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Agroforestry, Phytodiversity and Carbon Storage Potential of Doda District, Jammu and Kashmir

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Abstract—*The present study deals with the phytodiversity and carbon sequestration potential of agricultural areas of district Doda, Jammu and Kashmir. A total of 36 tree species were enumerated from the agricultural regions of the study area with diversity and richness indices having value of 2.71 and 1.98 respectively. Total carbon storage by the trees in the study area is 104.2 tons with Juglans regia having maximum value (22.7 tons) of carbon stock. More awareness generation is required to make the local people understand the value of agroforestry economically and environmentally.*

1. INTRODUCTION

Forestry is the major resource in northern state of Jammu and Kashmir with district Doda having maximum forest area of 5555 Sq. Km. There is high demand of timber, fruit and fodder in this regions because 75.2 percent population is residing in rural areas [6]. With this agroforestry tends to be a growing sector nowadays due to increasing population, decreasing forest area and deteriorating condition of forests. The trees in agricultural areas can help in maintaining ecological balance in various ways like soil stabilization by erosion control, water retention, carbon sequestration, as wind barriers and increase in biodiversity, *etc* [7]. In the study area agroforestry is being studied as a source of income generation for locals and also as ecosystem services provider.

2. STUDY AREA AND SAMPLING

This study was conducted in district Doda of Jammu and Kashmir for a period of four years from 2014 to 2018 having approximate area of 4500 km^2 with height ranging between 1000 to 4000 m above msl. In a random survey, a total of 60 quadrats of 3 hectare size each were laid for data collection. Non-destructive method was adopted for recording Girth (Girth at breast height) of tree species approximately 1.3 m from the ground level.

3. METHODOLOGY

Primary analysis of vegetation using phytosociological parameters was done [2]. Importance Value Index showing vegetation status of the study area was also calculated [1].

Species Diversity: Shannon-Wiener Index [9]

$H' = -\sum[(\frac{ni}{N})ln(\frac{ni}{N})]$

Where, *ni* = number of individuals of i^{th} species

N = total number of individuals of all species

Species Richness: Menhinick's Index [8]

$$Db = \frac{s}{\sqrt{n}}$$

Where, *s* = number of species

n = number of individuals

3.1. Carbon Estimation

Above Ground Biomass (AGB) is calculated using allometric equations developed by FSI [3] for various tree species of Himalayas in India which gave value for volume and then this value was multiplied by specific gravity of that particular tree species which gave us final value of AGB. The biomass obtained was converted into carbon [5] using formula as

Carbon stock, C (tons) = B x C.F

Where, B = Dry Biomass (tons)

C.F = Carbon fraction of biomass (0.47)

4. RESULTS

During phytosociological analysis in the study area a total of 36 tree species having 330 individuals have been reported. At certain places dense vegetation patches were observed. The maximum value for all the phytosociological parameters such as frequency, density, basal area and Importance Value Index (IVI) goes to *Malus domestica (Seb), Juglans regia (Akhrot)*

and the minimum value goes to *Citrus lemon (Nimbu)* as shown (Table 1). The total carbon sequestered by trees found in the agroforestry system of the study area was 104.15 tons which is fairly a good value in such a mountainous terrain. The carbon storage potential of *Juglans regia (Akhrot)* is highest among all the tree species found in the given scattered vegetation type followed by *Malus domestica (Seb)* and *Prunus armeniaca (Khubani)* (Table 3) which highlights their more economic and social rather than ecological importance [4]. The trees species in the agricultural zone of the study area are used for multiple purposes like fruit, fodder, medicine, timber, ornamental and firewood. But both Importance Value Index (IVI) and Carbon storage value were maximum for fruit trees because it was observed that they are good source of income for the local people in the study area.

4.1. Tables

Table 1: Table of Phytosociological status

Botanical name of trees	F	D	T.B.A	A	IVI
Abies pindrow	1.67	0.03	0.59	2	2.80
Aesculus indica	3.33	0.03	0.23	1	2.21
Cedrus deodara	18.3	0.23	2.23	1.2	15.8
Celtis axis	1.67	0.02	0.03	1	0.86
Cydonia oblonga	5	0.07	0.13	1.3	2.95
Cupressus sempervirens	1.67	0.02	0.04	1	0.89
Citrus lemon	1.67	0.02	0.01	1	0.80
Diospyros lotus linn.	8.33	0.08	0.41	1	4.99
Eucalyptus	13.3	0.20	1.10	1.5	10.55
Ficus palmata	1.67	0.02	0.02	1	0.82
Fraxiness hookeri	3.33	0.03	1.32	1	5.41
Juglans regia	41.6	0.62	6.24	1.4	41.0
Malus domestica	50	1.05	5.15	2.1	47.9
Melia azadirach	23.3	0.30	0.86	1.2	14.3
Olea ferruginea	13.3	0.30	0.78	2.1	11.3
Pinus gerardiana	8.3	0.18	1.31	2.2	9.49
Pinus roxburghii	3.3	0.03	0.28	1	2.35
Platanus orientalis	5	0.07	1.62	1.3	7.36
Pistacia chinensis	8.33	0.08	0.45	1.0	5.13
Pistacia integerrima	5	0.07	0.27	1.3	3.38
Populus ciliata	8.33	0.10	0.65	1.2	6.0
Prunus armeniaca	45	0.63	2.27	1.4	30.5
Prunus bokhariensis	3.33	0.03	0.03	1	1.60
Punica granatum	5	0.08	0.07	1.6	3.08
Pyrus communis	3.3	0.03	0.06	1	1.70
Pyrus pashia	3.3	0.03	0.10	1	1.83
Quercus floribunda	13.3	0.13	0.94	1	8.85
Quercus leucotrichophora	11.6	0.17	1.63	1.1	11.1
Quercus semecarpifolia	10.0	0.17	0.78	1	8.07
Rhus javanica	11.6	0.20	0.75	1.7	9.04
Rubenia pseudoacacia	3.33	0.07	0.05	2	2.28
Sterculia alata	6.67	0.07	0.21	1	3.64
Toona ciliata	10	0.20	0.49	2	7.81
Ulmus villosa	5	0.05	2.69	1	10.2
Ulmus wallichiana	1.67	0.03	0.08	2	1.30
Zizyphus mauritiana	5	0.05	0.06	1	2.46
Total	365	5.50	33.89		

Where, F = Frequency, D= Density, T.B.A. = Total Basal Area, A= Abundance, and IVI = Importance Value Index

Table 2: Diversity and Richness Indices

S. No.	Indices	Value
1	Shannon-Wiener Index (1949)	2.71
2	Menhinick's Index (1964)	1.98

Table 3: Carbon Sequestration Status of Tree sp

Botanical name of trees	Volume (m3)	Biomass (kg)	Carbon (kg)
Abies pindrow	9.24	4.44	2.08
Aesculus indica	2.35	1.25	0.59
Cedrus deodara	30.55	17.41	8.18
Celtis axis	0.26	0.147	0.07
Cydonia oblonga	1.47	0.71	0.33
Cupressus sempervirens	-9.22	-8.02	-3.77
Citrus lemon	0.11	0.097	0.05
Diospyros lotus linn.	2.06	1.940	0.91
Eucalyptus	12.15	8.62	4.05
Ficus palmata	-14.3	-8.13	-3.82
Fraxiness hookeri	15.04	11.88	5.58
Juglans regia	80.36	48.21	22.66
Malus domestica	64.05	45.47	21.37
Melia azadirach	5.79	3.24	1.52
Olea ferruginea	7.63	8.58	4.03
Pinus gerardiana	14.94	8.67	4.07
Pinus roxburghii	0.57	0.34	0.16
Platanus orientalis	19.00	11.21	5.27
Pistacia chinensis	6.82	5.93	2.79
Pistacia integerrima	3.75	2.55	1.20
Populus ciliata	6.82	3.14	1.48
Prunus armeniaca	27.44	24.97	11.74
Prunus bokhariensis	0.19	0.178	0.08
Punica granatum	-7.12	-3.35	-1.57
Pyrus communis	-7.52	-4.93	-2.32
Pyrus pashia	-4.92	-3.44	-1.62
Quercus floribunda	9.91	8.82	4.14
Quercus leucotrichophora	19.12	16.54	7.77
Quercus semecarpifolia	8.64	6.04	2.84
Rhus javanica	7.23	2.96	1.39
Rubenia pseudoacacia	-8.25	-6.19	-2.91
Sterculia alata	-1.78	-0.98	-0.46
Toona ciliata	4.21	2.33	1.10
Ulmus villosa	32.74	21.94	10.31
Ulmus wallichiana	-6.19	-4.14	-1.95
Zizyphus mauritiana	-7.36	-6.84	-3.22
Total	325.79	221.59	104.15

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5. CONCLUSION

Trees found in the agroforestry zone are having more significance economically as majority of them are fruit trees, some are fodder, ornamental and firewood trees and very few are medicinal tree species. A good diversity and richness was observed in the study area as a result of fruit cultivation of different varieties in agricultural areas. They are also acting as big carbon assimilators but this aspect of agroforestry has been least studied so far. A small proportion of population of the study area was aware of the multiple roles played by trees. There is need for imparting ecological education according to the region and social background of the people as farmers, government servants, elderly people, students, women, *etc*. especially young generation.

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