis*, *Mentha piperita*, *Mentha citrata*). An increase in litter production was recorded in all the intercropped in comparison to pure stands at all the ages. Higher concentration of N, P and K was observed in the litter of the intercropped stands which decreased with increasing ages of the pure stands. Nutrient concentration in green foliage, decreased with increasing ages of the stands. It was higher in the stands intercropped with *Mentha* spp. (*Mentha arvensis*, *Mentha piperita*, *Mentha citrata*) than the pure stands. Magnitude of retranslocation (%) in pure as well as intercropped plantation, increased with increasing ages of the stands.

Keywords: *Populus deltoides*, *Mentha* spp., Litterfall, Retranslocation

The role of rehabilitation of green dam in climate mitigation in Algeria

Sara Hezil

Centre de Recherche en Agropastoralisme- CRApast, Djelfa, Algeria, Sara.hezil@crapast.dz

Abstract

The programme of the plantation of the "Green Dam" launched during the 1970s in Algeria that have re-launched recently. The revival of this project is considered as the most projects in Northern Africa countries and an intelligent and innovative way to fight to fight against desertification and climate change. In this investigation we studied the newly plantation in the semi-arid area in the biodiversity in forests and its impact on adaptability on the climate change effects. Our findings revealed that revival the green dam with a heterogenic botanical species resistant will impacted significantly on the mitigation of impacts of the climate change.

Keywords: Algeria, Climate Change, Green Dam, and Forest

Sustaining resilience: Agroforestry in the Western Himalayan region as a climate change mitigator

Vijay Kumar
Dr. YSPUHF Nauni, Solan (H.P.), India, jamwalv596@gmail.com

Abstract

The Himalayan ecosystem is more vulnerable to the adverse effects of climate change, experiencing more rapid warming than the global average. This has led to various repercussions, such as rising temperatures, accelerated snowmelt, and an increased frequency of droughts and floods, remarkably impacting the area's food and water security, habitat well-being, and agricultural productivity. Recent Intergovernmental Panel on Climate Change (IPCC) reports underscore agroforestry as a promising agroecological strategy for climate change adaptation in the Western Himalayas. These systems exhibit resilience to climate change and possess the potential to uphold sustainable biomass and carbon stocks. Moreover, integrating diverse productions within agroforestry systems can mitigate vulnerabilities and bolster overall resilience. The Himalayan region boasts a longstanding tradition of tree-based smallholder agroforestry practices featuring a rich array of tree species. Over the years, smallholders have developed various indigenous agroforestry systems tailored to local needs and site-specific characteristics. These practices hold substantial promise for carbon storage and atmospheric carbon dioxide removal through enhanced tree growth and development. Carbon sequestration via agroforestry emerges as an economically attractive opportunity for addressing global climate change and engaging in carbon trading. By strategically incorporating trees into agricultural landscapes, these systems sequester carbon dioxide, thus mitigating climate change while enhancing essential ecosystem services for human well-being. Furthermore, the multifunctional aspect of agroforestry systems mitigates vulnerabilities by diversifying production, offering resilience against crop failures and market fluctuations. Agroforestry augments agricultural productivity while safeguarding livelihoods from climate-induced disruptions by leveraging complementary interactions among different components.

Keywords: Agroforestry, Western Himalayas, Climate change

Stand structure classification with STRUX index

Eva Barrocas
Monte Outeiro, Ferreira do Alentejo, Portugal, ev.barrocas@gmail.com

Abstract

The increasing climate change impacts are creating new challenges in the agroforestry systems in the Mediterranean. In the Iberian Peninsula, there are vast areas of *montado*, an ancestral open oak woodland, and a multifunctional agro-silvopastoral system. Despite the importance of the *montado*, the oak crown cover has been reduced. In the south of the Iberian Peninsula, the territorial combination of the soil susceptibility to desertification and the irregular water availability is threatening the future of this region. Understanding stand structure distribution concerning the patchy structure of the *montado* landscape should be considered an important point for future research and for the development of silviculture measures of adaptation and mitigation to climate change. The research carried out in this study seeks to deepen the knowledge about the dynamics of holm oak forest pure stands in the *montado* agroforestry system. The holm oak was the species chosen because it demonstrates remarkable drought resistance when compared to the other oaks. Besides, it can grow in various types of soil, even when the soil is less fertile. The crown cover was chosen as the main factor in this study. A new methodology was created to evaluate the structure in oak stands, that is the distinction between even-aged and uneven-aged stands, with an index, the STRUX Index. This index uses the diameter at breast height as dependent variable. The results showed that a higher crown cover of oak was linked to uneven-aged structure and higher values of above-ground biomass. Uneven-aged forest systems present an increasing resilience, which puts forward the possibility that continuous cover forestry can be a tool to mitigate the impacts of climate change in these systems.

Keywords: *montado*, agroforestry systems, stand structure, above-ground biomass, mitigation

Impact of cattle grazing on soil compaction: Case study in the *Montado* Mediterranean ecosystem

João Horta Marques[1,2],Shakib Shahidian[1],Emanuel Carreira[1],José Marques da Silva[1,3], Luís Paixão[3],Luís Lorenzo Paniagua[4],Francisco Moral[5],Isabel Ferraz de Oliveira[1] , Elvira Sales-Baptista[1], Sara Mendes[1], Daniel Bailote[1], João Serrano[1]

[1]MED - Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento & CHANGE, Universidade de Évora, Évora, Portugal, [2]CEF – Centro de Estudos Florestais e Laboratório Associado Terra, Instituto Superior de Agronomia, Universidade de Lisboa, Lisboa, Portugal, [3]AgroInsider Lda., 7005-841 Évora, Portugal, [4]Escuela de Ingenierías Agrarias, Universidad de Extremadura, Avenida Adolfo Suárez, S/N, 06007 Badajoz, Spain, [5]Departamento de Expresión Gráfica, Escuela de Ingenierías Industriales, Universidad de Extremadura, Avenida de Elvas, S/N, 06006 Badajoz, Spain, joao.horta.marques@uevora.pt

Abstract

Montado is the agro-silvo-pastoral system type dominant in the south of Portugal and Spain (*Dehesa*). Generally, includes dryland pastures, essentially composed of grasses and legumes. The predominant trees are cork oaks (Quercus suber L.) and/or holm oaks (Quercus rotundifolia Lam.). In 2021/2022 agricultural year, two plots of Mitra farm (University of Évora) with an area of around 20 ha, grazed by cattle on a deferred basis, were monitored. Were georeferenced 24 sampling areas (12 in each plot, half under tree canopy and half outside tree canopy). During this period, precipitation (average of 400 mm) was substantially lower than the climatic normal (approximately 600 mm). After precipitation events, pasture productivity and quality and soil resistance to penetration (cone index, CI) in the topsoil layer (depth 0-0.45 m) were measured. Despite the year being dry, pasture production can be considered normal in dryland pastures (plot A: 1.95 ± 0.51 ton of dry matter/ha; plot B: 1.65 ± 0.48 ton of dry matter/ha). In terms of soil compaction, significant differences were detected between points but not between plots, with, however, a weak correlation between CI and pasture productivity and no relationship between CI pasture quality. Trees effect was positive on pasture quality, but negative on pasture productivity. The results are limited to the characteristics of the year, but support the hypothesis of the *Montado's* resilience to climate change.

Keywords: Animal trampling; sensors; cone index; dryland pastures; productivity and quality

Integration of *Melaleuca alternifolia* (tea tree) as a versatile agroforestry species in Kenya and its potential contribution to climate change mitigation efforts

Dorcas Njoroge

Forestry Research Institute, p.o box 20412-00200 Nairobi, Kenya, wabudorcas90@gmail.com

Abstract

Agroforestry systems have emerged as vital strategies for sustainable land management and climate change mitigation, particularly in regions vulnerable to environmental degradation and agricultural challenges such as Kenya. This paper explores the integration of Melaleuca *alternifolia*, commonly known as tea tree, as a versatile agroforestry species in Kenya and its potential contribution to climate change mitigation efforts. *Melaleuca alternifolia* exhibits several characteristics that make it well-suited for agroforestry systems in Kenya. Its drought tolerance, ability to thrive in a variety of soil conditions, and resistance to pests and diseases make it resilient to the climatic variability experienced in many parts of the country. Moreover, the tea tree's extensive root system aids in soil stabilization, erosion control, and nutrient cycling, thereby improving soil health and enhancing the overall resilience of agroecosystems. Furthermore, the integration of *Melaleuca alternifolia* into agroforestry systems presents significant opportunities for climate change mitigation. As a fast-growing species, tea trees sequester substantial amounts of carbon dioxide from the atmosphere, contributing to carbon sequestration and mitigating greenhouse gas emissions. Additionally, the cultivation of *Melaleuca alternifolia* in agroforestry systems promotes biodiversity, provides habitat for wildlife, and diversifies income sources for smallholder farmers. In Kenya, where climate change poses significant challenges to agriculture and natural resource management, the adoption of *Melaleuca alternifolia* in agroforestry systems holds promise for enhancing the resilience of rural communities and ecosystems. However, successful implementation requires supportive policies, capacity building, and stakeholder engagement to overcome barriers such as limited access to quality planting materials and technical knowledge. In conclusion, the integration of *Melaleuca alternifolia* as an agroforestry tree in Kenya offers a multifaceted approach to address climate change impacts while promoting sustainable agriculture and rural development. Further research, investment, and collaboration are needed to unlock the full potential of tea tree agroforestry systems in Kenya and similar regions worldwide.

Keywords: agroforestry systems, agroecosystems