Public Assessment for Socioeconomic and Environmental Services of Agroforestry Networks in Kashmir Himalaya, India

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Abstract

Agroforestry is a dynamic ecologically based natural resources management system that diversifies for increased socioeconomic and environmental services for land-users. The study analyzed the prevalent agroforestry practices and their socioeconomic and environmental services to draw up recommendations for sustainable agroforestry development in Ganderbal district of Kashmir Himalaya. Multi-stage random sampling was employed to select a sample of 380 households of 10 villages under 3 blocks in the district for field survey. Data were collected using structured interviews and non-participant observations. Descriptive and analytical statistics were used for the data analysis. Results indicated that hortisilviagriculture (26.05%) is the most prevalent agroforestry system while the agrihorticulture (2.89%) is the least practiced agroforestry system. The agroforestry practice comprises planting of 14 categories of ethno-medicago-botanically important plants for livelihood security and ecological sustainability. Weighted Mean Score (WMS) indicated that self-reliance in forest resources (WMS, 2.99) was considered the most important socioeconomic service ranking as 1st whereas the communication exposure (WMS, 1.29) was perceived as least important and ranked as 10th. Conversely, biomass production (WMS, 2.80) was observed as the most important environmental service ranking as 1st while the reduction in pest and diseases incidence (WMS, 1.41) was perceived least important and rated as 10th. Correlation analysis specified that all the socioeconomic and environmental services were positively and significantly associated with the agroforestry adoption. The effective implementation of agroforestry as key component of community-based policies and programs, the study determined that the socioeconomic and environmental services encouraged adoption by rural farmers making it more viable and sustainable technically.

Keywords
Socioeconomic, Environmental, Agroforestry, Kashmir, Himalaya, India.

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Introduction

Agroforestry is the set of land-use practices involving the deliberate combination of trees, agricultural crops and/or animals on the same land management unit in some form of spatial arrangement or temporal sequence (Lundgren and Raintree, 1982).

According to Leakey (1996) the agroforestry is a dynamic, ecologically based natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies for increased social, economic and environmental...
benefits for land-users at all levels. Agroforestry as a land-use option potentially increases livelihood security through simultaneous production of food, fodder, firewood etc. and reduces vulnerability to climate and environmental change (Pandey, 2007; Tiwari et al., 2017). Agroforestry benefits individual landowners and communities alike, because agroforestry combines socioeconomic development with environmental amelioration (Arunachalam and Arunachalam, 2012). Agroforestry practices differ considerably from region to region, community to community and farmer to farmer depending upon the socioeconomic and environmental needs and circumstances (Pant, 2011; Islam et al., 2012). It offers an array of socioeconomic and environmental services which have contributed considerably towards agroforestry adoption, promotion and development (Banyal et al., 2011; Islam and Quli, 2016). It helps in sufficient production of food grains resulting in variation of food habits, stops traditional profession like hunting, gathering forest produces etc. and concentrate only in farming, ensures good and cheap fodder for livestock production, promotes communication exposure as people need contact with field extension functionaries, radio, newspaper etc. to gain more information on agroforestry (Bijalwan et al., 2011; Tiwari et al., 2017). It decreases migration by facilitating increased self-employment opportunities through interventions such as nursery raising, mat weaving, basket making etc. and contributes to the increased family income (Dagar, 2012; Ashraf et al., 2015). Additionally, the agroforestry practices increases biomass production (fuel wood, fodder, timber, medicine, vegetables, fruits etc.), improves soil conditions such as soil nutrition, moisture content of soil, water-holding capacity etc., improves groundwater recharge, reduces the dependency of people on the natural forests and reduces incidence of pest and diseases (Gangadharappa et al., 2010; Roy and Tiwari, 2012). Concurrently, the agroforestry moderates micro-climate (reduction of wind speed, stabilization of daily mean temperature, modification of solar radiation, increase of air humidity and decrease of evaporation) and mitigates land degradation through the means of controlling water erosion, soil erosion, reclaiming marginalized land and increasing irrigation and agricultural productivity (Jerneck and Olsson, 2013; Oyebamiji et al., 2013). With their multi-layered vegetation structures, agroforestry plantations serve as an important habitat for wild flora and fauna (Tangiang and Arunachalam, 2009).

Agroforestry have become a way of life since time immemorial in Kashmir Himalaya (Islam et al., 2012) and a means to achieve landscape amelioration from an environmental and socioeconomic point of view (Mughal et al., 2000). The general agroforestry systems being practiced traditionally are agrisilviculture, hortisilviculture, hortisilvi-pasture, agrisilvihorticulture and homegarden (Islam et al., 2017). The woody and fruit tree species mostly grown in agroforestry practices are Salix alba, Populus deltoides, Robinia pseudoacacia, Populus nigra, Morus alba, Juglans regia, Ulmus wallichiana, Ailanthus excelsa, Malus domestica, Pyrus communis, Prunus persica, Prunus armeniaca etc. (Islam et al., 2015). Agroforestry has made remarkable strides in recent years in Kashmir Himalaya, but many challenges remain in terms of its wider application (Islam et al., 2016). Notwithstanding, all its beneficial roles, agroforestry development rate falls far behind the expected (Banyal et al., 2011). The socioeconomic inequalities and disparity in environmental attributes in farming communities play significant differential role in agroforestry promotion and development (Jamala et al., 2013). To promote agroforestry development, a deeper
understanding of socioeconomic and environmental influences among rural communities is necessary for better agroforestry planning and implementation (Khandagale et al., 2012; Jacobson and Kar, 2013). Hence, it is necessary to identify and measure the range of benefits accrued to the rural people which are not well documented so far. Research is also required to quantify the benefits, to deal with the variability in benefits, to assess the effects of different policies and to examine the impact of agroforestry practices. To make the study viable and sustainable technically and policy-wise more useful, the researcher also thought it necessary to come up with insightful recommendations. The study aimed to analyze the agroforestry practices of the farmers, assess the socioeconomic and environmental benefits and draw up lessons and recommendations for sustainable agroforestry development in rural communities of Kashmir Himalaya.

Materials and Methods

Locale of study

The study was conducted in Ganderbal district of Kashmir Himalaya situated between 34.23°N longitude and 74.78°E latitude at an altitude of 1650-3000 meters above MSL. The geographical area of the district is 39304 ha, of which 27.86 percent is forest, 14.65 percent is under non-agricultural use, 8.04 percent is barren and un-cultivable land, 4.55 percent is permanent pastures and other grazing land, 2.48 percent is cultivable waste land and 42.42 percent is net area sown (Anonymous, 2011). The locale experiences both temperate and sub-alpine conditions and is well known for excessive annual rainfall (700 mm) and temperature varies from 5°C to 20°C. The district has total human population of 297446 (158,720 male and 138,726 female), the literacy rate of 59.98 percent, sex ratio of 874 female per 1000 males, family size of 6.62 and population density of 1148 per km². The district comprises of 84.19 percent of rural and 15.81 percent of urban population living in 136 villages and 44831 households (Census of India, 2011).

Sampling

The villages and households were selected employing multi-stage random sampling technique (Ray and Mondol, 2004). Three blocks namely, Ganderbal, Lar and Kanagan in the Ganderbal district were randomly selected in the first stage. Ten villages viz., Arhama, Yarmaqam, Manigam, Haripora, Manigam from Lar block, Wayil, Gotli bagh, Nunner, Urpash from Ganderbal block and Wussan from Kangan block were selected in the second stage involving simple random sampling. A total of 380 households were drawn from the sample villages having 5 percent sampling intensity for the field study and the respondents interviewed were either household heads or eldest members.

Data collection

Data were gathered using a well-structured pre-tested interview schedule and non-participant observation (Kumar, 2012). Interview schedule was prepared based on earlier works, reconnaissance survey, and discussion with local people and consultation with the experts. The interview schedule included household level informations on adoption of agroforestry practices and socioeconomic and environmental services of agroforestry networks. To find out the rural people’s perception towards the socioeconomic and environmental services of agroforestry networks, ten chief benefits under the socioeconomic and environmental categories were incorporated in the schedule and their degree of importance were measured by a 3-point continuum scale namely, very
important, moderately important and least important with their respective scores 3, 2 and 1 as per Singha et al., (2006). The ranking of agroforestry values was done from 1 to 10 on the basis of the weighted mean score to determine their relative importance. Under non-participant observation the data were recorded by watching and noting the phenomena.

Data analysis

The statistical tools viz., frequency (f), percentage (%), average (x), standard deviation, range, F test and co-efficient of correlation were applied for data analysis (Snedecor and Cochran, 1967) on MS Excel and Statistical Package for Social Sciences (SPSS) software. The weighted mean score (WMS) for each service was obtained by multiplying the frequencies with their respective scores, adding them up and dividing by the total number of people as follows:

\[ \text{Weighted Mean Score (WMS)} = \frac{\sum s_i f_i}{n} \]

Where,

- \( f_i \) = frequency of the people for \( i^{th} \) item
- \( s_i \) = score of the \( i^{th} \) item
- \( i = 0, 1, 2, 3, 4 \) or 5
- \( n = \) total number of people

Results and Discussion

Adoption of agroforestry practices

Out of the nine existing prominent agroforestry practices, hortisilviagriculture (26.05%), hortisilviculture (5.26%), silvipastoral (3.95%) and agrihorticulture (2.89%) (Fig. 1). These dominant agroforestry practices of the rural communities are comprised of planting 14 categories of ethno-medicago-botanically important plants viz., fodder (49), fuel (28), vegetable (29), cereals (4), pulses (4), medicinal (8), ornamental (9), fruit (19), timber (7), fencing (7), cottage industry (7), spice (7), edible seed/nut (4) and oilseed (Islam et al., 2017). These practices interact with each other through their protective and productive functions that benefit the communities as well as the micro-climate (Fouladbash and Currie, 2015). The protective services of agroforestry practices include preventing massive soil erosion, restoring or maintaining soil fertility through nutrient cycling, soil and water conservation, modifying microclimate and providing shade and as live fence and wind breaks (Chakraborty et al., 2015). The agroforestry practices provide socioeconomic services to the farmers through the improved farm productivity (timber, fuel wood, fodder, fruit, food, grains, vegetables etc.) both for the home consumption, cash income and future safety net (Mushtaq et al., 2012).

The categorization of households based on mean (13.25) and standard deviation (3.26) of adoption scores (Table 1) revealed that majority (52.11%) of them belonged to medium category followed by low (26.84%) and high (21.05%) categories. The adoption score ranged from 7.00 to 20.00. The mean score of agroforestry adoption showed prevalence of people with medium adoption level towards agroforestry practices. The adequate level of adoption could be due to satisfactory knowledge regarding complex agroforestry practices, scientific tree farming, widespread use of primitive indigenous techniques, awareness towards modern agroforestry technologies, appropriate
extension contact and participation, easiness in availability of quality input materials and tools and availability of financial support (Wani, 2010; Rawat and Vishvakarma, 2011).

**Socioeconomic services of agroforestry networks**

The relative ranking of socioeconomic services of agroforestry (Table 2) indicated that the self-reliance in forest resources was perceived highly important by majority (98.68%) of the people and ranked 1st (WMS, 2.99). The next utmost (96.84%) highly important socioeconomic service of agroforestry was agricultural support which was ranked 2nd (WMS, 2.96). Similarly, a substantial majority (61.05%) had considered the service, promotion in livestock production as highly important and assigned the rank 3rd (WMS, 2.27). Regarding the food security most (67.63%) of the people have shown moderately important perception and rated it 4th (WMS, 1.86). The income generation was opined as least important among considerable number (47.90%) of the people ranking it at 5th (WMS, 1.83). As regards, the other services namely, employment support, nutrition and health security, development of agroforestry industries, reduction in migration and communication exposure the exiting agroforestry practices could not bring substantial impact (Islam et al., 2016) that are desirable for the society and hence, adjudged least important.

On the contrary, the impact of the agroforestry services like food security, income generation, employment support and nutrition and health security among the rural communities in Kashmir Himalaya is comparatively moderate (Islam et al., 2015), hence, these services were considered moderately important. With respect to the other agroforestry services viz., development of agroforestry industries, reduction in migration and communication exposure the exiting agroforestry practices could not bring substantial impact (Islam et al., 2016) that are desirable for the society and hence, adjudged least important.

**Environmental services of agroforestry networks**

The rural people’s perception of the agroforestry environmental services (Table 3) indicated that the biomass production (WMS, 2.80), reduction of pressure on forests (WMS, 2.77) and biodiversity conservation (WMS, 2.72) were considered most important among majority (82.11-74.74%) of the people and assigned the rank 1st, 2nd and 3rd respectively. The environmental services like amelioration of the microclimate (WMS, 2.45), soil fertility improvement (WMS, 2.41), windbreak protection (WMS, 2.27) and ground water recharge (WMS, 1.96) were perceived as most important by 53.95-21.31% and moderately important by 37.11-52.90% of the people ranking them as 4th to 7th. Likewise, a substantial majority (66.58-71.84%) of the
people contemplated the services viz., pollution reduction (WMS, 1.48), erosion control (WMS, 1.45) and reduction in pest and diseases incidence (WMS, 1.41) as least important and were rated as 8th, 9th and 10th respectively. The F statistics (p < 0.05) showed that the environmental services ranked 1st to 3rd were significantly different with the services ranked between 4th to 7th and 8th to 10th.

Table.1 Descriptive statistics for agroforestry adoption in Kashmir Himalaya (N=380)

| Category                  | Households (%) | Mean | Std. Dev. | 95% Confidence Interval for Mean | Minimum | Maximum | Upper bound | Lower bound |
|---------------------------|----------------|------|-----------|----------------------------------|---------|---------|-------------|-------------|
| Low (< 10.00)             | 102 (26.84)    | 13.25| 3.26      |                                  | 7.00    | 20.00   |
| Medium (10.00 to 16.51)   | 198 (52.11)    | 12.78| 13.71     |                                  |         |         |
| High (> 16.51)            | 80 (21.05)     | 7.00 |           |                                  |         |         |

Table.2 Socioeconomic services of agroforestry networks in Kashmir Himalaya (N=380)

| Socioeconomic services                | Perception | WMS | Mean rank |
|---------------------------------------|------------|-----|-----------|
| Self-reliance in forest resources     | 375 (98.68)| 2.99| 1         |
| Agricultural support                  | 368 (96.84)| 2.96| 2         |
| Promotion in livestock production    | 232 (61.05)| 2.55| 3         |
| Nutrition and health security         | 20 (5.26)  | 1.56| 7         |
| Food security                         | 35 (9.21)  | 1.86| 4         |
| Development of agroforestry industries| 34 (8.95)  | 1.45| 8         |
| Reduction in migration                | 21 (5.53)  | 1.32| 9         |
| Income generation                     | 118 (31.05)| 1.83| 5         |
| Employment support                    | 98 (25.79) | 1.81| 6         |
| Communication exposure                | 07 (1.84)  | 1.29| 10        |

Table.3 Environmental services of agroforestry networks in Kashmir Himalaya (N=380)

| Environmental services                | Perception | WMS | Mean rank |
|---------------------------------------|------------|-----|-----------|
| Biomass production                    | 312 (82.11)| 2.80| 1         |
| Soil fertility improvement            | 198 (52.11)| 2.41| 5         |
| Amelioration of the microclimate      | 205 (53.95)| 2.45| 4         |
| Reduction of pressure on forests      | 304 (80.00)| 2.77| 2         |
| Biodiversity conservation             | 284 (74.74)| 2.72| 3         |
| Windbreak protection                  | 167 (43.95)| 2.27| 6         |
| Pollution reduction                   | 55 (14.47) | 1.48| 8         |
| Ground water recharge                 | 81 (21.31) | 1.96| 7         |
| Reduction in pest and diseases incidence| 48 (12.63)| 1.41| 10        |
| Erosion control                       | 53 (13.95) | 1.45| 9         |
Table 4: Correlation analysis of socioeconomic and environmental services with agroforestry adoption in Kashmir Himalaya (N=380)

| Socioeconomic services                          | Co-efficient of correlation (r) | Environmental services                      | Co-efficient of correlation (r) |
|------------------------------------------------|---------------------------------|---------------------------------------------|--------------------------------|
| Self-reliance in forest resources               | 0.678*                          | Biomass production                          | 0.652*                         |
| Agricultural support                            | 0.648*                          | Soil fertility improvement                  | 0.578*                         |
| Promotion in livestock production               | 0.743*                          | Amelioration of the microclimate             | 0.571*                         |
| Nutrition and health security                   | 0.554*                          | Reduction of pressure on forests            | 0.509*                         |
| Food security                                   | 0.638*                          | Biodiversity conservation                   | 0.476*                         |
| Development of agroforestry industries          | 0.560*                          | Windbreak protection                         | 0.460*                         |
| Reduction in migration                          | 0.532*                          | Pollution reduction                          | 0.405*                         |
| Income generation                               | 0.721*                          | Ground water recharge                        | 0.429*                         |
| Employment support                              | 0.559*                          | Reduction in pest and diseases incidence    | 0.456*                         |
| Communication exposure                          | 0.524*                          | Erosion control                             | 0.472*                         |

* = Significant at 5% level of probability

Fig. 1: Adoption of agroforestry practices in Kashmir Himalaya (N=380)

This is a fair reflection because the environmental services which provide tangible benefits that can be easily observable among the rural people were given higher ranking while the services giving intangible benefits which are least observable were ranked lower. The environmental services promoting productive, economic, human and social development were assigned higher values due to their socioeconomic and life supporting impact to the rural societies, which is in consistent with the previous workers (Kareemulla et al., 2009; Bijalwan et al., 2011). Contrary to this, the people rated the environmental services providing only protective functions to the rural populace such as soil and water conservation, erosion control, flood control, reduction in incidence of pests and diseases etc. as low which existed because of its imperceptible benefits (Mfitumukiza et al., 2017).
Correlation results

Simple correlation analysis (Table 4) indicated that all the socioeconomic and environmental services had shown positively significant association with the agroforestry adoption. The values of correlation coefficients (r) for the socioeconomic and environmental services worked out were, self-reliance in forest resources (0.678), agricultural support (0.648), promotion in livestock production (0.743), nutrition and health security (0.554), food security (0.638), development of agroforestry industries (0.560), reduction in migration (0.532), income generation (0.721), employment support (0.559) and communication exposure (0.524), biomass production (0.652), soil fertility improvement (0.578), amelioration of the microclimate (0.571), reduction of pressure on forests (0.509), biodiversity conservation (0.476), windbreak protection (0.460), pollution reduction (0.405), ground water recharge (0.429), reduction in pest and diseases incidence (0.456) and erosion control (0.472).

The agroforestry plantation for variety of socioeconomic services is an adaptive century-old indigenous practice of the rural communities in the Kashmir Himalaya (Mughal et al., 2000; Islam et al., 2015). This means that all the people in Kashmir Himalaya needs self-reliance in forest resources, agricultural support, promotion in livestock production, nutrition and health security, food security, development of agroforestry industries, reduction in migration, income generation, employment support and communication exposure.

The studies (Pant, 2011; Islam and Quli, 2016; Verma et al., 2017) also confirmed positively significant association between socioeconomic services and the agroforestry adoption. The adoption of various agroforestry practices besides providing socioeconomic services it offers a range of environmental services namely, biomass production, soil fertility improvement, amelioration of the microclimate, reduction of pressure on forests, biodiversity conservation, windbreak protection, pollution reduction, ground water recharge, reduction in pest and diseases incidence and erosion control which have been realized as potential benefits for livelihood security and ecological stability. The results are in consistent with Islam and Quli (2016), Quli et al., (2016) and Kumar et al., (2017).

The people of the Kashmir Himalaya practice nine prominent agroforestry systems to meet their socioeconomic and environmental needs. These agroforestry practices comprise planting of 14 categories of ethno-medicago-botanically important plants to meet the basic needs besides livelihood security and safety net function of the local populace.

The adequate knowledge regarding complicated agroforestry practices, extensive use of primitive indigenous techniques, scientific know-how regarding tree farming, high awareness towards modern agroforestry technologies, sufficient extension and communication facilities, easy accessibility of quality input materials and tools for agroforestry and financial support overwhelmingly facilitate agroforestry adoption and strengthening. But, this agroforestry adoption is strongly affected by some important socioeconomic and environmental services which associate a positive value. Hence, to promote and develop agroforestry networks further for socioeconomic improvement and environmental sustainability in the Kashmir Himalaya consideration of these services by the policy makers, planners and scientists is crucial.
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