RESEARCH ARTICLE

PREVALENT SILVIPASTORAL SYSTEM UNITS AMONG DIFFERENT FARMER CATEGORIES IN HIMACHAL PRADESH, NORTH WESTERN HIMALAYA, INDIA

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Abstract: The practice of agroforestry in Indian Himalayan state of Himachal Pradesh is as old as the agriculture itself. Farmers retain socially, ecologically and economically important trees, shrubs and herbs on their agroforestry land use systems for the multiple benefits they provides. Presently continuous expanding human and livestock population is leading huge pressure on nature and due to overuse of natural resources there are many incidences of natural disasters. Considering the tremendous scope of silvipastoral systems in improving productivity of degraded lands, livelihood of farming communities and in environmental security, present study was conducted in 12 representative villages of all four agro-climatic zones of Himachal Pradesh. Present study revealed that currently in Himachal Pradesh farmers are managing their silvipastoral land use systems traditionally and among all farmer categories marginal farmers were having more diverse system units 29, 16, 10 and 7 respectively in zone-I, II, III, IV whereas in small category 14, 10, 6, 2 and in medium category 3, 3, 2, 5 recorded in zone-I, II, III, IV respectively. Therefore considering the advantages of agroforestry, popularization of agroforestry through organizing mass scale unawareness programmes, distribution and plantation of improved and high yielding plant species along with technological interventions are urgently required for the utilization of full potential of existing silvipastoral systems.

Keywords: Agroforestry system, Farmers, Himachal Pradesh, Himalaya, Silvipastoral systems, System units

INTRODUCTION

In Indian Himalayan Region (IHR), approximately 20% land area exists under agroforestry (Nautiyal *et al*., 1998). Due to ease availability, accessibility and affordability indigenous Himalayan communities are highly dependent on agroforestry systems for fulfilling various daily livelihood needs viz., food, fodder, fiber, fuel, timber, manure, medicine etc. Besides, soil and water conservation these agroforestry systems also contributes significantly in increasing above ground and below ground carbon stock and in limiting global warming. Agroforestry is a land use system which combines woody perennial intentionally or deliberately with crops and livestock on the same land use management (Nair, 1995). Agroforestry is relatively a new name for old practice, and it is currently accepted as an approach with low external inputs to increase farm productivity. Agri-horticulture, silvi-horticulture, horti-pastoral, and silvi-pastoral systems are diversified land use options for agroforestry in the IHR. Silvipastoral systems are one of the well-known agroforestry system types which

intentionally combine fodder plants, such as grasses and leguminous herbs, with shrubs and trees for animal nutrition and complementary uses (Murgueitio *et al.,* 2011). India with only 2.3% of land area of the world, is maintaining nearly 17.4% of world human population and 10.7% of livestock creating huge pressure on land, water and other natural resources (Roy *et al*., 2019). India is largest producer of milk in the world, but animal productivity is very low (1538 kg/year) in comparison to global average (2238 kg/year) (Vijay *et al.,* 2018). Along with this there is a huge gap in fodder availability and demand in India (Ghosh et al., 2016) and as per National Forest Policy (1988) India has also the target to increase forest cover up to 33%. Currently, India is dedicated in achieving National Agroforestry Policy (NAP) goals i.e., conserving the natural resources and forests; protecting the environment, providing environmental and livelihood security to people and increasing the forest/tree. In Himachal Pradesh one of the North-western Indian Himalayan state about 90% of the people live in rural areas and their economy is primarily based on agriculture, horticulture and animal husbandry. The

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contribution of livestock rearing to the state domestic product is about 40%. Like other parts of the India this state is also facing the crises of food, fuel, fiber, timber and others along with many natural calamities. The land holdings of inhabitants are small and scattered and the majority of inhabitants fall into the marginal category. Small ruminants form a major part of livestock and pasture land (12698 thousand tons) followed by cultivated land (5439.3 thousand tons) and forests (2636.1 thousand tons) are major source of green fodder. The tree foliage is considered as major source of protein and energy to increase productivity of ruminants (Katoch, 2009) and during winter's tree foliage provide almost 80% of the fodder to local hill communities. The availability of green and dry fodder from all the available resources in the state is 3145 and 5298 thousand tons, while the demand is 6205 and 11516 thousand tons, respectively, indicating a gap of 26 and 54%, respectively (Dev *et al*., 2006). Besides, *Lantana camera* and other obnoxious weeds are causing decline in the productivity of fodder in agricultural and common property resources (Pathania and Dev 2011). Hence, considering all these, agroforestry practice is the only viable option to reduce the pressure on existing forests and to increase land productivity. Therefore, the present study was undertaken to observe the silvipastoral system units prevalent among different farmer categories in different agro-climatic zones of Himachal Pradesh.

MATERIALS AND METHODS

Extensive field surveys were conducted in all four agro-climatic zones of Himachal Pradesh and multi stage stratified random sampling technique was adopted for the selection of sites/representative villages. 12 villages viz., Zone I: Jogipanga (Una), Masiyana (Hamirpur), Bhakra (Bilaspur), Shiun Khas (Kangra); Zone II: Naun (Mandi), Banalgi (Solan), Keela Kalanj (Sirmour); Zone III: Ghiaghi (Kullu), Jarashi (Shimla), Kundi (Chamba); Zone IV: Roghi (Kinnaur), Muling (Lahaul & Spiti) representing all twelve districts and agro-climatic zones of Himachal Pradesh were selected for the present study after the discussion with forest officials of respective districts. Randomly 10 households or 10% of the total families (whichever is greater) in a village were selected for the collection of silvipastoral system units data. Usual personal observations, oral interviews and discussions with the knowledgeable people (various farmer category groups) were the basis for the collection of information on silvipastoral system units (basic functional units) from each selected village. The knowledgeable people were those who have been using fuel, fodder, fiber, etc., to benefit from these systems for the last 30-40 years. Stratified classification of agroforestry practices given by Zou and Sanford (1990) was used to indicate silvipastoral

system types and system units. A system type has been named considering the major components, whereas a system unit termed as a basic functional unit has been identified as a combination of specific species within a component with species from other components. Hence, a functional unit's woody + grass components and/or livestock were considered to identify silvipastoral systems and system units. The component which occupies the larger area of the total unit area and serves the major function, *i.e.*, the production of primary output needed by the farmers has been considered as the primary component. The component which occupies relatively lesser area of the total unit area compared to area under primary component and yielding secondary output needed by the farmers has been considered as secondary component. One knowledgeable person was hired from each village for the collection of fresh samples of species occurring in these systems. The samples collected were brought to the institute for identification and identified with the help of regional (Polunin & Stainton, 1984) and local floras (Nair, 1977; Chowdhery & Wadhwa, 1984; Dhaliwal & Sharma, 1999; Singh & Rawat, 2000; Aswal & Mehrotra, 1994).

RESULTS AND DISCUSSION

The tree cultivation in rural areas of India has been traditionally practiced since time immemorial by the farmers on farm lands, grazing grounds, on farm house, as home gardens and as windbreaks and shelterbelts etc., to meet their needs for timber, firewood; fodder etc., and the species composition in these land use systems varies depending upon landholding and basic requirement of the farmers (Toky *et al.,* 1989a). Considering the continuously increasing population the fulfillment of the basic requirements of people is the urgent necessity, but simultaneously fragile and sensitive environment needs to be kept in mind. In this scenario, agroforestry is the only sustainable option for the benefit of people and nature. Many agro-forestry systems both natural as well as manmade have been developed in different agro-climatic regions of the country, which have been found highly productive and environmental/ecofriendly. Both the agroforestry and silvipastoral systems are interrelated but their scope and application is different. Silvi-pastoralism refers to integrated systems involving agroforestry options with livestock. However agroforestry refers to the use of trees on farming systems in which trees are integrated with annual crop, livestock and fish. Agroforestry can thus be viewed more as intervention, whereas silvipastoral systems provide the link between trees and livestock as system components. Livestock are central to SDGs 1, 2, 8 and can directly or indirectly contribute to most of them. As part of the Global Agenda, the Global Network on silvopastoral systems promotes the

scaling up of silvipastoral systems throughout the world to support sustainable livestock production and complementary uses. At global level there are many examples of silvopastoral systems contributing to sustainable livestock production by reducing impact on natural resources, increasing productive efficiency and profitability, improving food security and animal welfare and contributing to the mitigation and adaptation to climate change. Due to its high productivity, environmental and livelihood potential, the government of India is also promoting agroforestry throughout the country as a tool for improving farmer's livelihood and to make India decarbonized economy. In Himachal Pradesh the practice of agroforestry is as old agriculture itself retaining trees on farmland for multiple benefits. In different agro-climatic zones farmers have tradition of cultivating food crops, raising trees for fodder, fuel, timber, medicine and fruits as well as rearing of animals together. Due to low input use these traditional agroforestry systems are socially accepted but difficult to quantify because of inherent complexities (Lehria, 2004). Verma *et al.* (2007) reported seven agroforestry systems viz., Agri-silviculture (AS), Agri-horticulture (AH), Agri-horti-silviculture (AHS), Pastoral-silvi-horticulture (PSH), Agri-silvi-horticulture (ASH), Silvipastoral (SP), Pastoral-horti-silviculture (PHS) from Himachal Pradesh. In silvipastoral land use systems farmers mainly retains tree species viz., *Grewia optiva, Morus alba, Bauhinia variegata, Dalbergia sissoo, Albizia chinensis, Terminalia arjuna, Sapindus mukorosii, Terminalia bellerica, Terminalia chebula, Aegle marmelos, Celtis australis, Quercus* spp., *Salix* spp.,*Poplar* spp., *Robinia pseudoacacia* etc. and grass species Poa spp., Eragrostis spp., *Apluda mutica, Chrysopogon fulvus, Heteropogon contortus, Themeda anathera, Pennisetum flaccidum, Imperata cylindrica, Setaria glauca, Paspalidium flavidum* etc. Present study revealed that traditional silvipastoral systems (protein banks, live fences and hedges and scattered trees in pasture lands) are prevalent in Himachal Pradesh. Total 107 silvipastoral system units prevalent among different farmer categories have been identified from four agro-climatic zones of Himachal Pradesh. The comparative status of silvipastoral system units prevalent among different farmer categories of Himachal Pradesh are described as under:

Agro-climatic zone-I
Total forty six silvipastoral system units prevalent in agro-climatic zone I of Himachal Pradesh have been identified from Jogipanga (Una), Shiun Khas (Kangra), Masiyana (Hamirpur) and Bhakra (Bilaspur). Farmer category wise system units in agro-climatic zone-I has been described as under:
Farmer category wise silvipastoral system units in Jogipanga (Una)
(a) Marginal farmer category
1. *Grewia optiva + Ficus auriculata + Erythrina*

suberosa + Bombax ceiba + Lannea coromandelica + Butea monopserma + Syzygium cumini + Natural grasses
2. *Bauhinia variegata + Ficus palmata + Lannea coromandelica + Bombax ceiba + Toona ciliata + Leucaena leucocephala* + Natural grasses
3. *Ziziphus jujuba + Acacia catechu + Bombax ceiba + Ficus auriculata + Pistacia chinensis* ssp. *integerrima* + Natural grasses
4. *Diospyros chloroxylon + Pinus roxburghii + Lannea coromandelica + Mallotus philippensis + Rhamnus triquetra + Pistacia chinensis* ssp. *integerrima* + Natural grasses
5. *Morus macroura + Bauhinia purpurea + Toona ciliata + Ficus racemosa + Erythrina suberosa + Ficus benghalensis + Gmelina arborea* + Natural grasses
6. *Pinus roxburghii + Phoenix sylvestris + Pyrus pashia* + Natural grasses
7. *Pinus roxburghii + Pyrus pashia + Wendlandia heynei* + Natural grasses
(b) Small farmer category
1. *Grewia optiva + Ficus auriculata + Erythrina suberosa + Bombax ceiba + Lannea coromandelica + Butea monopserma + Syzygium cumini* + Natural grasseses
2. *Bauhinia variegata + Phyllanthus emblica + Ficus auriculata + Morus alba + Butea monosperma + Bombax ceiba + Bambusa bambos + Vitex negundo*
3. *Dalbergia sissoo + Ziziphus jujuba + Flacourtia indica + Shorea robusta + Dendrocalamus hamiltonii*
4. *Ziziphus jujuba + Acacia catechu + Bombax ceiba + Ficus auriculata + Pistacia chinensis* ssp. *integerrima* +Natural grasses
5. *Acacia catechu + Cassia fistula + Leucaena leucocephala + Toona ciliata + Dendrocalamus hamiltonii* + Natural grasses
6. *Pinus roxburghii + Pyrus pashia + Wendlandia heynei* + Natural grasses
(c) Medium farmer category
1. *Grewia optiva + Ficus auriculata + Erythrina suberosa + Bombax ceiba + Lannea coromandelica + Butea monopserma + Syzygium cumini* + Natural grasses
2. *Bauhinia variegata + Ficus palmata + Lannea coromandelica + Bombax ceiba + Toona ciliata + Leucaena leucocephala* +Natural grasses
Farmer category wise silvipastoral system units in Shiun Khas (Kangra)
(a) Marginal farmer category
1. *Bauhinia variegata + Ficus palmata + Ficus benghalensis + Bombax ceiba + Syzygium cumini* + Natural grasses
2. *Grewia optiva + Ziziphus jujuba + Celtis australis + Ficus palmata + Mangifera indica + Lannea coromandelica + Falconeria insignis + Wendlandia heynei* + Natural grasses
3. *Phyllanthus emblica + Leucaena leucocephala +*

Cassia fistula + Aegle marmelos + Terminalia chebula + Ficus palmata + Mangifera indica + Albizia procera + Pistacia chinensis ssp. *integerrima + Morus alba + Bambusa bambos* + Natural grasses

4. *Terminalia bellirica + Phyllanthus emblica + Terminalia chebula + Albizia procera + Anogeissus latifolia + Albizia chinensis + Dendrocalamus hamiltonii* + Natural grasses

5. *Pinus roxburghii + Phoenix sylvestris + Pyrus pashia + Wendlandia heynei + Dendrocalamus strictus* + Natural grasses

6. *Pinus roxburghii + Pyrus pashia* + Natural grasses

(b) Small farmer category

1. *Grewia optiva + Ziziphus jujuba + Celtis australis + Ficus palmata + Mangifera indica + Lannea coromandelica + Falconeria insignis + Wendlandia heynei* + Natural grasses

2. *Terminalia bellirica + Leucaena leucocephala + Terminalia chebula + Ficus palmata + Lannea coromandelica + Falconeria insignis + Wendlandia heynei + Dendrocalamus strictus* + Natural grasses

3. *Pinus roxburghii + Pyrus pashia* + Natural grasses

Farmer category wise silvipastoral system units in Masiyana (Hamirpur)

(a) Marginal farmer category

1. *Grewia optiva + Celtis australis + Albizia lebbeck + Litsea chinensis + Ficus palmata + Aegle marmelos + Ficus relegiosa + Ficus auriculata* + Natural grasses

2. *Grewia optiva + Toona ciliata + Morus alba + Aegle marmelos + Mallotus phillipensis + Mangifera indica + Ficus palmate* + Natural grasses

3. *Bauhinia variegata + Albizia lebbeck + Ficus relegiosa + Ficus palmata + Bombax ceiba + Mangifera indica + Azadirachta indica + Ficus racemose* + Natural grasses

4. *Bauhinia variegata + Dalbergia sissoo + Leucaena leucocephala + Albizia lebbeck + Albizia procera + Mallotus philippensis + Melia azedarach* + Natural grasses

5. *Acacia catechu + Grewia optiva + Phyllanthus emblica + Pistacia chinensis* spp. *integerrima + Bombax ceiba + Dendrocalamus strictus*

6. *Grewia optiva + Morus serrata + Ficus auriculata + Albizia chinensis + Dendrocalamus strictus + Natural grasses*

7. *Pinus roxburghii + Pyrus pashia + Phoenix sylvestris + Flacourtia indica + Ficus palmata + Aegle marmelos + Bombax ceiba* + Natural grasses

8. *Acacia catechu + Cassia fistula + Flacourtia indica + Albizia procera + Terminalia tomentosa + Bombax ceiba + Ficus religiosa* + Natural grasses

9. *Morus serrata + Leucaena leucocephala +*

Ficus palmata + Lannea coromandelica + Rhamnus triquetra + Syzygium cumini + Ficus palmate + Natural grasses

(b) Small farmer category

1. *Dalbergia sissoo + Acacia catechu + Ziziphus jujuba + Celtis australis + Ficus palmata + Ficus relegiosa + Ficus benghalensis + Albizia procrea* + Natural grasses

2. *Bauhinia variegata + Acacia catechu + Toona ciliata + Mallotus philippensis + Ziziphus jujuba + Bambusa bambos + Terminalia tomentosa* + Natural grasses

3. *Acacia catechu + Leucaena leucocephala + Ficus palmata + Ficus auriculata + Melia azedarach + Dendrocalamus strictus* + Natural grasses

(c) Medium farmer category

1. *Bauhinia variegata + Albizia lebbeck + Ficus relegiosa + Ficus palmata + Bombax ceiba + Mangifera indica + Azadirachta indica + Ficus racemosa* + Natural grasses

Farmer category wise Silvipastoral system units in Bhakra (Bilaspur)

(a) Marginal farmer category

1. *Acacia catechu + Grewia optiva + Albizia procera + Bombax ceiba + Butea monosperma + Toona ciliata + Azadirachta indica + Bambusa bambos + Ficus racemosa* + Natural grasses

2. *Grewia optiva + Bauhinia variegata + Bauhinia purpurea + Morus alba + Bombax ceiba + Wendlandia heynei + Pithecellobium dulce + Flacourtia indica + Dendrocalamus hamiltonii* + Natural grasses

3. *Phyllanthus emblica + Dalbergia sissoo + Ziziphus jujuba + Erythrina indica + Bombax ceiba + Cassia fistula + Flacourtia indica + Dendrocalamus strictus* + Natural grasses

4. *Pinus roxburghii + Melia azedarach + Pistacia chinensis* ssp. *Integerrima + Lannea coromandelica + Mallotus philippensis + Bombax ceiba + Litsea glutinosa + Feronia limonia* + Natural grasses

5. *Pinus roxburghii + Pyrus pashia + Eucalyptus globulus + Butea monosperma + Erythrina indica* + Natural grasses

6. *Pinus roxburghii + Ficus palmata + Phoenix sylvestris + Toona ciliata + Melia azaderach + Pyrus pashia* + Natural grasses

7. *Mangifera indica + Acacia catechu + Dalbergia sissoo + Leucaena leucocephala + Bombax ceiba + Flacourtia indica + Mallotus philippensis + Toona ciliata + Wendlandia heynei* + Natural grasses

(b) Small farmer category

1. *Grewia optiva + Bauhinia variegata + Bauhinia purpurea + Morus alba + Bombax ceiba + Wendlandia heynei + Pithecellobium dulce + Flacourtia indica + Dendrocalamus hamiltonii +*

Natural grasses

2. *Acacia catechu + Grewia optiva + Albizia procera + Bombax ceiba + Butea monosperma + Toona ciliata + Azadirachta indica + Bambusa bambos + Ficus racemosa* + Natural grasses

Agro-climatic zone-II

Total twenty nine silvipastoral system units prevalent in agroclimatic zone-II of Himachal Pradesh have been identified from Naun (Mandi), Keela Kalanj (Sirmaur) and Banalgi (Solan). A Farmer category wise system unit in agroclimatic zone-II has been described as under:

Farmer category wise silvipastoral system units in Naun (Mandi)

(a) Marginal farmer category

1. *Grewia optiva + Celtis australis + Morus macroura+ Wendlandia heynei + Pyrus pashia + Pistacia chinensis* subsp. *integerrima + Melia azedarach + Ficus palmata + Vitex negundo+* Natural grasses

2. *Prunus cerasoides + Grewia optiva + Ficus palmata + Ficus auriculata + + Bombax ceiba + Melia azedarach Ficus auriculata + Toona ciliata + Punica granatum+* Natural grasses

3. *Pinus roxburghii + Quercus oblongata + Pyrus pashia + Eucalyptus globulus+* Natural grasses

4. *Myrica esculenta + Pinus roxburghii + Pinus wallichiana + Pyrus pashia + Dodonia viscosa+* Natural grasses

(b) Small farmer category

1. *Grewia optiva + Celtis australis + Morus macroura+ Wendlandia heynei + Pyrus pashia + Pistacia chinensis* subsp. *integerrima + Melia azedarach + Ficus palmata + Vitex negundo +* Natural grasses

2. *Pinus roxburghii + Pyrus pashia+* Natural grasses

Farmer category wise silvipastoral system units in Keela Kalanj (Sirmaur)

(a) Marginal farmer category

1. *Grewia optiva + Bauhinia variegata + Pinus roxburghii + Celtis australis + Bombax ceiba + Morus macroura + Ficus relegiosa + Punica granatum* + Natural grasses

2. *Phyllanthus emblica + Grewia optiva + Ficus palmata + Mallotus philippensis + Bombax ceiba + Pistacia chinensis* spp. *integerrima + Vitex negundo+* Natural grasses

3. *Pinus roxburghii + Ficus palmata+ Falconeria insigne + Lannea coromandelica+ Mallotus philippensis + Eucalyptus tereticornis + Quercus oblongata + Dendrocalamus strictus+* Natural grasses

4. *Toona ciliata + Leucaena leucocephala+ Terminalia tomentosa + Ailanthus excelsa + Ougeinia oojeinensis + Melia azedarach + Albizia lebback + Dendrocalamus strictus +* Natural grasses

5. *Pinus roxburghii + Pyrus pashia +Quercus leucotrichophora + Ficus palmata + Ficus*

racemosa + Mallotus philippensis + Natural grasses

6. *Pinus roxburghii + Ficus palmata + Ficus racemosa + Ficus auriculata + Dendrocalamus strictus* + Natural grasses

7. *Toona ciliata + Leucaena leucocephala+ Terminalia tomentosa + Ailanthus excelsa + Ougeinia oojeinensis + Melia azedarach + Albizia lebback + Dendrocalamus strictus+* Natural grasses

(b) Small farmer category

1. *Grewia optiva +Cassia fistula + Ziziphus jujuba + Ficus palmata + Anogeissus latifolia + Albizia lebbeck + Butea monosperma + Toona ciliata + Robinia pseudoacacia+* Natural grasses

2. *Phyllanthus emblica + Grewia optiva + Ficus palmata + Mallotus philippensis + Bombax ceiba + Pistacia chinensis* spp. *integerrima + Vitex negundo+* Natural grasses

3. *Pinus roxburghii + Ficus palmata + Ficus racemosa + Ficus auriculata + Dendrocalamus strictus* + Natural grasses

4. *Pinus roxburghii + Pyrus pashia +Quercus leucotrichophora + Ficus palmata + Ficus racemosa + Mallotus philippensis+* Natural grasses

5. *Toona ciliata + Leucaena leucocephala+ Terminalia tomentosa + Ailanthus excelsa + Ougeinia oojeinensis + Melia azedarach + Albizia lebback + Dendrocalamus strictus+* Natural grasses

(c) Medium farmer category

1. *Grewia optiva + Bauhinia variegata + Pinus roxburghii + Celtis australis + Bombax ceiba + Morus macroura + Ficus relegiosa + Punica granatum* + Natural grasses

Farmer category wise silvipastoral system units in Banalgi (Solan)

(a) Marginal farmer category

1. *Grewia optiva + Celtis australis + Bombax ceiba + Cassia fistula + Morus alba + Morus macroura + Robinia pseudoacacia + Salix tetrasperma + Olea europaea* ssp. *cuspidata + Albizia chinensis + Falconeria insignis+* Natural grasses

2. *Grewia optiva + Bauhinia variegata + Morus macroura + Pistacia chinensis* ssp. *integerrima + Ficus palmata + Ficus racemosa + Ficus religiosa + Lannea coromandelica + Bambusa bambos+* Natural grasses

3. *Bauhinia variegata + Phyllanthus emblica + Ziziphus jujuba + Melia azedarach + Ougeinia oojeinensis + Albizia chinensis + Terminalia tomentosa + Garuga pinnata*

4. *Pinus roxburghii + Phoenix sylvestris+ Pyrus pashia + Mallotus philippensis + Kydia calycina + Litsea glutinosa + Ficus auriculata + Ficus racemosa + Lannea coromandelica+* Natural grasses

5. *Pinus roxburghii + Pyrus pashia +* Natural

grasses

(b) Small farmer category

1. *Albizia odoratissima + Toona ciliata + Albizia lebbeck + Pyrus pashia + Ailanthus excelsa + Mallotus philippensis + Salix alba + Sterculia villosa + Grevillea robusta + Jacaranda mimosifolia + Bambusa bambos+* Natural grasses

2. *Grewia optiva + Celtis australis + Bombax ceiba + Cassia fistula + Morus alba + Morus macroura + Robinia pseudoacacia + Salix tetrasperma + Olea europaea* ssp. *cuspidata + Albizia chinensis + Falconeria insignis+* Natural grasses

3. *Pinus roxburghii + Pyrus pashia +* Natural grasses

(c) Medium farmer category

1. *Grewia optiva + Bauhinia variegata + Morus macroura + Pistacia chinensis* ssp. *integerrima + Ficus palmata + Ficus racemosa + Ficus religiosa + Lannea coromandelica + Bambusa bambos +* Natural grasses

2. *Bauhinia variegata + Phyllanthus emblica + Ziziphus jujuba + Melia azedarach + Ougeinia oojeinensis + Albizia chinensis + Terminalia tomentosa + Garuga pinnata +* Natural grasses

Agro-climatic zone-III

Total eighteen system units prevalent in agroclimatic zone-III of Himachal Pradesh have been identified from Ghiaghi (Kullu), Jarashi (Shimla) and Kundi (Shimla). A Farmer category wise system unit in agroclimatic zone-III has been described as under:

Farmer category wise silvipastoral system units in Ghiaghi (Kullu)

(a) Marginal farmer category

1. *Quercus floribunda + Robinia pseudoacacia + Ailanthus excelsa + Toona ciliata + Populus cliata + Brucea javanica +* Natural grasses

2. *Quercus oblongata + Cedrus deodara + Pyrus pashia + Ficus palmata + Celtis australis + Toona ciliata + Populus cliata + Salix babylonica+* Natural grasses

3. *Quercus floribunda + Quercus oblongata + Pyrus pashia + Ficus palmata + Celtis australis + Cedrus deodara + Robinia pseudoacacia + Lyonia ovalifoia +* Natural grasses

4. *Quercus floribunda + Picea smithiana + Salix tetrasperma + Ficus palmata + Morus serrata + Celtis australis + Pyrus pashia + Pinus wallichiana + Cedrus deodara + Olea europaea* ssp. *cuspidata + Alnus nitida + Aesculus indica +* Natural grasses

(b) Small farmer category

1. *Quercus oblongata + Cedrus deodara+ Pyrus pashia + Ficus palmata + Celtis australis + Toona ciliata + Populus cliata + Salix babylonica +* Natural grasses

2. *Quercus floribunda + Quercus oblongata + Pyrus pashia + Ficus palmata + Celtis australis + Cedrus deodara + Robinia pseudoacacia + Lyonia ovalifoia +* Natural grasses

(c) Medium farmer category

1. *Quercus floribunda + Picea smithiana + Salix tetrasperma + Ficus palmata + Morus serrata + Celtis australis + Pyrus pashia + Pinus wallichiana + Cedrus deodara + Olea europaea* ssp. *cuspidata + Alnus nitida + Aesculus indica +* Natural grasses

Farmer category wise silvipastoral system units in Jarashi (Shimla)

(a) Marginal farmer category

1. *Quercus oblongata + Prunus cerasoides + Pyrus pashia + Prunus armeniaca + Ailanthus excelsa + Morus serrata + Robinia pseudoacacia + Pistacia chinensis* ssp. *integerrima + Salix tetrasperma +* Natural grasses

2. *Quercus oblongata + Quercus floribunda + Cedrus deodara + Pinus wallichiana + Aesculus indica + Salix alba + Olea europaea* ssp. *cuspidata +* Natural grasses

3. *Quercus oblongata + Picea smithiana + Cedrus deodara + Aesculus indica + Pinus wallichiana +* Natural grasses

(b) Small farmer category

1. *Quercus oblongata + Prunus cerasoides + Pyrus pashia + Prunus armeniaca + Ailanthus excelsa + Morus serrata + Robinia pseudoacacia + Pistacia chinensis* ssp. *integerrima + Salix tetrasperma +* Natural grasses

2. *Quercus floribunda + Rhododendron arboreum + Celtis australis + Lyonia ovalifolia + Populus ciliata + Toona ciliata + Pinus wallichiana + Cedrus deodara + Ficus palmatA +* Natural grasses

Farmer category wise silvipastoral system units in Kundi (Chamba

(a) Marginal farmer category

1. *Grewia optiva + Celtis australis + Ficus palmata + Pyrus pashia +Ficus racemosa+Robinia pseudoacacia + Prunus cornuta + Melia azedarach + Prunus cerasoides+* Natural grasses

2. *Quercus oblongata + Morus alba + Prunus cerasoides + Robinia pseudoacacia + Junlans regia Aesculus indica + Ailanthus excelsa + Salix tetrasperma + Populus ciliata + Rhus cotinus +* Natural grasses

3. *Cedrus deodara + Pinus wallichiana +* Natural grasses

(b) Small farmer category

1. *Grewia optiva + Celtis australis + Ficus palmata + Pyrus pashia + Ficus racemose + Robinia pseudoacacia + Prunus cornuta + Melia azedarach + Prunus cerasoides +* Natural grasses

2. *Quercus oblongata + Morus alba + Prunus cerasoides + Robinia pseudoacacia + Junlans regia Aesculus indica + Ailanthus excelsa + Salix tetrasperma + Populus ciliata + Rhus cotinus +* Natural grass

(c) Medium farmer category

1. *Quercus oblongata + Morus alba + Prunus*

cerasoides + Robinia pseudoacacia + Juglans regia Aesculus indica + Ailanthus excelsa + Salix tetrasperma + Populus ciliata + Rhus cotinus+ Natural grasses

Agro-climatic zone-IV

Total fourteen system units prevalent in agroclimatic zone-III of Himachal Pradesh have been identified from Ghiaghi (Kullu), Jarashi (Shimla) and Kundi (Shimla). A Farmer category wise system unit in agroclimatic zone-III has been described as under:

Farmer category wise silvipastoral system units in Roghi (Kinnaur)

(a) Marginal farmer category

1. *Salix tetrasperma + Populus ciliata + Celtis australis + Salix alba + Prunus mira + Prunus armeniaca* + Natural grasses
2. *Pinus gerardiana + Ailanthus altissima + Quercus ilex + Pinus wallichiana + Prunus mira + Juglans regia* + Natural grasses
3. *Cedrus deodara + Pinus wallichiana* + Natural grasses
4. *Pinus gerardiana+ Ailanthus altissima + Quercus ilex + Pinus wallichiana + Prunus mira + Juglans regia* + Natural grasses

(b) Medium farmer category

1. *Salix tetrasperma + Populus ciliata + Celtis australis + Salix alba + Prunus mira + Prunus armeniaca* + Natural grasses
2. *Pinus gerardiana + Ailanthus altissima + Quercus ilex + Pinus wallichiana + Prunus mira + Juglans regia* + Natural grasses
3. *Cedrus dedara + Pinus wallichiana* + Natural grasses

Farmer category wise silvipastoral system units in Muling (Lahaul and Spiti)

(a) Marginal farmer category

1. *Salix fragilis + Salix alba + Salix acmophylla + Populus ciliata+ Robinia pseudoacacia + Malus baccata + Hippophae salicifolia* + Natural grasses
2. *Pinus wallichiana + Populus ciliata + Juniperus polycarpos + Rosa webbiana + Salix* spp. + Natural grasses
3. *Juniperus polycarpos + Rosa webbiana + Hippophae salicifolia* + Natural grasses

(c) Small farmer category

1. *Salix fragilis + Salix alba + Salix acmophylla + Populus ciliata + Robinia pseudoacacia + Malus baccata + Hippophae salicifolia* + Natural grasses
2. *Pinus wallichiana + Populus ciliata + Juniperus polycarpos + Rosa webbiana + Salix* spp. + Natural grasses

(d) Medium farmer category

1. *Salix fragilis + Salix alba + Salix acmophylla + Populus ciliata + Robinia pseudoacacia + Malus baccata + Hippophae salicifolia* + Natural grasses
2. *Juniperus polycarpos + Rosa webbiana + Hippophae salicifolia* + Natural grasses

Result of the present study are in conformity with the works of Upadhyaya (1997), Kumar (2004), Goswami (2009), Singh, (2012) and Tiwari et al. (2018). Variation in silvipastoral system units among different farmer categories in Himachal Pradesh is due to variation in climatic conditions, socio-economic status of the inhabitants, socio-economic status of farmers, preference for species, amount of income, agricultural inputs etc. During the present study in Himachal Pradesh among all farmer categories marginal farmers were having more diverse system units 29, 16, 10 and 7 respectively in zone-I, II, III, IV whereas in small category 14, 10, 6, 2 and in medium category 3, 3, 2, 5 recorded in zone-I, II, III, IV respectively.

CONCLUSION

Agroforestry is practiced in various forms in different parts of India. Popularity of Agroforestry has increased in India after launching National Agroforestry Policy in 2014. The Sub-Mission on Agroforestry (Har Medh Par Ped) Scheme is a live example which was launched in 2016-17 to encourage tree plantation on farmland along with crops/ cropping system. These agroforestry systems are not only contributing as rich source of socially, culturally and economically valued species for the rural and tribal communities throughout the North Western Himalayan region but also contributing in ecosystem balance. Present study revealed that traditional type of Silvipastoral systems are prevalent in Himachal Pradesh and marginal farmers were having more diverse silvipastoral system units in comparison to medium and small farmer. Thus for the full potential utilization of this agroforestry system type there is dire need of mass scale unawareness campaign for plantation of improved and high yielding plant species coupled with technological interventions are urgently required.

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