GRASSROOTS JOURNALS
ISSN 2564-4653 | 03(02) Dec 2023

AGROBIODIVERSITY & AGROECOLOGY | 03(02) DECEMBER 2023

Published by The Grassroots Institute (Canada) in partnership with University "Lucian Blaga" from Sibiu (Romania) and Fondacija Alica Banja Luka (Bosnia i Herzegovina). Website: https://grassrootsjournals.org/aa

M – 00371 | Research Article

Agroforestry: Enhancing Farm Tree Diversity and its Role in Rural Livelihoods

Uchita Lamichhane[1*], Pramod Ghimire[2]
[1]Faculty of Forestry, Agriculture and Forestry University, Nepal
Email: uchitalamichhane@afu.edu.np | ORCID: https://orcid.org/0000-0002-6545-4025
[2]Faculty of Forestry, Agriculture and Forestry University, Nepal
Email: pghimire@afu.edu.np | ORCID: https://orcid.org/0000-0002-2925-8844
** Corresponding author*

How to cite this paper:
Lamichhane, U. and Ghimire, P. (2023). Agroforestry: Enhancing Farm Tree Diversity and its Role in Rural Livelihoods. *Agrobiodiversity & Agroecology*, 03(02): 19-33. Doi: https://doi.org/10.33002/aa030202

Received: 21 November 2023
Reviewed: 02 February 2024
Accepted: 20 February 2024
Published: 15 March 2024

Abstract
Agroforestry represents a land use strategy grounded in ecological principles, offering benefits such as increased crop yields, consistent financial returns, and broader agricultural diversification. This study was conducted in Makawanpurgadhi rural municipality, from Makawanpur district, Nepal, which aimed to evaluate various agroforestry systems, the diversity of farm trees, and their impact on rural income. Field observation, interviews with key informants, and questionnaire survey were employed to augment socio-economic information, with a randomly selected sample of 106 households (i.e. Landowners). Farm tree diversity was assessed using the Shannon Wiener Diversity Index. The study identified five important agroforestry systems: homegarden, silvi-pasture, agrisilviculture, silvofisheries, and agrisilvihorticulture. The Silvi-pasture system reported as a promising agroforestry approach demonstrating greater species richness and diversity of farm tree compared to homegarden and agrisilvihorticulture. Moreover, agroforestry systems contributed significantly to household income, with 36.92% (NRs. 25,700 or USD 193 per household per year) attributed to agriculture and 28.88% (NRs. 16,900 or USD 127 per household per year) to livestock raring. It is recommended that agroforestry systems have a great deal of potential to conserve biodiversity and enhance rural livelihoods.

Keywords
Agriculture; Farm land; Farm trees; Income; Agroforestry

1. Introduction

Reducing pressure on forests and expanding the environment beyond forest areas are primary objectives of recent government policies and initiatives. Agroforestry (AF) systems are considered a viable solution to address land management and ecological concerns while also meeting the demands of a growing population and crop diversity (FAO 2003; Salinas, 2016; Schnell *et al.*, 2015). It integrates forestry, agriculture, and other land uses into the same unit of land to safeguard the production of diverse ranges of products and services while promoting enhanced environmental sustainability (Paudel *et al.,* 2019; Reed *et al.,* 2017; Shin *et al.,* 2020). In Nepal, AF plays a critical role in

producing food, fuel, timber, and other minor forest products, thereby generating income for underprivileged communities and contributing to environmental conservation (Amatya, Cedamon and Nuberg, 2018; Paudel *et al.,* 2019).

AF is an approach to land management that offers eco-agricultural solutions by integrating goals for improved food security with benefits in biodiversity conservation, particularly through promoting the use of native tree species (Acharya, 2006; Atta-Krah *et al.,* 2004; Reed *et al.,* 2017). Trees in and around agricultural lands provide valuable goods and services to communities. Agroforestry systems are critical for preserving and restoring the physical environment. They play an important role in reducing erosion, enriching soil fertility, reducing pollution, and promoting biodiversity conservation (Acharya, 2006; Atta-Krah *et al*., 2004; Ojha *et al.,* 2022). Soil fertility degradation, increased soil erosion, and decreased agricultural output have all been linked to declines in forest cover. Agroforestry shows promise as a solution to address these issues (Amatya, Cedamon and Nuberg, 2018; Carter and Gilmour, 1989; Paudel *et al.,* 2019). Studies worldwide indicate advancements in tree growth on private farmlands to counter the loss of forest trees (Baral *et al*., 2013; Ghimire and Bolakhe, 2020; Kang and Akinnifesi, 2000; Thapa *et al*., 1994).

Agriculture has historically served as the primary source of income across the Nepalese hills, with subsistence agriculture forming the backbone of economic activity in this region, closely intertwined with forest resources. These small-scale farming systems have traditionally relied on forest products, which provide a diverse array of goods and services crucial for both biodiversity conservation and subsistence (Acharya, 2006; Neupane *et al*., 2002; Ojha *et al.,* 2022). Agroforestry is a multidimensional approach to sustainable land management that offers numerous advantages for both rural communities and biodiversity conservation. Because of this, it has garnered considerable attention from conservation scientists seeking innovative solutions to environmental challenges (Acharya and Kafle, 2009; McNeely and Schroth, 2006; Ojha *et al.,* 2022). Despite this potential, Nepal's agricultural and forestry development plans have historically placed little emphasis on promoting agroforestry (Amatya, Cedamon and Nuberg, 2018). However, recent years have seen increased recognition of agroforestry's crucial role in sustaining rural agriculture, leading to initiatives aimed at promoting agroforestry at the farm level. While the focus has traditionally centered on trees within forests, those outside forested areas or on farms in Nepal represent vital resources for enhancing sustainable development and livelihoods. Furthermore, despite their significant contributions to human well-being and environmental preservation, trees on farmland and in various land use types around human settlements have not been systematically integrated into the national forest inventory (DFRS, 2015; Ghimire *et al.,* 2021). In this backdrop, this study primarily aims to evaluate farm tree diversity and its impact on rural livelihood enhancement.

2. Materials and Methods

2.1 Study Area

This research was conducted in ward number 6 of Makawanpurgadhi rural municipality, located in Makawanpur district, Nepal (Figure 1). This municipality shares borders with Bakaiya rural municipality to the east,

Bhimphedi rural municipality to the west and north, and Hetauda Sub-metropolitan City to the south. Topographically, the district spans from 27°10' to 27°40' latitude and 84° 41' to 85°31' longitudes, with Makawanpurgadhi rural municipality situated 34 km south of Kathmandu and 17 kilometers north of Hetauda city. The area experiences a tropical to subtropical climate, characterized by an average annual temperature of 28 degrees Celsius and approximately 240 mm of rainfall. Geologically, the region represents the upper Chure range and lower Mahabharat Hill's alternate strata, consisting of shale, schist, quartzite, and phyllite, alongside limestone beds, and various granite and gneiss (Bajracharya *et al.,* 2007; MRM, 2023). Agriculture and livestock farming are the primary occupations in this area.

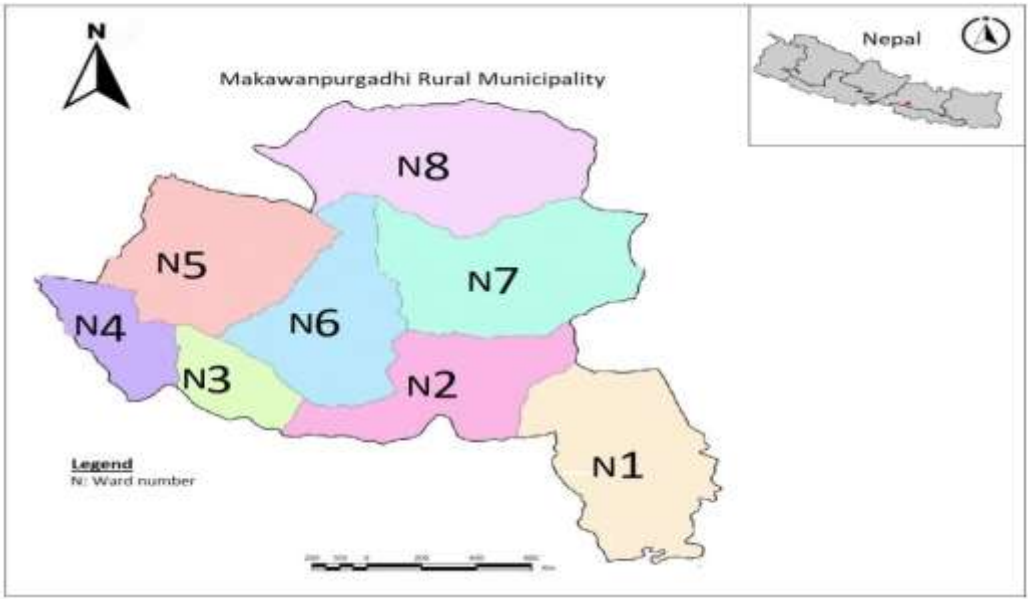


Figure 1: Map illustrating the study area

2.2 Sampling Method and Data Analysis

The research employed both qualitative and quantitative approaches to investigate the existing agroforestry system, tree diversity, and its contribution to local livelihood improvement. For the vegetation survey, circular plots (n=43) of size 1,000 m² with a radius of 17.84m were purposively laid out according to the prevalent agroforestry systems. During the vegetation survey of the household farm sample, all tree species and the number of individuals within each plot were counted. Subsequently, farm tree diversity was determined applying the Shannon-Weiner index, which considers both the evenness and abundance of the species present (Maturin, 1988). Shannon-Weiner index is represented by *H*, which is determined as:

$H = -\sum P_i * ln P_i$

Where, H =Shannon-Wiener index,

Similarly, the term evenness is represented by E, which is calculated as:

E = H/ lnS

Where, E= evenness,

H= The Shannon Diversity Index,

S= Total number of species with in the community

For socio-economic data analysis, a questionnaire survey was conducted on 106 farm households (including those from sample plot located households and adjoining households) to augment necessary information. Additionally, to validate and cross-check the data from the household survey, 3 focus groups and 23 key informant interviews were conducted. The collected data were analyzed using SPSS and presented through tables, graphs, figures, and charts to facilitate logical interpretation.

3. Results

3.1 Agroforestry Systems Adopted

In a given ecosystem, tree diversity plays a critical role in maintaining natural environmental equilibrium. This becomes particularly crucial in areas where natural forest encroachment and land degradation are diminishing biodiversity, potentially resulting in the loss of the natural ecosystem. This study reported five major agroforestry systems: homegarden, silvipasture, agrisilviculture, silvofisheries, and agrisilvihorticulture (Table 1). A survey of 106 household farms revealed that the majority of households adopted homegardens (58%), followed by silvipasture (41%), agrisilviculture (16%), silvofisheries (9%), and agrisilvihorticulture (4%). Homegardens are primarily adopted by households to fulfill their nutritional needs, ensure food security, preserve agrobiodiversity, and promote environmental sustainability.

Table 1: Agroforestry systems and species combinations

S.N.	*Types of Agroforestry System*	*Description*	*Major Species Combination*	*Percentage of HHs used*
1.	Homegarden	Growing cereals, vegetable spices with firewood, and fodder species.	*Mangifera indica, Atrocarpus heterophulus, Persea americana,* along with banana, pineapples, chili, turmeric, and vegetable species.	47%
2.	Silvipasture	Raising forest trees with livestock in the same land.	*Litsea monopetala*, *Ficus* sp., *Bauhinia* sp., grasses and livestok in rain faded land or fallow land.	24%
3.	Agrisilviculture	Cultivating seasonal agricultural crops along with mixed tree species.	*Tectona grandis, Dalbergia sissoo, Eucalyptus camaldulensis, Albizia lebbek* along with agricultural crops (such as Turmeric and ginger).	16%
4.	Silvofishery	Fish farming in conjunction with forest tree species.	*Mangifera indica, Dalbergia Sissoo, Eucalyptus camaldulensis*, *Bauhinia variegata,*	9%

S.N.	Types of Agroforestry System	Description	Major Species Combination	Percentage of HHs used
			Litsea monopetala on the riser of the fish ponds.	
5.	Agrisilvihorticulture	Growing agricultural crops alongside horticulture plants and forest trees.	Fruit–trees (such as banana, mango), along with agricultural crops alongside *Eucalyptus camaldulensis, Dalbergia Sissoo.*	4%

3.2 Diversity and Abundance of Species across various Agroforestry Systems

A total of 71 tree species were documented in the study site. Among these, *Mangifera indica*, *Atrocarpus heterophulus*, *Litsea monopetala*, *Artocarpus lakoocha,* and *Shorea robusta* emerged as the major tree species found on farmland (Figure 2). The two most abundant tree species planted on farmland were *Mangifera indica* and *Artocarpus heterophyllus*. Additionally, the tree diversity index and species richness were also estimated for every agroforestry system under the study, as detailed in table 2. The silvipasture system demonstrated the higher diversity index and species richness as compared to homegardens and agrisilvihorticulture, respectively. The silvipasture system emerged as the most diverse agroforestry system adopted, highlighting its preference and variability within the Makawanpurgadhi rural municipality.

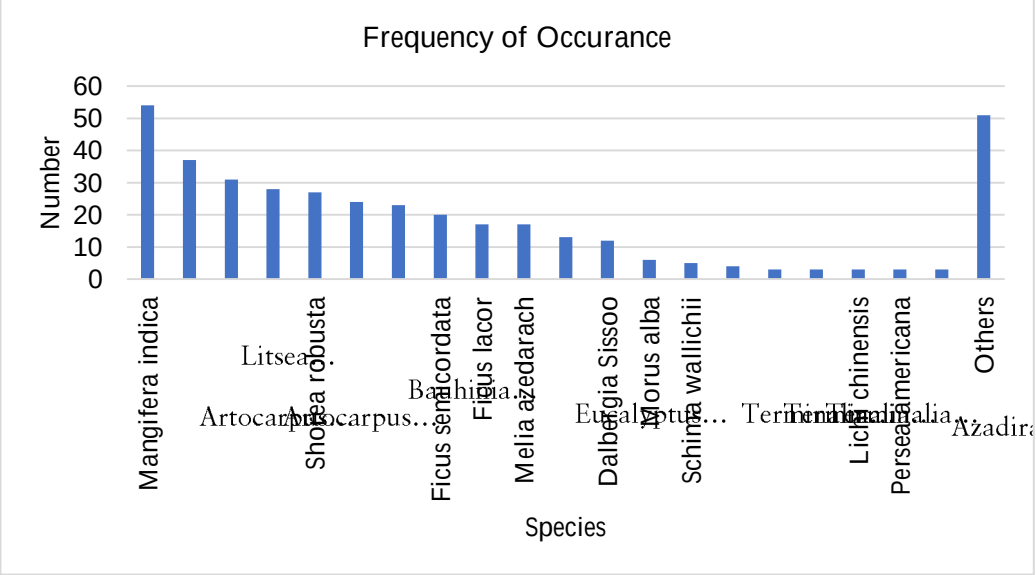


Figure 2: Frequency of farm tree species occurrence

3.3. Different Sources of Income of Studied Households

The socioeconomic data of 106 farm households was analyzed through a questionnaire survey to determine how much agroforestry systems contribute to rural livelihoods. Among the 106 farm households surveyed, 69 were male respondents and 37 were female respondents (Table 3). Additionally, 61.32% of

the households were engaged in agriculture-related occupations, while 38.68% relied on non-agricultural occupations, including government and private services (Table 3). Furthermore, the average annual income of the households was determined to be NRs. 170,990 (equivalent to USD 1,286), with the majority of households (43) falling into the category with an annual income of less than NRs. 150,000 (equivalent to USD 1,128) (Table 3).

Table 2: Species richness and farm tree diversity across various agroforestry systems

S.N.	*Agroforestry Systems*	*Species richness*	*Shannon Weiner Index*
1.	Homegarden	26	0.37
2.	Silvipasture	38	0.62
3.	Agrisilviculture	15	0.24
4.	Silvofishery	7	0.10
5.	Agrisilvihorticulture	21	0.30

Table 3: Socio-economic attributes of studied households

Class	*Attributes*	*Number*	*Percentage (%)*
Gender	Male	69	65.10
	Female	37	34.90
Occupation	Agriculture	65	61.32
	Government services	22	20.76
	Private services	19	17.92
Annual income (NRs.)	<150,000 (<USD 1,128)	43	40.57
	150,000-200,000 (USD 1,128-1,504)	37	34.90
	>200,000 (>USD 1,504)	26	24.53

3.4 Farm Trees' Contribution to the Agricultural and Livestock Income

Agroforestry is a land management strategy in which parts of forestry and agriculture are combined to provide a variety of benefits, including fuelwood, timber, food, fodder, and other agricultural and forestry-related goods and services within a given area and time frame. Respondents were queried regarding their overall income as well as the relative contributions of different income sources. According to the study findings, out of the average net annual household income, income from agriculture and livestock constituted 40.70% and 34.21%, respectively. Furthermore, the adopted agroforestry systems in the study area contributed 36.92% (NRs. 25,700, equivalent to USD 193, per household per year) and 28.88% (NRs. 16,900, equivalent to USD 127, per household per year) to the agricultural income and income from livestock farming, respectively (Figure 3).

4. Discussion

Agroforestry is not a novel practice; rather, it is emerging as a science. The objective of agroforestry development in Nepal is to mitigate environmental degradation while also fulfilling the demand for fodder, non-wood forest

products, fuelwood, and small timber, including aromatic and medicinal plants, both now and in the future (Amatya, Cedamon and Nuberg, 2018). Although, agroforestry practice has long been a longstanding part of traditional farming techniques in Nepal, they have also been shown to harbor higher biodiversity than Nepalese forests and provide farmers with additional market alternatives (Acharya, 2006). This study identified five major agroforestry systems, with the majority of households preferring homegardens due to their immediate access to fresh produce (Table 1). In terms of tree diversity, silvipasture systems demonstrated the higher species richness and diversity index, with home gardens and agrisilvihorticulture coming in second and third, respectively (Table 2). Nepal's agroforestry system has become increasingly diverse due to the country's growing commercialization and abandonment of agricultural land (Ulak *et al.,* 2021). The farmer-led approach is undeniably one of the most significant strategies for increasing tree cover in rural agriculture. This finding is in line with Ghimire and Bolakhe (2020) and Khanal (2011) who reported greater tree diversity and species richness in silvipasture systems in Makawanpur and Kaski districts, respectively. However, Baral *et al.* (2013) found that homegarden in the Kanchanpur district of Nepal exhibited higher tree diversity and species richness compared to agrisilviculture. The differences in results can be accounted to variations in geographic regions, which differ depending on the location within a specific zone. Nonetheless, it is evident how agroforestry techniques enhance farm tree diversity and contribute to environmental restoration.

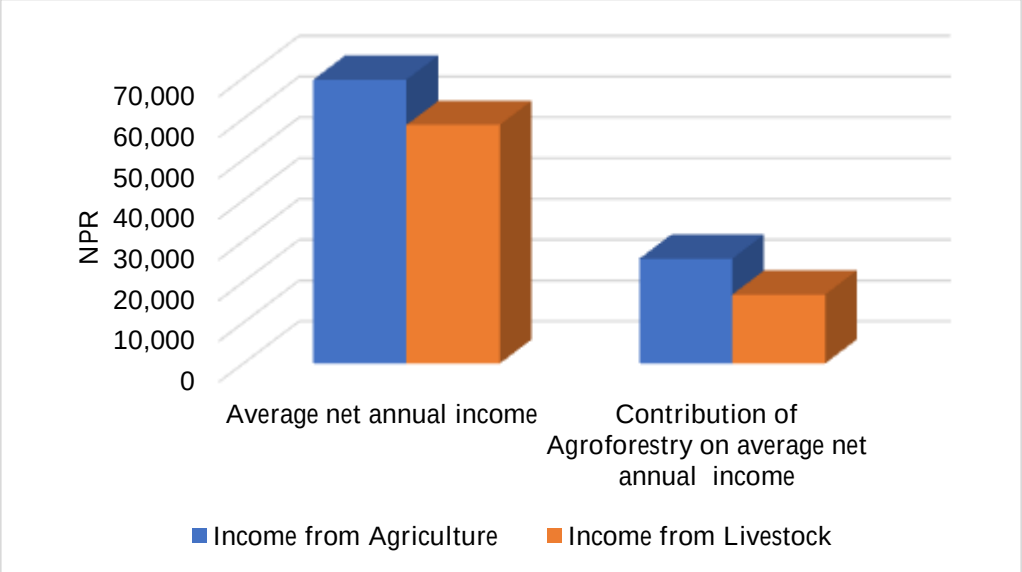


Figure 3: Contribution of agroforestry systems on agriculture and livestock income

Agroforestry strategy play a critical role in addressing hunger, improving local livelihoods, conserving biodiversity, and bolstering institutional and societal adaptability to climate change (Mbow *et al.,* 2014). In Nepal, agriculture remains the primary means of income for the majority of the population, with approximately 70% still engaged in agricultural activities (FAO, 2023; GC and Hall, 2022). Rural farmers rely on farmland to meet their daily needs, with the average per capita income (PCI) in Nepal standing at NRs.

186,067 annually (equivalent to USD 1,399) (CEIC Data, 2023). A significant portion of households (61.32%) in the study area were engaged in agricultural activities (Table 3). The average annual income of households was determined to be NRs. 170,990 (equivalent to USD 1,286). Of the total average net annual household income, income from agriculture and livestock constituted 40.70% and 34.21%, respectively. Notably, agroforestry systems contributed 36.92% and 28.88% to agriculture income and livestock income, respectively. According to the Agroforestry Network (2018), nine of the seventeen Sustainable Development Goals (SDGs) can be addressed through agroforestry. Of these, nine have the potential to be addressed through agroforestry, with a particular emphasis on goals including No poverty; Zero hunger; Climate action; and Life on land. This indicates the significance of agroforestry systems for improving local livelihoods in Nepalese context. These findings are consistent with those of Ghimire and Bolakhe (2020), who documented that in the Makawanpur district, agroforestry systems contributed 24.06% and 20.25%, respectively, to agricultural income and income form livestock rearing. In Kanchanpur district, similar results were also observed by Baral et al. (2013) where farm trees contributed 16.4% and 17.1% to agricultural income and income from livestock rearing, respectively. Therefore, agroforestry holds immense potential to uplift rural livelihoods by reducing local communities' dependence on forest resources.

5. Conclusions

A total of 71 farm tree species were documented across the five different agroforestry systems studied. Greater diversity index and species richness for farm tree were observed in Silvipasture, compared to homegarden and agrisilvihorticulture, respectively. Agroforestry in the study site contributed 36.92% and 28.88% to agriculture income and livestock income per household per year, respectively. These findings show the importance of suitable trees planted outside of forests can support rural communities' livelihoods and biodiversity. Future local and national forest sector strategies must take these resources into consideration, because trees outside of forests are essential for the upliftment of livelihoods of the local people.

6. Acknowledgements

The authors extend their sincerest gratitude to the local households of Makawanpurgadhi rural municipality for generously sharing their information during the questionnaire survey and field observations. Their cooperation and willingness to contribute to this study were invaluable and greatly appreciated.

7. References

Acharya, A.K. and Kafle, N. (2009). Land degradation issues in Nepal and its management through agroforestry. *Journal of Agriculture and Environment,* 10, 133–143. Available online at: https://nepalindata.com/media/resources/bulkuploaded/The_journal_of_agriculture_and_environment_june_2009_eng_may_17.pdf#page=121 [accessed 15 February 2024].

Acharya, K.P. (2006). Linking trees on farms with biodiversity conservation in

subsistence farming systems in Nepal. *Biodiversity & Conservation,* 15(2): 631–646. DOI: https://doi.org/10.1007/s10531-005-2091-7.

Agroforestry Network (2018). Achieving the global goals through agroforestry. Agroforestry Network and Vi-Skogen, Stockholm. Available online at: http://agroforestrynetwork.org.hemsida.eu/wp-content/uploads/2018/09/Achieving-the-Global-Goals-through-agroforestry.pdf [accessed 15 February 2024].

Amatya, S.M, Cedamon , E. and Nuberg, I. (2018). Agroforestry systems and practices in Nepal- Revised Eds. Agriculture and Forestry University, Rampur, Nepal, 108pp + xviii.

Atta-Krah, K., Kindt, R., Skilton, J. N. and Amaral, W. (2004). Managing biological and genetic diversity in tropical agroforestry. *Agroforestry System,* 61: 183-194. Available online at: https://apps.worldagroforestry.org/downloads/Publications/PDFS/ja04027.pdf [accessed 15 February 2024].

Bajracharya, R.M., Sitaula, B.K., Sharma, S., and Jeng, A. (2007). Soil Quality in the Nepalese Context: An Analytical Review *International Journal of Ecology and Environmental Sciences*, 33(2-3): 143-158.

Baral, S.K., Malla, R., Khanal, S. and Shakya, R. (2013). Trees on farms: Diversity, carbon pool and contribution to rural livelihoods in Kanchanpur District, Nepal. *Banko Janakari*, 23 (1): 3–11. Available online at: https://frtc.gov.np/old/downloadfile/Banko%20Janakari%20Vol%20231_1449572212.pdf#page=5 [accessed 15 February 2024].

Carter, A.S. and Gilmour, D.A. (1989). Increase in tree cover on private farm land in central Nepal. *Mountain Research and Development*, 381-391. DOI: https://doi.org/10.2307/3673586.

CEIC Data (2023). ISI Emerging Marketing Group Company. Mumbai, India. Available online at: https://www.ceicdata.com/en/indicator/nepal/gdp-per-capita [accessed 15 February 2024].

DFRS (2015). Forest Resource Assessment State of Nepal's Forests (FRA) Nepal, Department of Forest Research and Survey (DFRS), Kathmandu, Nepal.

FAO (2003). Trees outside forests, a key factor in integrated urban and rural management - Food for thought. First Part. Food and Agriculture Organization of the United Nations, Rome, Italy. 58 pp.

FAO (2023). Family Farming in Nepal. Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy. Available online at: https://www.fao.org/3/cb8001en/cb8001en.pdf [accessed 15 February 2024].

GC, R.K. and Hall, R.P. (2020). The Commercialization of Smallholder Farming—A Case Study from the Rural Western Middle Hills of Nepal. *Agriculture*, 10: 143. DOI: https://doi.org/10.3390/agriculture10050143.

Ghimire, P. and Bolakhe, S. (2020). Agroforestry systems: Biodiversity, carbon stocks and contribution to rural livelihood. *Journal of Agriculture and Forestry University*, 197-205. DOI: https://doi.org/10.3126/jafu.v4i1.47071.

Ghimire, P., Paudel, P., Bhatta, B., Gautam, P. and Devkota, N. (2021). Importance of Trees Outside Forest (TOF) for immediate earthquake response. *Journal of Biodiversity Conservation and Bioresource Management*, 6(1): 9–16. DOI: https://doi.org/10.3329/jbcbm.v6i1.51326.

Kang, B.T. and Akinnifesi, F.K. (2000). Agroforestry as Alternative Land-Use Production System for the Tropics. *Natural Resources Forum*, 24: 37–151. DOI: http://dx.doi.org/10.1111/j.1477-8947.2000.tb00938.x.

Khanal, S. (2011). Contribution of agroforestry in biodiversity conservation and rural needs fulfillment in Kanski district, Nepal. Thesis Submitted in Partial Fulfillment of the Requirement for the Masters Degree, Tribhuvan University, Institute of Forestry, Pokhara, Nepal.

Magurran, A.E. (1988). Ecological Diversity and its Measurement. Princeton, New Zealand: Princeton University Press.

Mbow, C., Smith, P., Skole, D., Duguma, L. and Bustamante, M. (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Curr. Opin. Environ. Sustain.*, 6: 8–14. DOI: https://doi.org/10.1016/j.cosust.2013.09.002.

McNeely, J.A. and Schroth, G. (2006). Agroforestry and Biodiversity and Conservation-Traditional Practices, Present Dynamics, and Lessons for the Future. *Agroforestry and Biodiversity Conservation*, 15: 549–554. DOI: https://doi.org/10.1007/s10531-005-2087-3.

MRM (2023). Annual Progress Report 2022-2023. Makawanpurgadhi Rural Municipality, Makawanpur, Nepal. Available online at: https://makawanpurgadhimun.gov.np/annual-progress-report [accessed 15 February 2024].

Neupane, R.P., Sharma, K.R. and Thapa, G.B. (2002). Adoption of agroforestry in the hills of Nepal: A logistic regression analysis. *Agricultural Systems,* 72(3): 177–196. DOI: https://doi.org/10.1016/S0308-521X(01)00066-X.

Ojha, R.B., Atreya, K., Kristiansen, P., Devkota, D. and Wilson, B. (2022). A systematic review and gap analysis of drivers, impacts, and restoration options for abandoned croplands in Nepal. *Land Use Policy*, 120: 106237. DOI: https://doi.org/10.1016/j.landusepol.2022.106237.

Paudel, P., Rimal, S., Ghimire, P. and Parajuli, K. (2019). Agro-forestry for enhancing adaptation of local community against drought in hilly region of Nepal. *International Journal of Agriculture Innovations and Research*, *7*(4): 440-445. Available online at: https://ijair.org/index.php/issues?view=publication&task=show&id=1251 [accessed 15 February 2024].

Reed, J., van Vianen, J., Foli, S., Clendenning, J., Yang, K., MacDonald, M., Petrokofsky, G., Padoch, C. and Sunderland, T. (2017). Trees for life: The ecosystem service contribution of trees to food production and livelihoods in the tropics. *Forest Policy and Economics*, 84: 62-71. DOI: https://doi.org/10.1016/j.forpol.2017.01.012.

Salinas, A.M. (2016). The role of agroforestry in biodiversity conservation and ecosystem service provisioning. *Agriculture for Development,* 28: 15-16. Available online at: https://www.researchgate.net/publication/306184685_The_role_of_agroforestry_in_biodiversity_conservation_and_ecosystem_service_provisioning#fullTextFileContent [accessed 15 February 2024].

Schnell, S., Altrell, D., Stahl, G. and Kleinn, C. (2015). The contribution of trees outside forests to national tree biomass and carbon stocks - a comparative study across three continents. *Environ. Monit. Assess.,* 187(1): 1-18. DOI: https://doi.org/10.1007/s10661-014-4197-4.

Shin, S., Soe, K.T., Lee, H., Kim, T.H., Lee, S. and Park, M.S. (2020). A systematic map of agroforestry research focusing on ecosystem services in the Asia-Pacific Region. *Forests*, 11(4): 368. DOI: https://doi.org/10.3390/f11040368.

Thapa, B. (1989). Farming systems in the Middle Hills of Nepal. *PAC Technical Paper-Pakhribas Agricultural Centre*, 114.

Ulak, S., Lama, B., Pradhan, D.K. and Bhattarai, S. (2021). Exploring agroforestry systems and practices in the Terai and hill regions of Nepal. *Banko Janakari*, 31(2): 3–12. DOI: https://doi.org/10.3126/banko.v31i2.41885.

.

Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	Author 1	Author 2
Conceived and designed the research or analysis	Yes	Yes
Collected the data	Yes	No
Contributed to data analysis and interpretation	Yes	Yes
Wrote the article/paper	Yes	No
Critical revision of the article/paper	Yes	Yes
Editing of the article/paper	Yes	Yes
Supervision	Yes	Yes
Project Administration	Yes	No
Funding Acquisition	No	No
Overall Contribution Proportion (%)	70	30

Funding
No funding was available for the research conducted for and writing of this paper. Therefore, acknowledging any support agency is not applicable in case of this research or the written work. However, informal support of institutional supervisors, colleagues and respondents is duly acknowledged.

Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge
The author(s) solemnly declare(s) that this research has not involved any Indigenous Peoples as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) and Self-Declaration in this regard are appended.

Research involving Plants
The author(s) solemnly declare(s) that this research has involved the plants for experiment or field studies. Some contexts of plants are also indirectly covered through literature review. Thus, during this research the author(s) obeyed the

principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research Involving Local Community Participants (Non-Indigenous) or Children
The author(s) solemnly declare(s) that this research has directly involved local community participants or respondents belonging to non-Indigenous peoples. But, this study did not involve any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people are only indirectly covered through literature review. A sample copy of the Consent Form implying prior informed consent (PIC) of the respondents is appended.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

Competing Interests/Conflict of Interest
Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

Attribution and Representation
All opinions and mistakes are the author(s)' own and cannot be attributed to the institutions they represent. The publisher is also not responsible either for such opinions and mistakes in the text or graphs or images.

Rights and Permissions

***

To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Declarations] from the published Abstract page accessible through and linked with the DOI: https://doi.org/10.33002/aa030202

INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous or Indigenous Respondents)

This form was translated into local language for the respondents

Title of the Research: Agroforestry: Enhancing Farm Tree Diversity and its Role in Rural Livelihoods

Principal Researcher: Uchita Lamichhane
Faculty of Forestry, Agriculture and Forestry University, Hetauda-10, Makawanpur district, Bagmati Province, Nepal

Research Supervisor: Pramod Ghimire
Faculty of Forestry, Agriculture and Forestry University, Hetauda-10, Makawanpur district, Bagmati Province, Nepal

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study were to evaluate various agroforestry systems, farm tree diversity, and their contribution on rural income.

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantanges and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to a better understanding on how farm trees promotion can transform rural livelihoods.

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

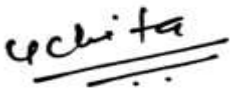
- ⇨ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇨ I can ask the research team questions and ask for satisfactory answers.
- ⇨ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇨ I have read this information and consent form and agree to participate in the research project.
- ⇨ I agree that the interviews be recorded in written form by the researcher: Yes ( ) No ( )

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher :  Date : 13-06-2023

Surname: Lamichhane First name: Uchita

- ⇨ Should you have any questions regarding this study, or to withdraw from the research, please contact Ms. Uchita Lamichhane by e-mail uchitalamichhane@afu.edu.np
- ⇨ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact the Pramod Ghimire, Faculty of Forestry, Agriculture and Forestry University, Hetauda-10, Makawanpur district, Bagmati Province, Nepal by e-mail pghimire@afu.edu.np