P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 7; July 2024; Page No. 06-11

Received: 07-04-2024
Accepted: 11-05-2024

Indexed Journal
Peer Reviewed Journal

Factors influencing adoption of agroforestry systems in Ladakh region

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DOI: https://doi.org/10.33545/26180723.2024.v7.i7a.757

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Abstract

The study titled "Evaluation of Factors Influencing Adoption of Agroforestry Systems in Ladakh Region" was conducted during 2019-2020 in the Leh district, situated between 34°09' N and 77°34' E, at altitudes ranging from 2900 to 5900 meters above sea level. The research employed a multistage random sampling technique to select sample blocks, villages, and households. The first stage involved randomly selecting seven blocks: Leh, Chuchot, Thiksay, Kharu, Khaltsi, Nimo, and Nyoma. In the second stage, eleven villages were randomly chosen: Phey, Stakna, Nang, Upshi, Hemis, Shara, Nurla, Skinding, Umla, Chilling, and Nyoma. A total of 164 households were surveyed, representing a 25 percent sampling intensity. The study incorporated both qualitative and quantitative methods, with data collected from secondary sources and primary field surveys. Eight agroforestry systems were identified in the district, with home gardens being the most commonly practiced by households (154). Different factors affecting adoption of agroforestry system. Among household variables, education, family size, main occupation, livestock size, landholding, annual income, and agroforestry extent showed positive and significant correlations with agroforestry-based livelihoods. In contrast, proximity to forests, access to alternate forest resources, and forest visits exhibited negative correlations. The study highlighted that family size, landholding size, education, and livestock ownership significantly influenced agroforestry-based livelihoods. The study concluded that the contribution of agroforestry resources to the household economy was insufficient and emphasized the need to promote agroforestry for the sustainable enhancement of rural livelihoods. It called for continuous attention from policymakers, scientists, social workers, and extensionists to support the development and promotion of agroforestry as a means of livelihood improvement for the rural poor. In summary, the research underscores the importance of agroforestry in Ladakh and provides valuable insights into the factors influencing its adoption and its potential for rural development.

Keywords: Agroforestry, livelihood, forest, Radom sampling, household

Introduction

Agroforestry holds significant promise for India's agriculture, offering the potential to expand the land under agroforestry to 53.23 million hectares, or 17.5% of the country's total area, by 2050, according to CAFRI (2015) [4]. This growth is expected to primarily come from fallow, cultivable fallow, degraded, and wasteland areas, which could be a game-changer for small and marginal farmers and rural development. The advantages of agroforestry in India are multifaceted. It can produce 100 million cubic meters of commercial and domestic timber/pulpwood, satisfying a substantial portion of the country's timber demand. Additionally, it can supply 150 million tons of firewood, meeting a significant portion of global demand (Chavan *et al.*, 2015) [5]. Agroforestry also plays a role in fulfilling green fodder requirements, covering 9-11% of the demand (CAFRI, 2015) []4. In regions with temperate climates, agroforestry systems, including boundary plantations, agri-silviculture on sloping lands, horti-silviculture, horti-silvi-pasture, horti-silvi-agriculture, and home gardens, have been adopted by farmers to cater to their livelihood needs (Mughal and Bhattacharya, 2002) [13]. The Horti-agriculture system has gained popularity in the Kashmir valley, contributing to rural livelihoods and environmental services (Nabi, 2016) [14]. However, for agroforestry to have a meaningful impact, successful adoption by farmers is paramount.

Agroforestry is a complex and ecologically-driven land management system that diversifies and sustains development by incorporating trees into farming ecosystems. Its primary goal is to optimize various products and services, such as food, wood, shelter, and soil stabilization, ultimately leading to higher crop yields, increased income, food security, and resilience to climate change for those who work the land (Mead, 2004) [12]. The influence of agroforestry on rural livelihoods varies across communities and depends on factors like gender, education, and access to resources and infrastructure. Nevertheless, it offers significant socioeconomic, ecological, and cultural benefits (Sarmah and Arunachalm, 2011) [18].

In Ladakh, a region characterized by harsh winters and limited natural vegetation, traditional agroforestry systems have emerged as a lifeline. These systems, motivated by the need for fuelwood and fodder, play a crucial role in meeting subsistence needs during the long winter months. Due to sparse natural vegetation resulting from overgrazing and excessive vegetation removal for fuelwood, agroforestry has become indispensable for the supply of food, fodder, and

timber. The key components of the agri-silviculture system practiced in the region include Poplar, Salix, Juniper species, apricot, and apple trees. In summary, agroforestry represents a promising solution to India's agricultural and environmental challenges. It has the potential to expand forested areas, provide essential products, and enhance rural livelihoods, making it a sustainable and multifaceted approach to land management. However, the successful integration of agroforestry into agricultural systems is crucial to fully realize its potential across the country.

Materials and Methods

Study area

The study was conducted in cold arid area at different villages of Leh during 2019-2020 with the objective to find the factors influencing adoption of agroforestry Systems. Eleven villages Phey, Stakna, Upshi, Hemis, Shara, Nurla, Skinding Umla, Chilling and Nyoma were selected for the study. Agriculture is the backbone of the local economy, with horticulture, notably apricot and apple farming, gaining significance.

Design of research

The present study will explore the factors influence adoption of agroforestry practices in the region using Ex-Post-Facto Research Design. (Kumar, 2012) [9].

Sampling technique and sampling

The study followed a multi-stage random sampling approach to select sample villages and households. In the first stage, seven blocks were chosen randomly within the district. The second stage involved the random selection of eleven villages. A total of 164 households were then selected for the field study, with a 25 percent sampling intensity, using a basic random sampling method. Interviews were conducted with either the heads of households or the eldest members as respondents.

Data Collection

In order to achieve the research goals, both qualitative methods- secondary sources and primary field surveys were used for collection. The variables are selected after an extensive analysis of available related literature, the research area's reconnaissance survey, intense discussions with local residents, forest authorities, extension scientists and other experts, and also useful knowledge obtained by different organizations. The variables were evaluated by asking detailed questions using multiple previously adopted scales or measures (Venkataramaiah, 1990; Singha *et al.*, 2006) [26, 22].

Results and Discussion

Agroforestry systems adopted by Farmers

Eight agroforestry systems were found to be practiced by most farmers in the current study area:

Agrisilviculture, Silvipastoral, Agri-horti-silviculture, Hortipastoral, Agri-horticulture, Horti-silviculture, Agri-silvopastoral systems and homegardens. Results of farmers households survey with an average land size shows that among different agroforestry systems homegarden was adopted by maximum respondent (154) with 15 hectares land under this system followed by agri-silviculture systems (146) with area 32.65 hectares and only 19 respondent was practised agri-horticulture system with area 3.95 hectares (Fig.1).

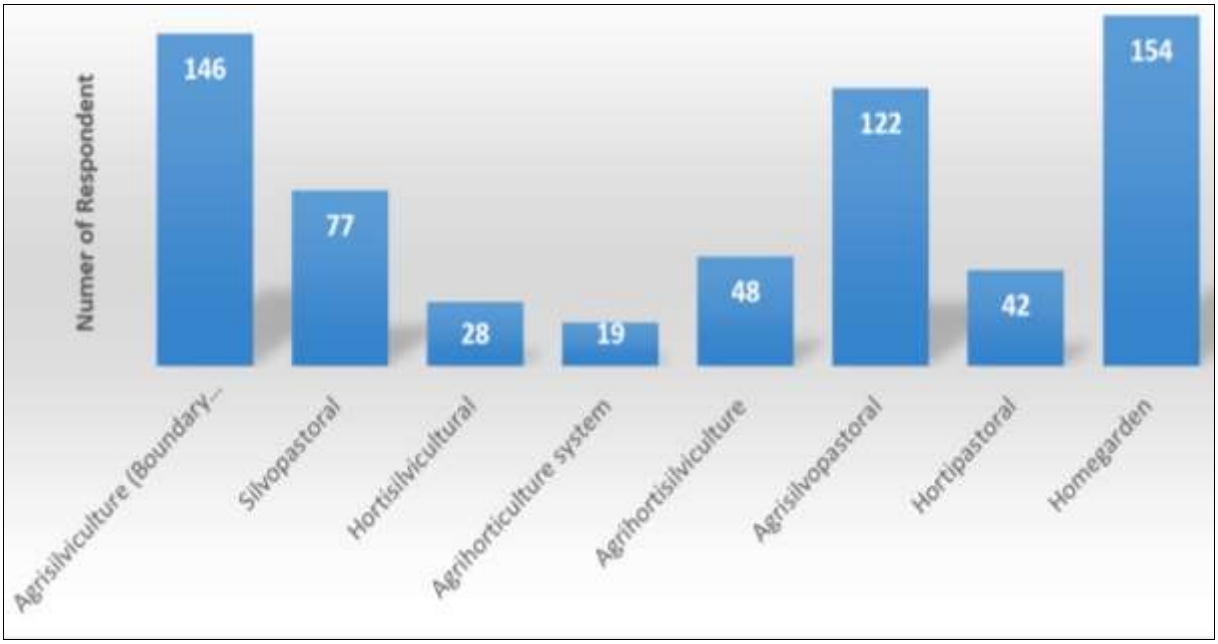

Fig 1: Landuse pattern

Factors Affecting Adoption of Agroforestry

During the survey the different factors which influence agroforestry adoption in the area were studied which include age, education, family size, size of land holding, herd size, main occupation and gross annual income.

Age, Education and Family size

Analysis of Table 1 found that the most of the respondents (48.17%) were middle aged followed by young (28.04%) age and old (23.78%) groups respectively. The pervasiveness of middle-aged respondents could be

endorsed to the fact that middle-aged individuals are generally enthusiastic, innovative and hard-working with more experience, vigour, enthusiasm, inclination and challenge. (Pal, 2009; Sinha *et al*., 2010) [16, 23]. Regarding education in the surveyed area it was found that maximum respondent (24.39%) were illiterate followed by below primary (22.56%), primary (16.46%), high school (14.63%), middle (13.41%) and graduate and above (8.53%). Low literacy may be due to derisory socio-economic circumstances, lack of educational facilities, greater participation of boys and girls in livelihood earnings, and ignorance of education (Singh *et al*., 2011) [27]. Majority of the respondents in the study area were having small sized families (56.00%) and rest (43.9%) large sized families. Because of increasing individualism, individuals in nuclear families tend to lead separate lives with personal properties and proper accommodation.

Size of land holding, Herd size

The data in Table 2 indicated that the maximum respondent (75.00%) were marginal farmers followed by small (23.17%), medium (1.82%) and number of landless and large farmers were nil (0.00%). The prevalence of marginal farmers in the region surveyed is attributed to the community's nuclear and neolocal system of families that urged early land dissolution from generation to generation and among married off-springs. (Prakash and Sharma, 2008) [17]. 53.00% of the respondents owning upto 5 livestock followed by 26.82% were having 6-10 livestock, 9.7% possessed more than 10 livestock and 10.36% of them were having no livestock at all. The fact that livestock rearing was the most common secondary occupation may be due to keeping good numbers of livestock. In addition to providing food, social, economic, religious and recreational benefits to citizens, livestock promotes agriculture and allied activities. (Prakash and Sharma, 2008; Bijalwan *et al*., 2011) [17, 3].

Table 1: Age, education and family size of the sample households (N=164)

Age		Education		Family size	
Category	**Household**	**Category**	**Household**	**Category**	**Household**
Young (up to 30 years)	46 (28.04)	Illiterate	40 (24.39)	Small (up to 5 members)	92 (56.00)
Middle (31 to 50 years)	79 (48.17)	Below primary	37 (22.56)	Large (> 5 members)	72 (43.9)
Old (> 50 years)	39 (23.78)	Primary	27 (16.46)	-	-
-	-	Middle	22 (13.41)	-	-
-	-	High school	24 (14.63)	-	-
-	-	Graduate & above	14 (8.53)	-	-
X ± S.E. = 39.57 ± 0.91		X ± S.E. = 2.05 ± 0.14		X ± S.E. = 1.43 ± 0.03	

Figures in the parentheses show percentages

Table 2: Size of land holding and herd size in the sample households (N=164)

Size of land holding		Herd size	
Category	**Household**	**Category**	**Household**
Landless	0 (0.00)	No livestock	17 (10.36)
Marginal (< 1.00 ha)	123 (75.00)	Up to 5 livestock	87 (53.04)
Small (1.01-2.00 ha)	38 (23.17)	6 to 10 livestock	44 (26.82)
Medium (2.01-4.00 ha)	3 (1.82)	> 10 livestock	16 (9.75)
Large (> 4.00 ha)	0	-	-
X ± S.E. = 1.26 ± 0.03		X ± S.E. = 1.34 ± 0.06	

Figures in the parentheses show percentage

Main occupation, Gross annual income

Analysis indicate that main occupation of the respondents were engaged in agriculture (35.3%) followed by service (25.6%), As agriculture and service are the backbone of the region's economy, most respondents either belong to farming families or depend on service for their livelihoods. The families involved in other professions and activities were also working in agriculture as their subsidiary occupation. (Sharma *et al*., 1989; Pal, 2009) [17, 16]. The study established the predominance of families in the surveyed area were having high gross annual income i.e > 90000 annum^{-1}. The possible cause for this may be that the majority of respondents in the surveyed were engaged in service. Low agricultural productivity due to lack of irrigation facilities, scientific know-how, advanced machinery and equipment, mono-cropping system, low soil productivity and erratic climate conditions produce poor income for farmers. (Gupta *et al*., 2009) [6].

Extent of agroforestry, Access to alternate forest resources

It was observe that the highest (57.31 %) of households had agroforestry coverage of upto 0.5 ha, followed by (25%) with 0.51-1.00 ha and (17.68%) with >1.00 ha. The average degree of extent of agroforestry among the households sampled in the region was recorded to be 0.10 ha. The results in Table 4 showed that the highest number of households (51.82%) never visited the social/community woods, accompanied very regularly (29.87%) and frequently (18.29%). The overall social/community forest access score was 0.47, which means that most households never have access to alternative forest resources. The greater the reach of agroforestry and access to alternative forest resources the greater the contribution of agroforestry resources to livelihood security, and vice versa. The availability of social/community forest in the nearby villages and level of access by the households to the social/community forests is a key factor influencing extraction and consumption pattern of agroforestry resources (Adhikari *et al*., 2004; Singha *et al*., 2006) [1, 22].

Table 3: Main occupation and gross annual income in the sample households (N=164)

Main occupation		Gross annual income	
Category	**Household**	**Category**	**Household**
Wage labour	22 (13.4)	Very low income (Up to Rs.30000/ annum)	15 (9.14)
Caste occupation	9 (5.4)	Low income (Rs.30001 to 60000/annum)	19 (11.58)
Cultivation	58 (35.3)	Medium income (Rs.60001 to Rs.90000/annum)	23 (14.02)
Business	27 (16.4)	High income (>Rs.90000/annum)	107 (65.24)
Service	42 (25.6)	-	-
Any other	6 (3.6)	-	-
X ± S.E. = 3.46 ± 1.14		X ± S.E. =247372±16072.93	

Figures in the parentheses show percentages

Table 4: Extent of agroforestry and access to alternate forest resources of the sample household (N=164)

S. No.	Extent of agroforestry		Access to alternate forest resources	
	Category	**Household**	**Category**	**Household**
1.	Upto 0.5 ha	94 (57.31)	Very frequently	49 (29.87)
2.	0.51-1.00 ha	41 (25.00)	Frequently	30 (18.29)
3.	> 1.00ha	29 (17.68)	Never	85 (51.82)
x ±S.E. = 0.10 ± 0.009			x ±S.E. = 0.47±0.05	

S.E.= Standard Error, Figures in the parentheses indicate percentages

3.2.5 Proximity to Forest and Frequency of fores visits

The Table 5 specified that maximum (62.19%) of households having <5 km proximity to the forest followed by 5-10 km (31.09%), 10-15 km (6.7%) and >15 km (0.00%). The average proximity to the forest among sample households was observed to be 1.44 km. The results in Table 6 showed that the highest (56.09%) of households never visited the forests, sometimes accompanied occassionally (27.4%), frequently (12.19%) and quite regularly (4.26 %). The mean frequency score of forest visits among sample household was 1.64.

Table 6: Proximity to forest and frequency of forest visits of the sample households (N=164)

Proximity to forest		Frequency of forest visits	
Category	**Household**	**Category**	**Household**
< 5 km	102 (62.19)	Very frequently	7 (4.26)
5-10 km	51 (31.09)	Frequently	20 (12.19)
10-15 km	11 (6.7)	Occasionally	45 (27.4)
> 15 km	0 (0.00)	Never	92 (56.09)
X ± S.E. = 1.44 ± 0.04		X ± S.E. = 1.64 ± 0.06	

Figures in the parentheses show percentage

Impact of household characteristics on agroforestry resources based livelihood

Karl Pearson's product moment co-efficient of correlation (r) was worked out for ascertaining the relationship between the various socio-economic, forest resources and biophysical variables and agroforestry resources based livelihood.

Correlation Analysis

The results in the Table 7 depicted that out of eleven socio-economic, forest resources and biophysical variables, seven attributes *viz*., education, family size, main occupation, livestock size, land holding, annual income and agroforestry extent exhibited positive and significant relationship with agroforestry resources based livelihood whereas, the proximity to forest, access to alternate forest resources and forest visit showed negatively and significant correlation. The relationship between age and agroforestry resources based livelihood was non- significant. The positive connection between education and livelihoods dependent on agroforestry capital is well illustrated by the fact that education contributes to beneficial improvements in human behaviour and makes the person step in the right direction. (Hope *et al.*, 2003; Luck *et al.*, 2009) [8, 10], the knowledge is built up through education, which makes the person aware of new innovations (Thamban *et al.*, 2008; Sood *et al.*, 2008) [25, 24] and the change in attitude is partly a function of education (Singha *et al.*, 2006) [22]. The optimistic and important relationship of the composition of the family with the livelihood based on the agroforestry resource may be due to the fact that indigenous people, being an important member of their nuclear family, could have taken independent decisions on any matter relating to the generation of livelihoods for their families (Thamban *et al.*, 2008; Macro *et al.*, 2010) [25, 11] and there was greater diversification of livelihoods and opportunities for larger families, resulting in larger livelihoods dependent on agroforestry wealth. (Sood *et al.*, 2008; Senanayake *et al.*, 2009; Arfin *et al.*, 2012) [24, 19, 2].

The economic attributes *viz*., size of land holding, livestock possession, main occupation and annual income of the indigenous people exhibited direct bearing on the household economy (Thamban *et al.*, 2008; Nagesha and Gangadharappa, 2006) [25, 15], facilitating the possession of livelihood assets that's why the higher the magnitudes of these characteristics the higher will be agroforestry resources based livelihood. The size of agroforestry, forest visits and access to alternative forest services are the main indicators of the indigenous people natural capital (Nagesha and Gangadharappa, 2006; Singha *et al.*, 2006) [15, 22] playing a critical role in the self-sufficiency and security of forest resources. Thus, these characteristics contributed positively and substantially to the subsistence dependent on agroforestry resources. The strength of crops has a direct effect on domestic food and nutrition welfare, the alleviation of poverty and the development of socioeconomic conditions. A positively significant correlation is seen between land size and agroforestry resources based livelihood. This was to be expected because in absolute terms bigger plots of land would produce more than small lands (Guuroh *et al.*, 2013) [7].

Table 7: Correlation analysis of household variables with the agro-forestry resources based livelihood.

S. No	Household variables (code)	Co-efficient correlation (r)	of	P-value
1.	Age (X_1)	0.166		0.100*
2.	Education (X_2)	0.843		0.00**
3.	Size of family (X_3)	0.615		0.00**
4.	Size of landholding (X_4)	0.847		0.00**
5.	Livestock possession (X_5)	0.794		0.00**
6.	Main occupation (X_6)	0.614		0.00**
7.	Extent of agroforestry (X_7)	0.785		0.00**
8.	Annual income (X_8)	0.381		0.00**
9.	Proximity of forests (X_9)	-0.852		0.00**
10.	Access to alternate forest resources (X_{10})	-0.787		0.00**
11.	Forest visit (X_{11})	-0.756		0.00**
*=non-significant, **= significant (p<0.01)				

Conclusion

The agroforestry play a crucial role in livelihood security of the rural people by providing fuel wood, fodder, timber, fruits, agricultural crops, vegetables, medicines, *etc*. and contributing significantly to the gross annual income and employment opportunities of the household besides acting as safety net in cases of exigency. Study provided valuable insights into the agroforestry landscape of this high-altitude region. It revealed the existence of eight diverse agroforestry systems, with home gardens being the most prevalent among households. These systems incorporate a range of tree species, agricultural crops, and livestock, showcasing their multifunctional nature. Moreover, the study identified key household attributes, including age, education, family size, landholding, and livestock possession, as significant contributors to agroforestry-based livelihoods. However, challenges related to proximity to forests and access to alternate resources from forests were noted. Overall, the research emphasizes the need for increased promotion and development of agroforestry to enhance the livelihoods of rural communities in Ladakh, calling for sustained attention and support from policymakers, scientists, social workers, and extensionists to realize the potential of agroforestry as a sustainable economic and ecological solution in the region

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