NANGARHAR UNIVERSITY
INTERNATIONAL JOURNAL OF BIOSCIENCES
NUIJB
ORIGINAL ARTICLE
e-ISSN: 2957-9988
Special Issue, 2024

Received: 17 Dec 2023 Accepted After Revision: 21 Jan 2024 Published Online: 10 Feb 2024

Potential Deforestation and Greenhouse Gas Emission from Tree-Based Land Use Systems in Kashmir Himalayas

Nazir Ahmad Pala*[1], Iqra Farooq[1], Gulam Mohidun Bhat[1], Iqbal Jeelani[1], Megna Rashid[1], Ishtiyak Ahmad Peerzada[1], Abdul Rashid Malik[1], and Pervaz Ahmad Sofi[1]
[1]Faculty of Forestry, SKUAST-Kashmir, India
***Corresponding author: nazirpaul@gmail.com**

ABSTRACT
The present study was reported in context of potential deforestation and its impact on GHG emissions from tree-based land use system of Ganderbal district in Kashmir Himalayas. The present study was aimed at quantifying and estimating the potential deforestation of different tree-based land-use systems and their role in mitigating climate change. Most of the tree species grown under agroforestry were local and multipurpose trees that were economically useful to the farmers. Poplar (*Populus deltoids)* was the most predominant species followed by willow, (*Salix alba), Apricot (Prunus armeniaca) apple (Malus domestica)*, and Kiker (*Robinia pseudoacacia).* The majority of the tree species under agroforestry were maintained for fuelwood and fodder, and only a few species for timber. *Populus deltoides, Populus nigra, Salix alba, and Salix fragilis* were found to be highly preferred for fuelwood, fodder, and timber extraction. The average biomass (fuelwood, fodder, and small timber extraction of 297 Q/yr and potential deforestation of 156.32 Q/yr was recorded from the study area. Horti-Silvi-pastoral systems and Homegardens were recorded for the highest biomass extraction. Hence these trees-based land use systems can be utilized for small-scale needs and deforestation can be reduced.
Keywords: Trees, Gases, Deforestation, Himalaya, Fuelwood

INTRODUCTION
The introduction of trees in agricultural landscapes often improve the productivity of systems while providing opportunities to create carbon sinks and provide suitable ways to reduce CO2 emissions in the atmosphere (Chauhan et al., 2019). The potential of trees on farmlands to sequester carbon depends upon the woody species composition, age of trees, geographic location, agro-ecological conditions, management regimes, and soil characteristics. Trees on farmlands or agricultural landscapes if primarily designed to sequester carbon a unique opportunity to increase carbon stocks in the terrestrial biosphere (Albrect and Kandji, 2003). Agroforestry is important as a carbon sequestration strategy because of carbon storage potential in its multiple plant species and soil as well as its applicability in agricultural lands and reforestation (Nair et al., 2010). The important role of Agroforestry in the sequestration of carbon has raised the global interest in controlling the emissions of Greenhouse gases (Pala et al., 2020). Woodlands sequester more carbon as compared to other systems and are thus an important natural means to monitor climate change. With this background the present study was aimed at quantifying and estimating potential deforestation of different tree-based land use systems and their role in mitigating climate change.

MATERIAL AND METHODS
The present research problem was carried out in the Division of Silviculture and Agroforestry, Faculty of Forestry Benhama, Watlar Ganderbal, SKUAST-Kashmir, during the year 2019-2021. The respondents of the study area were asked to specify their preferences for fuelwood, fodder, and timber/small timber species. The identification of major fuelwood, fodder, and timber species were mainly based on interviews, informal discussions, and observations. The quantity of fuelwood and fodder collection was estimated over a period of 24 hours using a weight survey method (Mitchell, 1979). Fuelwood consumption per capita per day was calculated on the basis of total fuelwood consumed by a family, divided by the total number of family members. The annual rate of deforestation and rate of greenhouse gases emission per year as a result of burning of fuelwood was evaluated following Tahir *et al.* (2010). For woody biomass, a conversion factor of 0.5 t C/t dm is used (Intergovernmental Panel on Climate Change [IPCC], 2010). The emission of CO_2 from fuelwood burning was

estimated by converting total carbon content (t C) to carbon dioxide content (t CO_2) using the conversion ratio of 44 t CO_2/12 t C (IPCC, 2010). This may be given by the following equations:

Ct = Mt × Mf	(1)
CO_2 = Mt × Mf X Mc× (44/12)	(2)

where in Equation (1), Ct is the carbon content of woody biomass (0.5 t C/t dm), Mt is the total biomass burnt (t dm), Mf is the fraction of biomass oxidized (0.9), and in Equation (2), CO_2 equals the total CO_2 (t CO_2) released from the fuelwood burning and Mc equals the biomass carbon content (0.5 t C/t dm) (IPCC, 2010). Non-CO_2 gas emissions include CO, CH_4, NO, N_2O, and $NO_{X,}$ and will be estimated using the equations (Delmas, 1994).

RESULTS AND DISCUSSION

Preference of species: In the study area, the species different species of Poplar and willow (*Populus deltoides, Populus nigra, Salix alba and Salix fragilis)* were found to be highly preferred for fuelwood, fodder, and timber extraction. *Robinia pseudoacacia* was highly preferred for both fuelwood and fodder but had zero preference for timber. The species like *Ailanthus altissima, Ailanthus excelsa, Aesculus indica, Prunus domestica and Prunus armeniaca* were moderately preferred for fodder but had least preference for fuelwood and zero for timber. *Juglans regia* was moderately preferred for timber, least for fuelwood and had zero preference for fodder.

Table 1: Biomass extraction and potential GHG emissions of the tree species.

Tree Species	Common name	BM (Q/yr)	PD (m^3)	CB (tC t dm)	tC	tCO_2	tCO	tCH_4	tNO	tNO_x
Populus deltoides	Poplar	15	7.89	7.5	6.75	24.75	0.945	0.108	0.018	0.007
Populus nigra	Poplar	14	7.37	7	6.3	23.10	0.882	0.101	0.016	0.023
Salix alba	White willow	17	8.95	8.5	7.65	28.05	1.071	0.122	0.020	0.007
Salix fragilis	Cricket willow	10	5.26	5	4.5	16.50	0.630	0.072	0.012	0.014
Ulmus villosa	Elm	7	3.68	3.5	3.15	11.55	0.441	0.050	0.008	0.013
Ailanthus altissima	Alamther	10	5.26	5	4.5	16.50	0.630	0.072	0.012	0.018
Ailanthus excelsa	Alamther	6	3.16	3	2.7	9.90	0.378	0.043	0.007	0.016
Aesculus indica	Horse-chestnut	4	2.11	2	1.8	6.60	0.252	0.029	0.005	0.005
Robinia pseudoacacia	Kiker	13	6.84	6.5	5.85	21.45	0.819	0.094	0.015	0.004
Juglans regia	Walnut	4	2.11	2	1.8	6.60	0.252	0.029	0.005	0.004
Malus domestica	Apple	8	4.21	4	3.6	13.20	0.504	0.058	0.009	0.002
Pyrus communis	Pear	7	3.68	3.5	3.15	11.55	0.441	0.050	0.008	0.002
Prunus avium	Cherry	10	5.26	5	4.5	16.50	0.630	0.072	0.012	0.007
Prunus persica	Peach	9	4.74	4.5	4.05	14.85	0.567	0.065	0.011	0.023
Prunus amygdalus	Almond	3	1.58	1.5	1.35	4.95	0.189	0.022	0.004	0.007
Prunus domestica	Palm	2	1.05	1	0.9	3.30	0.126	0.014	0.002	0.014
Prunus armeniaca	Apricot	2	1.05	1	0.9	3.30	0.126	0.014	0.002	0.013
Punica grantum	Pomegrante	1	0.53	0.5	0.45	1.65	0.063	0.007	0.001	0.018
Diospyros kaki	Persimon	1	0.53	0.5	0.45	1.65	0.063	0.007	0.001	***0.002***
		143	**75.26**	**71.5**	**64.3**	**235.9**	**9.009**	**1.030**	**0.167**	**0.007**

BM= Biomass (Quintals/year); PD= Potential deforestation (m^3); CB= Carbon content in biomass; tC= Total carbon released; tCO_2=Total carbon-dioxide emissions; tCO= Total carbon-monoxide emissions; tCH_4= Total methane emissions; tNO= Total nitric oxide emissions; tN_2O=Total nitrous oxide emissions; tNO_x= Total nitrogen oxide emissions.

Biomass extraction status and GHG emissions of the study area*:* A total quantity of 143 quintals of biomass utilized for fuelwood, fodder, and small timber is being extracted from studied agroforestry systems annually (Table 1) These 19 species which are mentioned in Table 1with an average deforestation potential of 75.26 m^3. The total green house gas (GHG) emissions of 64.35 and 235.95 of tC and tCO_2 are emission potentials of this extracted material. The maximum CO_2 emission was recorded from *Salix alba* (28.05). Among the three blocks, Ganderbal (125 Q/yr) was recorded for maximum biomass extraction and whereas, Gund (82 Q/yr) was found to have minimum biomass extraction. Among the agroforestry systems, Horti-silvi-pastoral systems (121 Q/yr) were recorded to have maximum biomass extraction and whereas, Horti-agricultural systems (29 Q/yr) were recorded for minimum biomass (Farooq, 2021) An average value of 9.009, 1.030, 0.167, 0.007 and 0.256 of tCO, tCH_4, tNO, tN_2O and tNO_x respectively were recorded for non-CO_2 emissions. Among these recorded nineteen species the maximum biomass extraction was reported from *Salix alba* (17 Q/yr) followed by *Populus deltoides* (15 Q/yr) with potential deforestation of (8.95 m^3) and (7.89 m^3) respectively. The minimum quantity of 1 Q/yr is being extracted from *Diospyros kaki* and *Punica grantum* each with deforestation potential of (0.53 m^3).

CONCLUSION

The present study highlights the role of tree-based land use systems and trees outside the forest in providing the basic and minimum requirements for livelihood sustenance in terms of fuelwood, fodder, and small timber. Development of different agroforestry systems is also worth appreciating for their role in mitigation of climate change by providing number of tangible and intangible ecosystem services. Among the agroforestry systems, Horti-silvi-pastoral systems were recorded to have maximum biomass extraction and whereas, Horti-agricultural systems were recorded for minimum biomass. The study recommends the extension of these agroforestry systems in other parts of the Himalayan ecosystem having similar type of site factors.

Acknowledgment: Authors are thankful to all the households for providing information

Conflict of Interest: All the authors declare that they do not have any conflict of Interest.

Funding: This research received no external funding.

Authors Contributions: NAP & IF designed the study, NAP, IF, MG & GMB conducted the field survey, IF & IJ analysed the data, PIA & ARM prepared the draft, NAP & PIA finalized the manuscript**.**

REFERENCES

Albrecht, A., & Kandji, S. T. (2003). Carbon sequestration in tropical agroforestry systems. Agriculture, Ecosystems and Environment, 99(1-3), 15-27.

Chauhan, S. K., Singh, S., Sharma, S., Sharma, R., & Saralch, H. S. (2019). Tree biomass and carbon sequestration in four short rotation tree plantations. Range Management and Agroforestry, 40(1), 77-82.

Delmas, R. (1994). An overview of present knowledge on methane emission from biomass burning. Fertilizer Research, 37(3), 181-190.

Farooq, I. (2021). Assessment of tree diversity and potential carbon stock of prominent agroforestry systems in Ganderbal, J&K. M. Sc thesis, SKUAST-Kashmir, Shalimar.

Mitchell, R. (1979). An analysis of Indian agroecosystems. Interprint, New Delhi, India. pp: 180.

Nair, P. K. R., Nair, V. D., Kumar, B. M., & Showalter, J. M. (2010). Carbon sequestration in agroforestry systems. Advances in Agronomy, 108, 237-307.

Pala, N. A., Sarkar, B. C., Gokhale, Y., Manohar, A. K., Shukla, G., & Chakravarty, S. (2020). Potential of Homestead gardens to gain from global carbon markets to mitigate climate change in Coach Behar, West Bengal. Indian Forester, 146(2), 159-164.

Tahir, B. A. E., Fadl, K. E. M., & Fadlalmula, A. G. D. (2010). Forest biodiversity in Kordofan region, Sudan: Effects of climate change, pests, disease and human activity. Biodiversity, 11(3-4), 34-44