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## Prominent agroforestry systems in district Baramulla of J&K, India

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### Abstract

The present investigation entitled “Prominent Agroforestry Systems in District Baramulla of J&K, India” was carried out in district Baramulla of J&K. Survey based on identification of different agroforestry systems of District Baramulla was carried out using Proportional allocation method through random selection procedures. A total of 217 farmers were selected to document the land use pattern of district Baramulla. Studies conducted revealed that maximum number of farmers belonged to marginal category (60.37%) having up to 1.0 ha of land, followed by small (27.65%), medium (8.39%), and large (3.69%) land holdings farmers. A total 6 agro forestry systems were found in the study area i.e. Agri-horti-silviculture, Horti-agriculture, Agri-silviculture, Horti-silvi-pasture, Horti-pasture and Horti-silvi-agriculture. It was revealed that maximum number of farmers (37.87%) were practicing Agri-horti-silviculture, followed by Horti-agriculture system (25.68%), Agri-silviculture (15.73%), Horti-silvi-pasture (8.86%), Horti-pasture (6.51%), and least of farmers were practicing Horti-silvi-agriculture (5.42%) agroforestry systems in the District Baramulla. Poplar and willow were the common tree components found across all the agroforestry systems, whereas Apple and Pear dominated the fruit based agroforestry systems.

**Keywords:** Agroforestry systems, Baramulla, farmers, agri-horti-silviculture

### Introduction

Agroforestry is one of the sustainable approaches to land-use management where both agriculture and forestry combine into an integrated production system to get maximum benefits (Nair, 1998) [5]. Agroforestry refers to the practice of purposeful growing of trees and crops and/or animals, in interacting combinations, for a variety of benefits and services such as increasing crop yields, reducing food insecurity, enhancing environmental services, and resilience of agroecosystems (Ajayi *et al.*, 2011) [3]. As per World Agroforestry Centre, “Agroforestry is a deliberate integration of woody components with agricultural and pastoral operations on the same piece of land either in a spatial or temporal sequence in such a way that both ecological and economic interactions occur between them”. Both agriculture and forestry are combined into an integrated agroforestry system to achieve maximum benefits by a greater efficiency in resource such as nutrients, light and water capture (Kohli *et al.*, 2008) [4]. Area under agroforestry worldwide is reported 1,023 million ha (Nair *et al.*, 2009) [2], whereas in India area under agroforestry is estimated at 25.32 Mha, or 8.2% of total geographical area of the country, this includes 20.0 Mha in cultivated lands (7.0 M ha in irrigated and 13.0 M ha in rainfed areas) and 5.32 Mha in other areas such as shifting cultivation, (Dhyani *et al.*, 2013b) [7]. At present, agroforestry meets almost half of the demand for fuel wood, 2/3<sup>rd</sup> of the small timber, 70-80% of wood for plywood, 60% of the raw material for paper & pulp and 9-11% of the requirement for green fodder for livestock, in addition to meeting the food, fruit, fiber, medicine, and timber needs of the households (ICAR, 2010) [6]. Agroforestry is practiced in all the world’s continents. Almost half of the world’s agricultural lands have a minimum tree cover of 10%, suggesting that agroforestry, an integrated system of trees, crops and/or livestock in a managed farm or agricultural landscape (Zomer *et al.*, 2009) [8]. There are more than 2000 tree species being used in agroforestry. Keeping in view the importance of Agroforestry, present study was conducted with the aim to study prominent Agroforestry systems in district Baramulla of Jammu and Kashmir.

## Materials and Methods

### Experimental site

The topography of the district is mixed with both mountainous and plain areas. Baramulla district has rugged and hilly terrain, about 60 percent of the district is mountainous and 40 percent is plain area. The height varies between 1150 to 4400 meters. The district Baramulla located in the northern tip of India which covered by three sides (North, East and South) by India and one side (East) by Pakistan, the geographical extents of the study area is from 33°58' to 34°22' North latitudes and 73°54' to 74°42' East longitudes (Malik *et al.*, 2017) <sup>[10]</sup>.

District Baramulla comprises of four Sub-Divisions - Sopore, Uri, Pattan and Gulmarg; sixteen Tehsils - Baramulla, Wagoora, Kunzer, Pattan, Tangmarg, Kawarhama, Kreeri, Uri, Boniyar, Sopore, Zainageer, Dangerpora, Khoie, Dangiwachha, Watergam and Rafiabab. The district has been divided into twenty six blocks namely Baramulla, Uri, Boniyar, Rohama, Sopore, Wagoora, Zainageer, Pattan,

Kunzer, Tangmarg, Singpora, Rafiabab, Kandi Belt of Rafiabab, Nadihal, Narwav, Parapilla, Bjhama, Noorkhah, Sangrama, Tujjar Sharief, Hardaboora, Lalpora, Wayal, Khaipora, Chandilwanigam and Sheerabad which serve as prime units of economic development. Baramulla has been further sliced in to 367 panchayats comprising 554 revenue villages

### Methodology

Survey based on identification of different agroforestry systems of District Baramulla was carried out using Proportional allocation method through random selection procedures, as shown in the table 1. The sampling was based on a well-designed questionnaire. Survey based on identification of different agroforestry systems of District Baramulla was carried out using Proportional allocation method through random sampling procedures. A total of 217 farmers were selected to document the land use pattern of district Baramulla.

**Table 1:** Details/Methodology for the selection of sample area

Sub-division Tehsils	Gulmarg			Uri		Sopore		Pattan
	Tangmarg	Kunzer	Kawarhama	Uri	Baramulla	Sopore	kreeri	Pattan
Total no of blocks/tehsil	3	3	1	4	3	2	1	2
Blocks selected /tehsil	2	2	1	2	2	1	1	1
Villages selected/blocks	3	2	2	3	3	1	2	4
Farmers selected/villages	7	7	7	7	7	7	7	7
Farmers selected/ tehsil	42	28	14	42	42	7	14	28

Total tehsils selected: 16

Total blocks selected: 26

Total villages selected: 544 (5% of village)

## Results and Discussion

### Classification of farmers in District Baramulla

Classification of farmers by land holding was carried out in the eight Tehsils of the Baramulla district (Table 1). Afterwards, one block was selected from each tehsil and the

farmers were classified as marginal (upto 1 ha), small (01-02 ha), medium (2.1 to 4.0 ha), large 4.1 and above as per. The district was dominated by 60.37% (131) marginal followed by 27.65% (60) small, 8.39% (18) medium and 3.69% (8) large farmers (Table 2).

**Table 2:** Classification of farmers as per land holding of Agroforestry systems across the Baramulla district

S. No.	Tehsil	Block selected	Marginal (Nos.)	Small (Nos.)	Medium (Nos.)	Large (No's)	Total (Nos.)
01	Tangmarg	2	26	12	3	1	42
02	Kunzer	2	19	6	2	1	28
03	Kawarhama	1	10	3	1	-	14
04	Uri	2	28	12	2	-	42
05	Baramulla	2	24	14	2	2	42
06	Sopore	1	3	2	1	1	7
07	Kreeri	1	8	3	2	1	14
08	Pattan	1	13	8	5	2	28
Total		12	131 (60.37)	60 (27.65)	18 (8.39)	8 (3.69)	217

Figures in parenthesis represent % age of the total sample (217)

**Table 3:** Extent of adoption of various agroforestry systems by different farmer groups

S. No.	Agroforestry System	Farmers group				
		Marginal	Small	Medium	Large	Total
1	Agri-horti-silviculture	125 (57.61)	58 (26.73)	18 (8.30)	8 (3.69)	209 (37.80)
2	Horti-agriculture	105 (48.39)	30 (13.83)	4 (1.85)	3 (1.39)	142 (25.68)
3	Agri-silviculture	40 (18.44)	30 (13.83)	12 (5.52)	5 (2.30)	87 (15.73)
4	Horti-silvi-pasture	10 (4.61)	25 (11.53)	10 (4.61)	4 (1.85)	49 (8.86)
5	Horti-pasture	4 (1.85)	16 (7.38)	10 (4.61)	6 (2.76)	36 (6.51)
6	Horti-silvi-agriculture	3 (1.38)	12 (5.52)	9 (4.15)	6 (2.76)	30 (5.42)

Figures in parenthesis represent % age of the total sample (217)

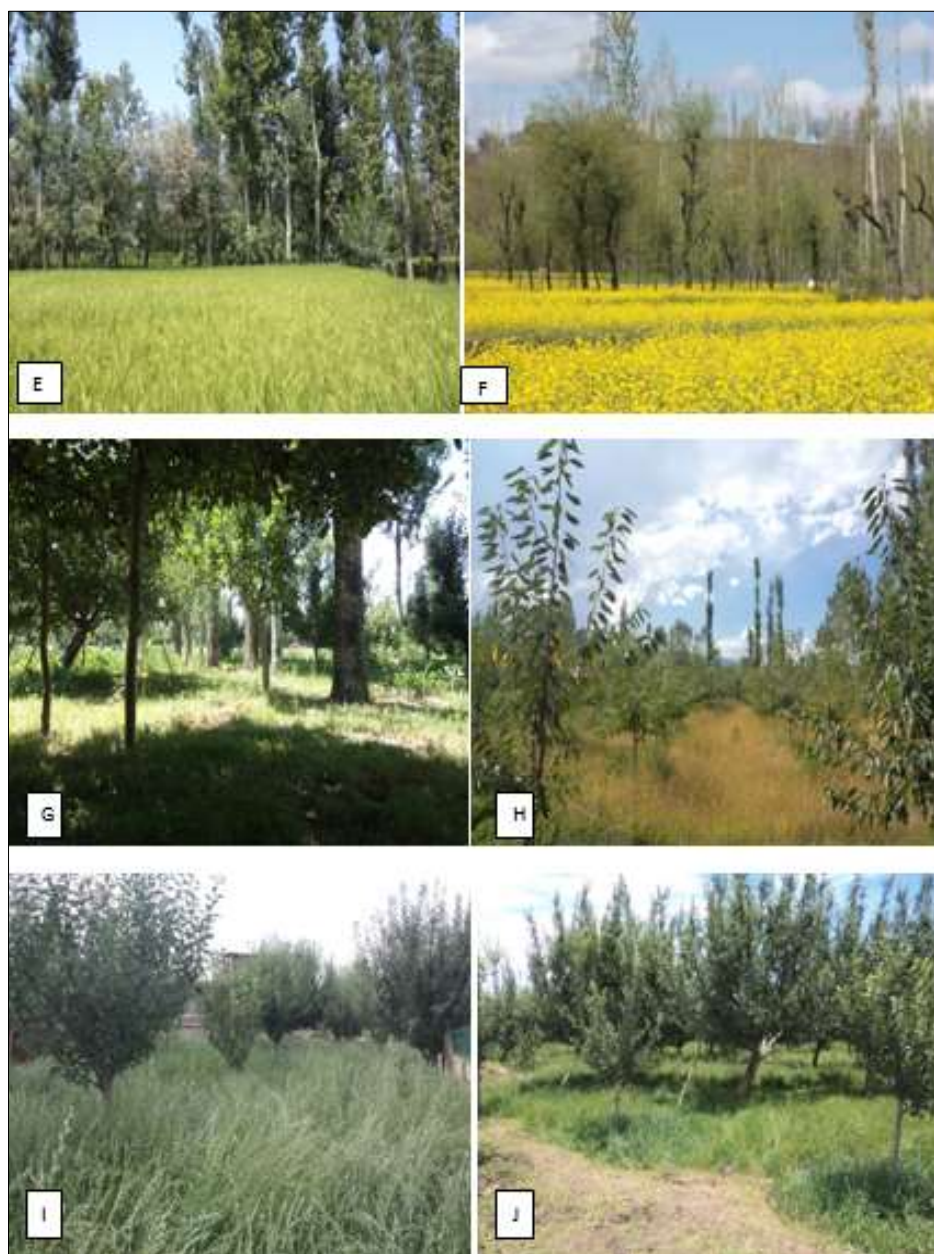
**Table 4:** Components of prominent agroforestry systems across Baramulla district

S. No.	Nature of system	Tree components	Fruit tree components	Crop components/ Grasses	
				Rabi	Kharif
1	Agri-horti-silviculture (home gardens)	<i>Populus deltoides</i> , <i>populus balsamifera</i> <i>Salix alba</i> , <i>Salix fragilis</i> , <i>Ulmus villosa</i> , <i>Robinia pseudoacacia</i> , <i>Ailanthus altissima</i> and <i>Aesculus indica</i> .	<i>Malus domestica</i> , <i>Prunus persica</i> , <i>Pyrus communis</i> , <i>Vitis vinifera</i> , <i>Prunus avium</i> , <i>Punica granatum</i> , <i>Apricot</i> , <i>Ficus carica</i> , <i>Corylus avellana</i> , <i>Juglans regia</i> and <i>Prunus domestica</i>	Radish, Turnip, Garlic, kale, Carrot, Onion, Cabbage, Cauliflower, Knol-khol and Pea.	Beans, Chili, knol-khol Brinjal, Maize, Ocimum, Tomato, Potato and kale.
2	Horti-agriculture	-	<i>Malus domestica</i> , <i>Prunus persica</i> , <i>Pyrus communis</i> , <i>Vitis vinifera</i> , <i>Prunus domestica</i> , <i>Juglans regia</i> and <i>Prunus avium</i> .	Oats, Wheat, Radish, Turnip, Garlic, kale, Mustard, Cabbage and pea.	Beans, Maize, Pigeon peas, Mung beans (green gram), Cow peas, Chili, Brinjal and Ocimum.
3	Agri-silviculture (boundary plantation)	<i>Salix alba</i> , <i>Salix fragilis</i> , <i>Populus deltoides</i> , <i>Populus balsamifera</i> <i>Robinia pseudoacacia</i> and <i>Ulmus villosa</i> .	-	Mustard, Oats and Wheat.	Paddy, Maize
4	Horti-silvipasture	<i>Salix alba</i> , <i>Salix fragilis</i> , <i>Populus deltoides</i> , <i>Populus balsamifera</i> , <i>Ulmus villosa</i> , <i>Robinia pseudoacacia</i> , <i>Ailanthus altissima</i> and <i>Aesculus indica</i> .	<i>Malus domestica</i> , <i>Prunus pesica</i> , <i>Pyrus communis</i> , <i>Vitis vinifera</i> and <i>Prunus avium</i> .	<i>Trifolium repens</i> (white clover), <i>Trifolium pretense</i> (red clover), <i>Cynodon dactylon</i> , <i>Brumus lanceolatus</i> , <i>poa persica</i> <i>Daucus carrata</i> , <i>Amaranthus hybridus</i> , and <i>Cichorium intybus</i> .	
5	Horti-pasture	-	<i>Malus domestica</i> , <i>Prunus pesica</i> , <i>Pyrus communis</i> , <i>Vitis vinifera</i> , <i>juglans regia</i> , <i>Prunus armeniacea</i> and <i>Prunus avium</i> .	<i>Trifolium repens</i> (white clover), <i>Trifolium pretense</i> (red clover), <i>Avena sativa</i> , <i>Sisymbrium irio</i> , <i>Tragopogon dubius</i> , <i>Daucus carrata</i> , <i>Amaranthus hybridus</i> , <i>Cichorium intybus</i> , <i>Medicago sps</i> , <i>Ranunculus lactus</i> , <i>Sonchus obraccus</i> , <i>Lespediza juncea</i> , <i>Polygonum aviculare</i> , <i>Plantago lanceolata</i> , <i>Hordeum vulgare</i> , <i>Vulpia sps</i> , <i>Stachys vericea</i> , <i>Echinochloa calnum</i> , <i>Sorghum halepense</i> , <i>Seteria italic</i> , <i>Seteria viridis</i> , <i>lolium temulentum</i> , <i>Brumus lanceolatus</i> , <i>poa persica</i> , <i>Cynodon dactylon</i> and <i>Agropyron canaliculatum</i>	
6	Horti-silviculture	<i>Salix alba</i> , <i>Salix fragilis</i> , <i>Populus deltoides</i> , <i>populus balsamifera</i> , <i>Ulmus villosa</i> , <i>Ailanthus altissima</i> and <i>Aesculus indica</i>	<i>Malus domestica</i> , <i>Prunus pesica</i> , <i>Pyrus communis</i> , <i>Vitis vinifera</i> and <i>Prunus domestica</i>	Garlic, Radish, Turnip, kale, Oats, Mustard, Peas and Onion.	Beans, Maize, knoll-khol, chili, Tomato, and Brinjal

**Table 5:** Most prominent Agroforestry system selected for evaluation

S. No.	Agroforestry systems	Extent of adaptation No. of farmers (%)	Trees	Fruit trees	Crop components/Grasses	
					Rabi	Kharif
1	Agri-horti-silviculture (home gardens)	209 (37.80)	Poplar and Salix	Apple and Pear.	Radish, Garlic, kale and Beans.	Beans, Chili, knoll-khol, Brinjal and Maize.
2	Horti-agriculture	142 (25.68)	-	Apple, Walnut and Pear.	Radish, Turnip, Garlic, Oats and kale.	Beans, Maize, Black gram, Mung beans, and Cow peas
3	Agri-silviculture (boundary plantation)	87 (15.37)	Poplar and Salix	-	Mustard, Oats, Maize and Paddy.	





A= Poplar + Apple + Chili and B =Poplar + Apple + Turnip under Agri-horti-silviculture system.  
 C = Walnut + Oats and D = Apple + Garlic under Horti-agriculture system  
 E = Poplar + Paddy and Salix + Poplar + Mustard under Agri – silviculture system.  
 G = Poplar + Apple + Grass and H = Poplar + Cherry + Grass under Horti-silvi-pasture system  
 I = Apple + *Lolium temulentum* and Apple + Grasses under Horti-pasture system

**Fig 1:** Photo plates of prominent agroforestry systems

### Extent of adoption of various agroforestry systems

The extent to adoption of different Agroforestry systems in district Baramulla is shown in Table 3. Agri-horti silviculture was found to be the dominated agroforestry system adopted by the farmers of Baramulla district. The highest adoption of Agri-horti silviculture varied from 57.61% (125) among marginal to 3.69% (8) among large farmers. On the other hand, the Horti-silvi-agriculture system was least adopted and its adoption was between 1.38% (3) among large farmers and 2.76% (6) marginal farmers. The other agroforestry systems adopted by farmers were Horti-agriculture 48.39% (105) among marginal farmers and 1.39% (3) by large farmers. Agri-silviculture 13.83% (30) among small farmers and 2.30% (5) by large farmers. Horti-silvi-pasture 4.61% (10) among marginal farmers and 1.85% (4) by large farmers. Horti-pasture 4.61% (10) among medium farmers and 2.76% (6) by large farmers.

### Components of prominent agroforestry systems across Baramulla district

The six agroforestry systems that were prevalent across the Baramulla district were Agri-horti-silviculture, Horti-agriculture, Agri-silviculture (boundary plantation), Horti-silvi-pasture, Horti-pasture and Horti-silvi-agriculture (Table 4). In Agri-horti-silviculture the tree components included *Salix alba*, *Salix fragilis*, *Populus deltoides*, *Populus balsamifera*, *Ulmus villosa*, *Robinia pseudoacacia*, *Ailanthus altissima*, *Aesculus indica*. While fruit tree components included *Punica granatum*, *Malus domestica*, *Prunus persica*, *Pyrus communis*, *Vitis vinifera*, *Prunus avium*. Rabi crop component included kale, peas, carrot, knol-khol, garlic, turnip, radish, cauliflower, while *kharif* crop included spinach, tomato, knol-khol, kale, maize, brinjal, beans, and potato.

In Horti-agriculture system fruit tree components included *Malus domestica*, *Prunus persica*, *Pyrus communis*, *Vitis vinifera*, *Prunus avium*. Rabi crop components included oats, kale, Turnip, knol-khol, radish, mustard and kharif crop included beans, knol-khol, chilli, potato, maize and kale.

Tree components of boundary plantation included *Salix alba*, *Salix fragilis*, *Populus deltoides*, *Populus balsamifera* and *Ulmus villosa*. In crop components, Rabi crops included oats/mustard and paddy during the kharif season.

The forest tree components of the Horti-silvi-pasture system are *Salix alba*, *Salix fragilis*, *Populus deltoides*, *Populus nigra*, *Populus balsamifera*, *Robinia pseudoacacia*, *Ulmus villosa*, *Ailanthus altissima*, while, the fruit tree are *Malus domestica*, *Pyrus communis*, *Prunus persica*, *Vitis vinifera*, *Punica granatum* and perennial grasses includes *Trifolium repens* (white clover) *Polygonium hydropiper* (water pepper), *Trifolium pretense* (red clover), *Lolium perenne* (ryegrass), *Bromus japonicus* (japanese brome), and *Avena sativa* (wild oats)....

In Horti-pasture forest tree species included *Populus deltoides*, *Salix alba*, *Ulmus villosa*, *Populus nigra*, *Robinia pseudoacacia*, *Ailanthus altissima* while, grasses included *Trifolium repens* (white clover) *Polygonium hydropiper* (water pepper), *Trifolium pretense* (red clover), *Lolium perenne* (ryegrass), *Bromus japonicus* (japanese brome), and *Avena sativa* (wild oats). In Horti-silvi-agriculture the forest tree species included *Populus deltoides*, *Salix alba*, *Ulmus villosa*, *Populus nigra*, *Robinia pseudoacacia*, *Ailanthus altissima*, while fruit trees species included *Juglans regia*, *Malus domestica*, *Prunus perica*, *Prunus amygdalus*, *Vitis vinifera*. In crop components Rabi included oats, mustard, peas, garlic, onion, turnip, radish while, kharif crop included knol-khol, cucumber, beans, chilli and potato.

### Most prominent agroforestry systems

Most prominent agroforestry systems selected for evaluation of carbon sequestration in the study are Agri-horti silviculture, Horti-agriculture and Agri-silviculture (Table 5). The Agri-horti silviculture was the most prominent system adopted by 37.80% farmers of the district Baramulla. The Horti-agriculture system was adopted by 25.68% farmers. Agri-silviculture system was adopted by 15.37% of farmers. Mughal and Bhattacharya (2002) <sup>[11]</sup> identified several agroforestry systems in the Kashmir valley which includes boundary plantations, agri-silviculture, horti-silviculture, horti-pasture, horti-silvi-agriculture and kitchen gardens. Broad evaluations of the systems show that only three tree species i.e. *Populus deltoides* *Salix alba* and *Robinia pseudoacacia* are extensively planted. Mughal and Khan (2007) <sup>[12]</sup> reported that there were only seven systems prevalent in Kashmir province. Home gardens were practiced by majority of farmers 96.32% (209) of farmers followed by Horti-agriculture 65.42% (142), Boundary plantation 40.10% (87), Horti-silvi-pasture 22.59% (49) Horti-pasture 16.59% (36) and Horti-silvi-agriculture only by 13.83% (30). The findings of our study are also in conformity with the studies conducted by, Bijwalwan, 2009 <sup>[14]</sup>, Chauhan *et al.*, 2012 <sup>[15]</sup>, Galhena *et al.*, 2013 <sup>[1]</sup> and Banyal *et al.*, 2016 <sup>[13]</sup>.

### Conclusion

Present study revealed that 60.37% of total surveyed farmers belonged to marginal category having up to 1.0 ha of land, followed by small (27.65%), medium (8.39%), and (3.69%)

large land holdings farmers. The six prevalent agroforestry systems were identified in study area, though with varied rate of existence/adoption. The identified systems of study area were Agri-horti-silviculture, Horti-agriculture, Agri-silviculture, Horti-silvi-pasture, Horti-pasture and Horti-silvi-agriculture. It was revealed that 37.87% of surveyed farmers were practicing Agri-horti-silviculture, followed by 25.68% with Horti-agriculture system, 15.73% Agri-silviculture, 8.86% Horti-silvi-pasture, 6.51% Horti-pasture, and 5.42% Horti-silvi-agriculture agroforestry systems in the District of Baramulla. Poplar and willow were the common tree components found across all the agroforestry systems, whereas Apple and Pear dominated the fruit based agroforestry systems.

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