Policy Brief on
Development of Agroforestry Systems in Nepal

June, 2019

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Forewords

Agroforestry (AF) is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. The World Bank estimates, over 1.2 billion people derive their livelihoods from agroforestry systems

The outcomes of agroforestry have not been acknowledged sufficiently in policy formulation, nor has it been integrated into land-use planning. Thus, strong policy works related to the agroforestry is urgently needed to be developed and implemented. So, this policy brief will be milestone to know about impact of exotic tree species plantation in Nepal and guide to policy maker, forester and related line agency to develop agroforestry system in Nepal.

I would like to thank Green Governance Nepal consultancy for preparing this report. I appreciate Milan Dhungana for conducting this program. I would like to express my gratitude former Director General of FRTC Dr. Deepak Kumar Kharal and Former DDG Dr. Buddi Sagar Poudel for supervising and guiding the program. I would like to further thank to DDG Mr Dhirendra Kumar Pradhan for his support. I am further thankful to Reviewer team Mr Bimal Kumar Acharya, Mrs Manju Ghimire, Mr Bishnu Prasad Dhakal and Mr Kiran Kumar Pokharel for improving this document in publishable form. At last but not least, I acknowledge all professional, FRTC staff and who involved directly or indirectly to shape this document.

I am very hopeful that this document will be helpful to guide and support the policy maker, researcher and student for further management on exotic tree species.

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Director General
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Glossary of terms

Afforestation	Direct human-induced conversion of land that historically has not been forested to forested land through planting, seeding, and/or the human-induced promotion of natural seed sources. Plantation
Agroforestry system	A land-use management system in which woody perennials (trees, shrubs, bamboos, palm trees, woody lianas) are grown on the same land management unit with crops and/or livestock to create interactions considered beneficial to the producer and/or the land.
Alley Cropping	An agroforestry intercropping system in which species of shrubs or trees are planted at spacing relatively close within row and wide between row, to leave room for herbaceous cropping between that is in the alleys (syn. hedgerow intercropping)
Climate change adaptation	The efforts by society or ecosystems to prepare for or adjust to the impact brought about by changing climate
Climate smart agriculture	An approach to developing the technical, policy, and investment conditions to achieve sustainable agricultural development for food security under climate change
Ecosystem service	An ecological process or function having monetary or nonmonetary value to individuals or society at large. Ecosystems services are (1) supporting services, such as productivity or biodiversity maintenance; (2) provisioning services, such as food, fiber, or fish; (3) regulating services, such as climate regulation or carbon sequestration; and (4) cultural services, such as tourism or spiritual and aesthetic appreciation
Home-garden	A private-property garden around a house that contains various trees, crops, and animals. Home gardens exist more in tropical areas than in cooler climates.
Intercropping system	The growing of two or more different species of crops simultaneously, as in alternate rows in the same field or single tract of land.
Live Fence	Rows of living plants, such as grasses, shrubs, and trees, that are strategically planted to work as a structural barrier
Mulch	A natural or artificially applied layer of plant residues or other materials such as stones, sands, paper or brush on the surface of the soil
Multifunctional agriculture	The practice of farming that produces various non-commodity outputs in addition to food.
Shelterbelt	A single row or multiple rows of trees and shrubs planted in a linear fashion and established upwind of the areas to be protected. Often time this this term is more often used interchangeably with windbreaks.

Shifting cultivation	Traditional farming practice of slash and burn the forest and cultivate the agricultural crops for specific period of time In others, whole settlements move and clear new land once the old is no longer productive.
Silvi-pasture	The intentional combination of trees, forage plants, and livestock in an integrated, intensively managed system
Tangya system	Method of raising forest trees in combination with (seasonal) agricultural crops. Used in the early stages of establishing a forest plantation. It not only provides some food but can lessen the establishment costs

1. Introduction

Agroforestry (AF) is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components.This may happen at field, farm or landscape scale.

Agroforestry is not a new concept but an age-old practice evolved in the particular context pertaining to socio-economic, political and ecological aspect. There are long traditions of agroforestry in many parts of the world but it has only attracted the attention of scientists and emerged as a major part of international agricultural development since the 1970s (FAO, 2017). This concept at the policy level has been little encouraged and acknowledged and therefore this has left us behind in many fronts.

Nonetheless, the AF is regarded as an effective, low-cost means of minimizing the degradation of cultivated land and even increasing the productive capacity of agricultural ecosystems. It diversifies the ecosystem services, creates a green cover for carbon sequestration, generates fresh environments, and hence has gained popularity among farmers, and researchers. Having so many beneficial impacts, AF is desirable form of land use worldwide and agrarian country like Nepal where livestock herding constitutes the integral of a farming system.

The World Bank estimates, over 1.2 billion people derive their livelihoods from agroforestry systems. Owing to its capacity to enhance multiple functions in agriculture, agroforestry will become increasingly important in land-use practices around the world (Kabiru et al. 2018). For example, agroforestry systems on five million hectares in Niger increased annual agricultural production by around 500,000 tons. In Zambia, maize yields have increased by 88 to 190 per cent when grown in an agroforestry system under the canopies of *acacia like species (Faider biaalbida)* (WAF, 2019).Another example includes leguminous trees pull nitrogen, a nutrient critical for plant growth, out of the air and release it into the ground. These nitrogen-fixing trees are often used in agroforestry systems and in organic farming. It is also found that incorporating trees like *Faidher biaalbida* increases the productivity of degraded land, resulting in an increase in crop yield of between 89 and 318 percent (Ortolani, 2017).

Furthermore, a study conducted in 2014 found that agroforestry improves soil structure and increases drainage, especially during wet periods. In eastern Zambia and Zimbabwe, steady-state infiltration rates were 42 to 600 percent higher when maize was rotated with leguminous trees compared to monocultures of maize and drainage was improved by 88 to 900 percent (Ortolani, 2017). However, adoption of agroforestry is constrained by cultural belief systems, weak institutions, complex land tenure system, inadequate knowledge and skill and lack of adequate enabling policy environment. It is of utmost important to note that the various forms of

agroforestry systems/practices are evolved in different socio-economic, political and ecological contexts and it may be naive to think that there is a one size fit all agroforestry system.

There are several barriers at the farm level and policy level primarily in development countries at the farm level. Analysis reveals that there are few value chains developed for agroforestry products and for connecting them to consumers and the market. The slow return on investment in agroforestry is another problem to enhance agroforestry, as many farmers, especially women, do not have access to capital, credit or secure tenure of their land.

Even though, agroforestry has provided significant contribution to the national and local economy, this sector is still disadvantaged by insufficient policies, legal constraints and a lack of coordination between the governmental sectors– namely, agriculture, forestry, rural development, environment and trade.

The outcomes of agroforestry have not been acknowledged sufficiently in policy formulation, nor has it been integrated into land-use planning. Thus, strong policy works related to the agroforestry is urgently needed to be developed and implemented.

Within these backdrops, the current policy brief reviews global, regional, national and sub-national agroforestry policies, legal instrument, management systems/practices, institutional mechanisms and their roles, responsibilities and authorities. While reviewing literature, priority was given to South Asia countries due to the similarities in climate, geography, forest species and agro biodiversity and other socio-economic factors. Finally, policy recommendations were drawn based desk reviews including journal articles, book chapters, progress report, manual, working paper and other periodic reports.

2. Global Agroforestry Practices

The farmers, grazers, and forest dwellers have an intimate knowledge of these traditional practices. History of agroforestry dates back to almost 1700 years ago in parts of China. This practice followed in Finland in the 18th century, and was practiced in some part of Germany until 1920s. In tropical America, multistory agroforestry system was practiced, where coconut with lower layers of papaya, banana or citrus fruits and shrub layers of coffee and maize were grown. Agroforestry, the inclusion of trees within farming systems, has been a traditional land use developed by subsistence farmers throughout most of the world (Zomer et al., 2009).

In Africa, agroforestry is practiced based on the geography and people's requirements. The main types of agroforestry include grazing or farming under savanna trees, coffee and cocoa grown under shade trees, planting of individual trees or woodlots by farmers, intercropping between young plantation trees or grazing between older ones, sowing of tree seeds on abandoned fallow land to speed up the restoration of fertility, the "garden" type of agriculture in fertile and densely populated areas where trees, shrubs, and annual crops are grown on the same piece of land, and modern forms like alley cropping.

Tree crops like oil palm and rubber trees, and the traditional migratory slash-and-burn agriculture, are also forms of agroforestry. Furthermore, different types of agroforestry and silvo-pastoralism (combinations of animal husbandry and forestry) found in sub-Saharan Africa (Cook

and Grut, 1989). In southern Nigeria, yam, maize, pumpkins and beans were grown under scattered trees.

Various agroforestry practices can be seen in Europe including Silvoarable agroforestry, forest farming, riparian buffer strips, improved strips, multipurpose trees and silvopasture, for example, forested areas are used for production or harvest of natural standing specialty crops for medicinal, ornamental or culinary uses under forest farming. Similarly, the USA is practicing five major agroforestry systems namely tree-agronomic crop systems (alley cropping and intercropping), riparian vegetative buffer strip systems, tree-animal systems (silvo-pasturing), forest/specialty crop systems (forest farming) and windbreak systems (Gene Garrett and Buck, 1997).

Philippines practices agroforestry systems as agrisilvicultural systems (crops-including tree/ shrub crops-and trees), silvopastoral systems (pasture/ animals plustrees), and agrosilvopastoral systems (crops pasture/animals trees) based on the nature of the components. For the agrisilvicultural systems, various sub-systems and practices are included such as hedgerow intercropping (alley cropping), multistory combination of plant communities belonging to multiple species, multipurpose trees and shrubs on farmland, shade trees for commercial plantation crops, shelterbelts and windbreaks, soil conservation hedges on crop production fields, and so on . These technologies aim at improving the soil fertility and promoting soil and water) conservation (Katayama and Luna, 1998). Verma et al. (2016) listed the various types of Agroforestry systems in India including Tangya system, Alley-cropping, Home garden and Aqua forestry (Annex-1).

2.1 Global/International Institutions on Agroforestry

There are only handfuls of international institutions that work on agroforestry. Many international institutions not solely works on agroforestry but also includes this sector under its remit to help benefit the larger communities and countries, among the primary are the International Development Research Centre (IDRC), Food and Agriculture Organization (FAO) and Swedish International Development Authority (SIDA) and Australian center for International Agricultural Research.

Established in 1978 as International Centre for Research in Agroforestry (ICARF) and changed to World Agroforestry Centre in 2012. The ICARF is globally significant research organization focused in agroforestry with the vision "an equitable world where all possible have viable livelihoods supported by healthy and productive landscapes." The center is promoting agroforestry researches in developing countries. It has led several strategic researches as well as developed a strong science culture. With it's headquarter in Nairobi, Kenya, ICARF operates six regional programmes and conducts researches in more than 30 countries. The ICARF has a numerous publication based on its researches which have significant impacts on defining agroforestry and leading agroforestry as one of most desirable and effective landscape management in developing nations.

University of Missouri established The Center for Agroforestry in 1991, is one of leading centers contributing to the science underlying agroforestry, the science and practice of intensive land-use management combining trees and/or shrubs with crops and/or livestock. The five integrated practices namely forest farming, alley cropping; silvo-pasture, riparian buffers, and wind breaks enhance land, aquatic habitats and improve biodiversity while sustaining land resource for generations. Likewise, Australian Agroforestry Foundation is another not-for-profit organization committed to providing education and extension support to help farmers, develop and sustain forests within the Australian Agriculture Landscape. The AAF have been working to promote farmer's participation in multipurpose tree growing on farms since 1993 in Australia.

In addition, region refers to South Asia with which Nepal shares many factors in common and also appears to be more relevant as compared with European countries and. The prominent South Asian agroforestry systems include parkland systems; agri-silviculture involving poplar (*Populusdeltoides*) and Eucalyptus spp.; plantation agriculture involving coffee (*Coffee spp.*), tea, cacao (*Theobroma cacao*), and spices (e.g. black pepper, cardamom) in association with a wide spectrum of trees, betel vine intercropping systems with coconut, para rubber and other trees commercial crop production under the shade of trees in natural forests. Deliberate growing of trees on field bunds (risers) and in agricultural fields as scattered trees and the practice to utilize the open interspaces in the newly planted orchards and forests for cultivating field crops are also widespread in the South Asia continent.

Towards the end of 19th century, forest plantation has been established adopting agroforestry systems, which is known as *Tangya* agroforestry system. This system was first started from Burma in 1850s, where teak (*Tectona grandis*) plantation areas were given to shifting cultivators to grow agriculture crops. Tangya agroforestry has been adopted widely in South Asia in 1890s. In Bangladesh, plantation was established adopting Tangya approach in between 1887 to 1890s, whereas this in West Bengal of India in 1896. Nepal too adopted Tangya approach in Tamagadi Bara in 1970 (Amatya et al., 2018).

Another important regional institution is Indian Council of Agriculture Researches (ICAR) established under Ministry of Agriculture and Farmers Welfare. The ICAR has conducted numbers of researches in agroforestry system viz.: integrated nutrient management in Sapota under agroforestry systems, agroforestry systems for sustainable crop yields and economics in rainfed areas.Besides, there are numbers of universities working on agroforestry sectors. These include: Dr. Rajendra Prasad Central Agricultural University, Rani Laxmi Bai Central Agricultural University, Uttar Pradesh; Central Agriculture University, Manipur; and ICAR-Indian Agricultural Research Institute. India has many agroforestry interventions, and researches carried out with the help of several associating actors including World Agroforestry Center.

3 National Agroforestry Systems/Practices

3.1 Traditional Agroforestry Practices

As elsewhere, agroforestry practices in Nepal are traditional and specific to the social, economic and agro-ecological conditions. In this system, multiple use of land is possible due to the planting of fodder, fire wood and timber in terrace bunds, borders and slopes with agricultural crops.

Traditional agroforestry farming system of Nepal includes growing of trees, agriculture crops and livestock for the purpose of subsistence livelihood as since ages, rural people keep livestock for milk, woolen, meat and draft animal power. Livestock herding necessitates planting fodder trees in their farms and it provides the leaf litters for animal bedding. In recent decades, farmers have started cultivating cash crops such as cardamom under Alder (*Alnus nepalensis*), ginger and turmeric under tree shade and home gardens, coffee plant under IpilIpil (*Leucaena leucocephala*) and shade trees, and tea under Sissoo (*Dalbergia sissoo*) and Siris (*Albezzia spp.*), vegetables, and fruits (orange, banana, papaya, mango, apple etc.) for commercial purposes. These changes in crops and cropping pattern have changed the agricultural landscape and motivate institutions and researchers to improve the systems considering the very environment under which they are subject to.

In the mid hills of Nepal, for examples, places such as Naldung and Hinguwapati, KavrePalanchok district, alley cropping is common with Ipil-Ipil (*Leucaena spp*) as the hedge crop. Alley or hedge-cropping was first introduced in Nepal to farmers in Bahunepati in Sindhupalanchok district (Arens, 1984; Baidya, 1990). In this method Ipil-Ipil (*Leucaena spp.*) was sown 2-4 m apart in rows along the contour in farmers' field and the resulting hedge cut periodically to 15-30 cm above ground level to provide fodder and green manure. Ipil-Ipil (*Leucaena spp*) was planted at one meter spacing along terrace risers. This method was very successful and contributed expansion of livestock significantly in that area.

Similarly in Dhading district, Nepal Agroforestry Foundation (NAF) has been engaged in promoting agroforestry since 1993/1994. Rural households planted a number of exotic fodder and grass species, including ipilipil (*Leucaena leucocephala* and *Leucaena diversifolia*) , calliandra (*Calliandra calothyrsus*), bhatmase (*Flemingia con-gesta*), kimbu (*Morus alba*), gauzuma (*Gauzumaulmifolia*), NB21 (*Pennisetum sp.*), Napier (*Pennisetum purpureum*), and Stylo (*Stylosanthes guianensis*) to maximize the household income in addition to local species. Fodder species are planted on terrace risers, edges of farmlands and fallow lands and crops are grown in terraces. Through regular pruning, trees are maintained at breast height (1.5 m) to minimize their possible adverse effects on crop yields.

In addition, the major agroforestry practices observed in Tanahu district were silvopasture, hortisilviculture and NTFP cultivation. More than half (55 %) of the households adopted silvopasture followed by Hortisilviculture (35 %) and NTFP cultivation (9 %), in hortisilviculture system fruit tree, fodder tree and NTFPs species were found as a major crop combination. The major components of the silvopasture system found were different tree species, animal (mostly goats) and fodder and grasses. Similarly, in agrisilvipasture system ginger was cultivated as an agricultural component together with tree and NTFP species in some user groups.

In the eastern Nepal, where cardamom was increasingly grown, alder and siris are the widely used forest species to provide the required quantity of sheds to high value cash crops. Perhaps the cardamom garden is the simpler form of agroforestry systems in Nepal adopted by private farmers. Also home garden is a common sight in tropical zone such as Jhapa where assemblage of plants including coconuts, beetle nut, vines and herbaceous plant can be observed in the surrounding of homestead.

However, there is a dearth of research and study in agroforestry sector. Most studies were confined in small pocket area and therefore not adequately comprehensive. Arrangement of species components for various agroforestry systems for Nepal is presented in Annex-2 (Amatya et al., 2018).

3.2 Evolution of Agroforestry systems

Despite agroforestry practices in traditional practices for Nepal, attempt was put to improve the agroforestry system to include wider local communities as a beneficiaries. Government has put efforts to link agroforestry systems with poverty eradication and biodiversity conservation by introducing various species, their combinations and maximizing the use of land of agricultural system.

Agroforestry practice was first started in Nepal in 1970 in Tamagadiarea in Bara district, where forest areas encroached by the hill migrants were planted and given to encroachers to grow agriculture crops (Amatya et al., 2018). The main aim of this practice was to protect remaining forests from encroachment. Then Tarai Community Forestry Development Project and Sagarnath Forestry Development Project have also practiced this system in large scale from 1983 to 1992. These projects have given plantation areas (1 ha/Hh) for poor farmers living around for 4-5 years on simple agreement to grow agriculture crops without any damage to trees. Farmers were responsible to replant seedlings when planted trees were damaged during growing crops in Tangya plots.

3.3 National Agroforestry Institutions

The agroforestry practices have been age old practice but the legal mandated national institutions pertaining to agroforestry was evolved much later though not explicitly. The government of Nepal respond to implement/improve the agroforestry systems/practices in recent years by devising Agroforestry Inter Ministerial Coordination Committee (AFIMCC) in particular and also mandates parts of roles to Ministry of Forests and Environment (MoFE), Ministry of Agriculture and Livestock Development, Department of Forest and Soil Conservation (DoFSC) and Forest Research and Training Center (FRTC).

The AFIMCC is the focal institution for matter related with development of agroforestry systems. This is the most explicit institution envisioned by National Agroforestry Policy, 2076. This committee is mandated for program planning, coordination and executing monitoring and evaluation in federal, province and local level. The National Agroforestry Policy (2076) put forth

policies, strategies, institution and its roles, responsibilities and authorities. The success of agroforestry systems/practices rely greatly on the effective implementation of this policy.

Similarly, the Ministry of Forest and Environment also remits to work in agroforestry. The Forest and Watershed Division is assigned to work for the promotion of Agroforestry amongst many other forest systems such as urban forestry and private forestry.Similarly, the DoFSC is one of the four departments that looks after agroforestry issues. Agroforestry has also been the responsibility of Community Forestry Division while a separate section has been set up (i.e. Private and Agroforestry) for promoting and assisting agroforestry.

Likewise, Forest Research and Training Center, previously known as Department of Forest Research and Survey (DFRS)works in the areas of knowledge productions, dissemination and capacity building. The FRTC has set up Forest Technology Development Division which works primarily on developing and demonstrating appropriate technology related to management of forest resources, and determining ways of optimizing productivity through appropriate species composition specific to objectives. Under the Forest Technology Development Division, Urban and Agroforestry section develops policy briefs, conducts researches and provides capacity to extension workers.

Established in 1991 as an autonomous body under Nepal Agricultural Research Council Act 1991, Nepal Agriculture Research Council is focused in conducting researches in agriculture and its allied subject like agronomy, productivity, value chain etc. Agro forestry and farm forestry also constitute its research areas. The strategic vision of NARC is to develop technologies for the agri-silvopastoral system including improving the soil fertility in agroforestry. In summary, the government institutions responsible for agroforestry systems is illustrated in Annex-4.

Another prominent NGO is Nepal Agroforestry Foundation (NAF) established in 1991 and engaged in promoting agroforestry in several areas of Dhading district since 1993/1994. In collaboration with many development and research partners, it works in capacity building and knowledge dissemination. Households involved in the agroforestry projects have established a number of exotic fodder and grass species, including ipilipil (*Leucaena leucocephala* and *Leucaena diversifolia*) , calliandra (*Calliandra calothyrsus*), bhatmase (*Flemingia con- gesta*) , kimbu (*Morus alba*), gauzuma (*Gauzum aulmifolia*), NB21 (*Pennisetum sp.*), Napier (*Pennisetum purpureum*), and Stylo (*Stylosanthes guianensis*), in addition to local species. Fodder species are planted on terrace risers, edges of farmlands and fallow lands and crops are grown in terraces. Through regular pruning, trees are maintained at breast height (1.5 m) to minimize their possible adverse effects on crop yields.

Academia includes primarily Agro Forestry College and Institute of Forestry. The Agro Forestry College was established in 2010, which was the first agroforestry technical university of Nepal. Similarly, under the Faculty of Forestry, there is a department called Department of Silviculture and Forest Biology that imparts course on agroforestry system and management. Similarly,

Institute of Forestry under Tribhuvan University has been imparting education of agroforestry system and practices in graduate level.

3.4 Policies and Legal Provisions

In an attempt to acknowledge the significance of agroforestry system and to enable to policy environment to to upscale in appropriate agro-ecological zones, government has sort of policy initiation but much has to be done. Considering usefulness and benefits of agroforestry system, legal provisions are not adequate to upscale and replicate in other similar places. Firstly it is imperative to take stock of existing legal provisions pertaining to agroforestry systems/practices in Nepal:

- **The Constitution of Nepal (2072)** has not explicitly mentioned about AF systems, however the constitution encourages the optimum land use forms such as agroforestry for bio-diversity and pro-poor forestry practice. Similarly, constitution has mentioned about the common rights regarding management of natural resources in its annex.
- **Forest Act 1991:** The major guiding documents is Forest Act which states that any part of national forest can be handed as leasehold for the conservation and development through operation of agroforestry.
- **National Forest Policy, 2019:** As compared with other policies, National Forest Policy (2019) is perhaps the most explicit on national strategies for agroforestry systems. The 6th objective of it proposes to develop forest as mean of income generation through fruits and agroforestry. In addition, objective 5 mentions the conservation of forest resources and utilizing in multiple ways including intercropping of forest and agriculture crops. Similarly, policy 8.6 acknowledges the need of conserving forests outside national forests where soft loans will be offered to promote agroforestry etc.
- **National Agro-forestry Policy, 20176:** This is probably the most explicit legal document pertaining to Agro-forestry systems in Nepal. The policy put forth relevant policies, strategies, institution and its roles, responsibilities and authorities. It envisions an Agro-forestry Inter Ministerial Coordination Committee (AFIMCC) for program planning, coordination among key stakeholders and, monitoring and evaluation in federal, province and local level. The success of agroforestry systems/practices rely greatly on the effective implementation of this policy.
- **Guidelines for Lending Leasehold Forest to Commercial Purpose, 2068:** One relevant objective is providing leasehold forest for biological diversity, agroforestry and NTFP based enterprises.
- **Forestry Sector Strategies (2016-2025)** has regarded agroforestry as one of the possible interventions in private lands. Tarai and Inner Tarai have been mentioned as feasible areas of developing agroforestry. The table below presents the major legal provisions
- **Agriculture Development Strategies (2015-2035):** It covers several issues pertaining to agriculture. An emphasis has been given to agroforestry as one of probable land use systems (373 B and 374 C). It proposes developing agroforestry friendly models specific to climate change, and establishing agroforestry based industries by motivating poor community and private sectors.

- **Nepal Biodiversity Strategies and Action Plan (2014-2020):** Acknowledges agroforestry as a key management intervention for conserving trees outside protected areas. It also emphasizes that agroforestry could substantially contribute to conservation of local biodiversity if properly managed.
- **Agroforestry Implementation Guidelines, 2073 (Prime Minister Agriculture Modernization Project):** Under the Prime Minister Agriculture Modernization Project, agroforestry was taken as a key intervention and corresponding guideline was prepared. Seven zones and super zone were declared and various programs are proposed for agroforestry promotions viz.: Jhapa, Kabhre, Bara, Kaski, Danga, Jumla, Kailali and zones from these super zone were then VDCs from above mentioned districts. The main objective of the program is to encourage and promote agroforestry, enhancing income generation by developing fruit trees.

4. Characteristic of species for Agroforestry

One of the most important tasks of Agroforestry system is the selection of suitable tree/shrub species in the particular ecological zone. Needless to say, the species selection also varies according to the agroforestry systems. It is important to note that these are general characteristics of the tree/shrub species. Suitability of species is highest when all seven characteristics are met. In the real world, however, there might be a situation where combination of few characteristic will be reasonably adequate to meet the objective. Following are the characteristics of species (Fig 2).
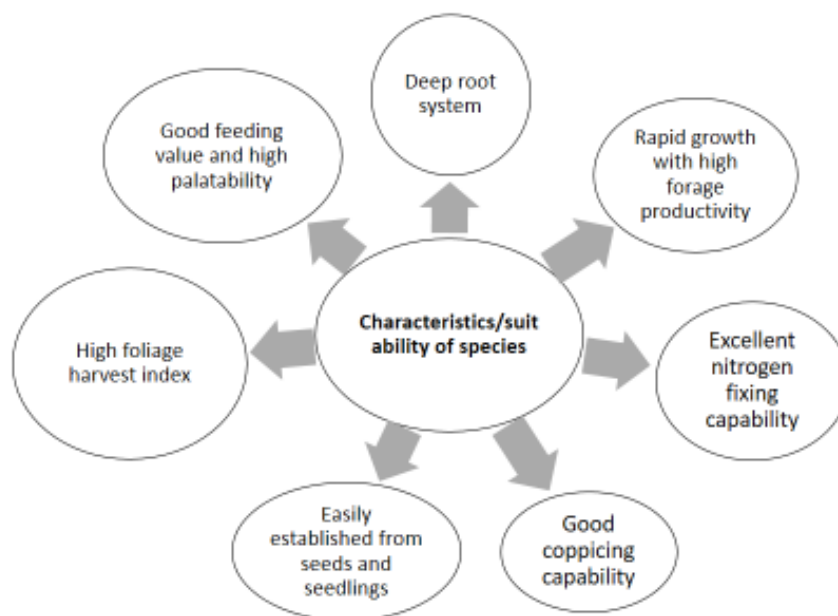

Figure 2: Characteristics of species for Agroforestry (WAF, 2006)

5.Challenges

Followings are the challenges for effectively implementing the agroforestry systems/practices benefiting people, biodiversity and natural environments.

➢ Reduced productivity of the land,
➢ Inadequate research of agroforestry systems at the ecosystem or landscape level, even then majority of studies are of short term nature,
➢ Inadequate/limited knowledge on the composition of trees/shrubs/crops specific to agroforestry systems and eco-regions,
➢ Shortage of quality planting materials and improved seed varieties,
➢ Underdeveloped marketing infrastructures for agroforestry products,
➢ Capacity of Institution dedicated for promote agroforestry systems/measures
➢ Creating synergy between key stakeholders (Ministry of Forests and Environment, Ministry of Agriculture and Livestock Development, National Planning Commission, NARC, Academia),
➢ Lack of processing and semi processing units for agricultural products,
➢ Multi stage tax at various stages of processing,
➢ No adequate data and information due to limited research and study,
➢ Lack of awareness
➢ Lack of knowledge and skill among implementers
➢ Lack of knowledge of tree seedling management, pest and disease control, and adequate seeds and germplasm supply,
➢ Inadequate trained staffs with government to promote/support/implement agroforestry systems/measures particularly in provincial and local level,
➢ Insufficiency of enabling policy environment,

6. Opportunities

Nepal is an agricultural country and majority of its population rely on agriculture and livestock herding for subsistence living. Since ages, people have beendoing traditional agriculture practices which are only sufficient to make people survive but not producing surplus for cash income. This is due to the ineffective/inadequate practice leading to mono agriculture practice despite having plenty of arable land. As population increased causing small land holding. This has started to exert some pressures to seek out an appropriate strategy/approach to maximize the land utility thereby increase productivity.

In the changed context, combination of crops either forestry or agriculture were used to maximize the land use and also to increase the soil fertility for the conservation of bio-diversity. The general objective of agroforestry is to allow varieties of crops having various cycle, growth and nutrient requirements to flourish in the same area of land and observe/replicate the best fit combination for local requirement.

Agroforestry system has been also adopted to address the food insecurity problem and reduce poverty who in absence of agriculture land face the severe deprivation. With some success

models, agroforestry system provides a huge opportunity to tackle the food deficiency for landless people and help survive through subsistence livelihood.

Apart from this, there are numbers of benefit of agroforestry practice such as land stability, increased soil carbon, reduction in greenhouse gas and healthy environment. As rural areas in developing countries like Nepal are confronting low income and poverty arising, agroforestry offers an opportunity to address such problems through integration of site specific, high value perennials, including aromatic and medicinal plants, into it. It can also make a good contribution to local environmental conservation, such as soil conservation and climatic change mitigation and adaptation.

It may mitigate farmers' vulnerability to any economic crisis in the event of any future climate change by enabling them to grow high value perennials which are suitable in changed conditions. Agroforestry reduces the dependency on forest resources for examples fuelwood, fodder, leaf litter, timber and becomes an important carbon offset option. This tree-based agroforestry practices could bring opportunities for rural development through promoting agro industries by providing raw materials and improving local economies by reducing unemployment. According to an estimate, In India, one hectare of the plantation in wood-based industries create about 450 man employment, thus, 30 million ha has the potential to create approximately 15,000 million man-days of employment besides creating job opportunities in wood based value chain (Sharma et.al. 2017).

Similarly, according to the study conducted at then Dhaitbung VDC of Rasuwa district, it was found that agroforestry has generated employments and livelihood support for the local people (Pandit et al. 2008). Finding further revealed that agro forestry system practiced in project area; gross income and net income analysis in project village are more profitable than control village farms. Income from sale of livestock, fruits, milk and milk products was higher in project village whereas income from public services, wage labor was somehow same.

With the appropriate policy and legal instrument in place, leasehold and national forest can be be an appropriate means to tackle poverty by maintaining/improving the soil fertility in the long run. The integration of agroforestry into existing farming system is the strongest driver to meet the food sufficiency of rural resident for longer months.

7. Recommendations

Based on the desk reviews and key informant interview, recommendations categorized in to key components are presented below.

Policy and legal instruments related recommendations

- The Agroforestry Inter-ministerial Coordination Committee needs to take initiation as envisioned in National Agroforestry Policy, 2076;
- The Agroforestry Inter-ministerial Coordination Committee needs to develop relevant policies/guidelines (*karyabidi*) in federal, province and local levels for developing incentive mechanism for private farmers or cooperatives interested in developing agroforestry systems,

- Revisit/consolidate agroforestry-related policy frameworks and mechanisms for cross-sectors coordination in all levels (federal, province and local),
- Government shall adopt policies that use agroforestry to tackle impact of climate change.

Institutional recommendations

- The Agroforestry Inter-ministerial Coordination Committee needs to work closely with the Ministry of Forests and Environments, Ministry of Agriculture and Livestock Development, National Planning Commission, NARC and farmer's representatives while developing policies/guidelines,
- The Agroforestry Inter-ministerial Coordination Committee to reach out to other like-minded institutions (GO/NGOs/Civil Society Organizations/ INGOs etc.) for the development and promotion of agroforestry systems,
- Take initiations to develop/refine curricula on agroforestry and support academia (Agro Forestry University, Institute of Forestry),

Capacity Building

- Develop/invest the capacity of agriculture and forestry extension workers to better implement and monitor the agroforestry technologies in the ground,
- Organize National Agroforestry Conference in every two years to institutionalize learning and to further agroforestry systems/practices,
- Develop/invest capacity of key stakeholders (GO, NGOs and NRM Based institutions) to overcome technical problems in practicing Agroforestry systems,
- Trees might serve as hosts to diseases, insects, birds and small animals so, knowledge on pest and disease and their remedial measures is essential,
- Organize/invest extension programs for farmers practicing agroforestry in the communities in local government level. Those farmers having agroforestry farms/home gardens or potential farmers should be provided with training for imparting knowledge and skills,
- Provide facilities for those government staffs who want to pursue higher education in agroforestry subject.

Operational recommendations

- Identify and prioritize potential areas for development of agroforestry systems/practices in federal, province and local levels,
- Need to specify the time period for landless people to have access on Tangya system so they will not reside in the forest permanently. Currently maximum 4-5 years is the set period that local people are allowed to cultivate food crops in Tangya system. However time period varies with the forest tree species. Food crops cease to exist on the land when the treesclose canopy and therefore this aspect needs to be carefully considered,
- Develop/invest agroforestry model farm in each province under the leadership of AFIMCC,

- Provide facilities/incentives for those enterprises based on the products of agroforestry practices/systems,
- Develop/upgrade markets for agroforestry products in all levels- federal, province and local,
- Rapid regeneration of aggressive trees may displace food crops and take over entire fields so, care needs to be taken while selecting tree species. In this purpose, generally species will be selected having characteristics such as rapid growth with high foliage productivity, excellent nitrogen fixing capability, good coppicing capability, easily established from seeds and seedlings, high foliage harvest index, deep root system and goof feeding value and high palatability,
- Select legume trees with small or light crowns to ensure sunlight reaches the food/agricultural crops,
- Select deep-rooted trees to ensure that they absorb moisture and nutrients from the deeper subsoil and also stabilize soil,
- Space the trees further apart to reduce their competitive effect on the food crops,
- Regulate reasonable basic price for local commodity within the local producer level,
- Bring the agricultural crops under the insurance scheme by giving subsidy in line with government policy,
- Introduce/upscale new agroforestry technologies such as hedgerows intercropping, fodder banks, fertilizer trees along terraces and soil bunds,
- Replace problematic tree species with appropriate tress that are best fit in various agroforestry systems/practices and valuable in terms of products and services,

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Annex -1: Description of agroforestry systems/practices in India (Verma et al., 2016)

S.N	Agroforestry systems	Descriptions
1	Tangya system	Food crops are interplanted with trees in a unit area of land for 2-3 years. Food crops cease to exist on the land when the tree crops close canopy. The system has proved effective in providing food for forestry workers and forage for cutting by cattle rearers.
2	Integrated Tangya	Similar to Tangya farming, but here, when the tree canopy is closed, livestock grazing substitute raising of agricultural crops
3	Improved fallow in shifting cultivation	Introduction of cover crops on the farmland in an effort to minimize soil degradation associated with agriculture
4	Alley-cropping (hedge row intercropping)	Arable crops are grown between hedgerows of planted shrubs and trees, preferably leguminous species that are periodically pruned to prevent shading of the companion crops.
5	Alley farming	Trees, shrubs and other perennials are planted with agricultural crops to supplement the woody plants in the row
6	Trees on farmland	The farmers plant or retain trees on their farmland, both for food, income, soil improvement and environmental amelioration and for shade during the adverse weather condition
7	Scattered trees also known as parkland system	This system is characterized by well grown scattered trees on cultivated and recently fallowed land. These parklands develop when crop cultivation on a piece of land becomes more permanent. The trees are scattered far apart so that they do not compete with their neighbors. Parkland trees are deep rooted, have capacity to fix nitrogen, produce litter that decomposes well and add as much as possible to soil organic matter.
8	Boundary planting	Fast growing trees are planted on the boundary of field, terraces and streams banks, works as live fences, erosion control structures.
9	Shelterbelts	Agroforestry system in which food crops are planted between rows of trees belts planted as shelter. The trees and shrubs are planted in one or more rows at right angle to prevailing winds
10	Windbreaks	Here, double rows of trees are planted around the boundary of a food crop farm on the windward side. Each windbreak is 150m long with 100 trees planted at escapement of 3m x 3m
11	Home garden	Tropical home gardens consist of an assemblage of plants which may include trees, shrubs, vines and herbaceous plants growing in or adjacent to a homestead.
12	Multipurpose trees on cropland (trees on	Farmers intentionally leave few trees on farms when clearing the land in the practice. The trees commonly left are those of

	farmland or farm forestry)	economic importance to the farmers.
13	Trees in social conservation	Woody plants, whether in hedges or not, planted to stabilize the soil on terrace edges and other conservation
14	Aqua forestry	This system is a practice that links trees with aquaculture. Trees are planted around fishponds to provide fodder for herbivorous fish.
15	Apiculture (apisilviculture)	Carefully chosen woody species grown for their nectar-producing flowers and pollen valued by bees can boost wax and honey production
16	Protein bank	Woody perennial vegetation judiciously used helps to supply forage during dry seasons or years of low rainfall.

Annex-2: Species arrangement specific to agroforestry systems/practices (Amatya etal., (2018).

Agroforestry System or Practice	Description and arrangement of components	Agroecological zones
A. Agrisilviculture (crops and trees including shrubs)		
1. Siris (*Albizia*) – tea (*Camellia sinensis*)	Tea under Siris (*Albizia*) trees in random mix pattern	Tarai in Eastern Nepal
2. Sisoo (*Dalbergiasisso*) –tea	Tea under Sisau (*Dalbergiasisso*) trees in random mix pattern	Tarai in Eastern Nepal
3. Utis (*Alnusnepalensis*) –tea	Tea under Utis (*Alnusnepalensis*) in random mix pattern	Midhills in Eastern Nepal
4. Betel nut (*Areca catechu*) – cardamom (mix)	Cardamom (*Elettariacardamomum)* under Betel nuts (*Areca catechu*) planted in regular spacing of 3m x 4m	Tarai in Eastern Nepal
5. Betel nut (*Areca catechu*) Bakaino (*Melia azedarach*), Siris (*Albizia*) Sisau (*Dalbergia sisso*) – crops	Betel nut and maize, rice, vegetable intercropping, Trees on borders	Tarai in Eastern Nepal
6. Tea Utis (*Alnus nepalesnis*) - Loth salla (*Taxu swallichiana*) - Tea	Tea under Utis (*Alnus nepalesnis*) and Loth Sallo (*Taxus wallichiana*) in random mix patters	Midhills in Eastern Terai
7. Utis (*Alnusnepalensis*)-Cardamom (*Elettaria cardamomum*	Cardamom (*Elettaria cardamomum*) under Utis in mix random planting	Midhills in Eastern and Central Nepal
8. Utis (*Alnus nepalensis*)-Amriso	Amriso (*Thysanola enalatifolia*) under Utis at wider spacing (4m x 5m) or Utis in farm border for narrow lots	Midhills in Eastern and Central Nepal

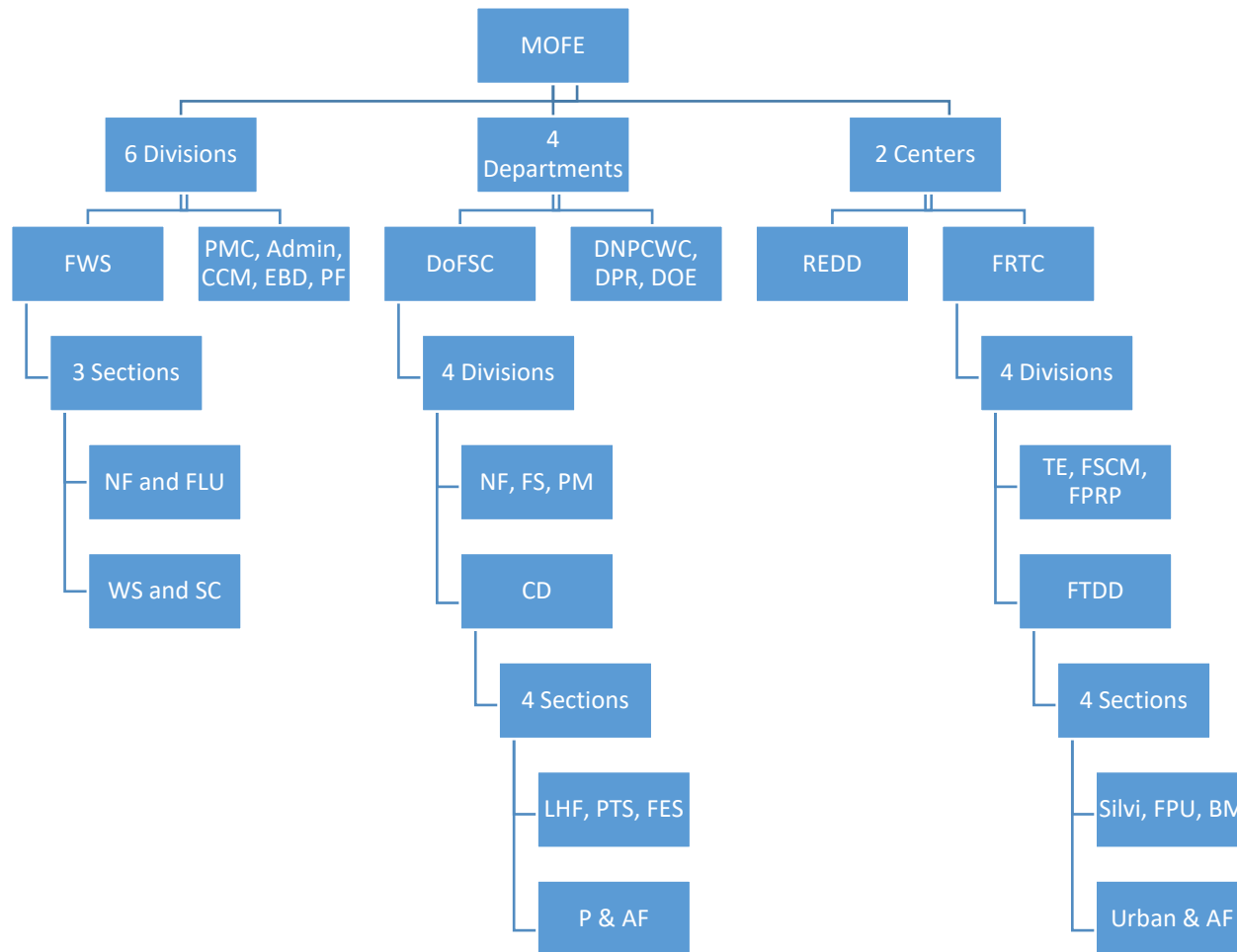|		
9. Bhanj (*Quercu sspp*) – cereal crops, lentils, vegetables	Cereal crops (maize, wheat, millet), lentils and vegetable grown on terraced bari under widely spaced naturally growing Quercus	Midhills in Farwestern Nepal
B. Agro-silvo-pastoral (crops, pasture/animals)		
10. Ritha (trees– cereal, lentils and vegetable	Cereal crops (maize, wheat, millet), lentils and vegetable grown on terraced bari under Naturally growing and widely spaced Ritta (*Sapindus mukorossi*) trees	Midhills in Farwestern Nepal
11. Chiuri – cereal, lentils and vegetable	Cereal crops (maize, wheat, millet), lentils and vegetable grown on terraced bari under Naturally growing and widely spaced Chiuri trees	Midhills in Farwestern Nepal
12. Utis-chilaune-fodder trees – maize	Maize as alley crop; naturally growing Utis (Alnus nepalensis), Chilaune (*Schima wallichii*) and fodder on terrace risers	Midhills in Eastern and Central Nepal
13. Utis-chilaune-fodder trees– tea	Tea as alley crop; naturally growing Utis (*Alnus nepalensis*), Chilaune (*Schima wallichii*) and fodder on terrace risers	Midhills in Eastern Nepal
14. Utis-chilaune-fodder trees – cardamom	Cardamom as alley crop; naturally growing Utis (*Alnus nepalensis*), Chilaune (*Schima wallichii*) and fodder on terrace risers	Midhills in Eastern Nepal
15. Utis-chilaune-fodder trees – amriso	Amriso (*Thysanola enalatifolia*) as alley crop; naturally growing Utis (*Alnus nepalensis*), Chilaune (*Schima wallichii*) and fodder on terrace risers	Midhills in Eastern and Central Nepal
16. Utis-chilaune-fodder trees – ginger	Amriso (*Thysanola enalatifolia*) as alley crop; naturally growing Utis (*Alnus nepalensis*), Chilaune (*Schima wallichii*) and fodder on terrace risers	Midhills in Eastern and Central Nepal
17. Multi-purpose trees on terrace risers – cereal crops – fodder grasses - animal (cut and carry)	Alley cropping of cereals on terraces, multipurpose trees and forage grasses on terrace risers, and cut-carry system for animals (goat, cow, buffalo)	Midhills Central Nepal
18. Multi-purpose trees – fodder grasses	Amriso (*Thysanola enalatifolia*) for grass and broom), fodder grasses and multipurpose trees in mix random plantings	Midhills Central Nepal

19. Fodder trees– banana – animal (goat – cut and carry)	Banana on terraces; fodder trees on terrace risers and goat (cut-and-carry system)	Midhills Central Nepal
20. Fodder trees– banana-ginger -animal (goat – cut and carry)	Banana and ginger on terraces; fodder trees on terrace risers and goat (cut-and-carry system)	Midhills Central Nepal
C. Silvopastoral (pasture/animals and trees)		
21. Fodder trees– ginger -animal (goat – cut and carry)	Ginger on terraces; fodder trees on terrace risers and goat (cut and carry system)	Midhills Central Nepal
22. Fodder trees– amriso - animal (goat – cut and carry)	Amriso (Thysanola enalatifolia) on terraces; fodder trees on terrace risers and goat (cut-and-carry system)	Midhills Central Nepal
23. Fosro(Grevia) trees - cereals (maize, rice, wheat, millet), lentil and vegetables), goat and cattle (cut and carry system)	Cereal crops (maize, wheat, millet), lentils and vegetable grown on terraced bari under naturally growing and widely spaced Forest trees; goat, cattle and buffalo in cut and carry system	Midhills Farwestern Nepal
24. Betel nut – goat grazing	Tethered goats grazing under mature Betel nuts (Areca catechu)	Tarai Eastern Nepal
25. Timber trees – bamboo- forage grasses	Tethered and free-range goats grazing under multi-story systems: Upper storey – timber trees-Haldu (*Adina cardifolia*), Bakaino (*Melia azedarach*), Gutel, (*Trewia nudiflora*), Siris (*Albizia*); middle story -bamboo; ground cover–forage grasses	Tarai Eastern Nepal
26. Fodder trees -fodder grasses- animals (goat)	Tethered and free-range goats grazing open grazing and cut and carry system	All Midhills
27. Trees – apiculture	Bees kept in homestead feeding on farm trees and community forest	Mid-hill Central Nepal
28. Small woodlots – grasses – animals (tethered and cut and-carry system)	Naturally grown fodder grasses under woodlots; animals are tethered and cut-and-carry system	Mid-hill Farwestern Nepal
D. Silvofishery (trees with fish on ponds or mangroves)		
29. Multi-purpose trees-fish, Central Nepal	Multipurpose (fodder and firewood) planted on border or dikes of fi sh ponds (mainly tilapia)	Midhill Central Nepal

30. Timber trees – banana on borders of banana of fish pond	Fishpond with multi-story system on dike and borders: Teak (*Tectona grandis*) and Sisau (*Dalbergia sisoo*)trees in upper storey, Banana in the middle storey and grasses as ground cover	TaraiFarwestern Nepal
E. Home garden		
31. Homestead – multistory system – cereal, vegetables, spices, and animals	A homestead with small compartment of multistory system: Upper stratum: betel nut with betel leaf, pepper species), coconut, Bakaino (MPTS) Mid stratum: banana, fruits (banana, guava, citrus), eskos, black pepper Lower stratum: grasses, vegetables (mustard, colocassia, corn, turmeric ginger)Animal shed for cow, goat or buffalo	Tarai Eastern Nepal
32. Multipurpose trees, fodder trees and fruit trees on terrace risers crops (maize, vegetables, and vines) on alleys-homestead (house and animal shed)	A homestead with intensive cultivation of cereal (maize, wheat, rice or millet), vegetables, spices on terraces or alleys, and multipurpose trees (timber, fruits, fodder, firewood) and grasses on terrace risers, and animals in cut-and-carry system	All Tarai and Midhills
33. Teak, Sisau - fruit trees-vegetables, homestead and animals (cut and carry system)	Homestead with teak, Sisau, fruit trees (mango, guava, papaya); vegetable patch and animals on cut-and carry system	Tarai Farwestern Nepal

Annex-3: Policy/legal Documents and Provisions

Policy/legal documents	Legal provisions
Constitution of Nepal, 2072	• Article 30 of the constitution has ensured right to clean environment and 30 (3) says no hindrance meant while maintaining balance between ecology and development process. • Annex 9 has provisioned that forest, wildlife, birds, water utilization, ecology and biodiversity fall under common rights of federal, provincial and local governments.
Local Government Operation Act, 2074	• Local governments have provisions to care, protect, manage and use of local natural resources including forests. • 10, 15, 18, 21 of Annex 9 in constitution of Nepal has implied importance to natural environment and agriculture.
National Forest Policy, 2019	• 6th Objective mentioned that making forest as means of income generation through planting fruits and developing agroforestry whereas 5th objective indirectly mentioned the conservation of forest resources and utilizing it in multiple ways which include intercropping of forest and agriculture crops. • In Policy 8.6, Policy emphasizes conservation of forests outside national forests where soft loans will be offered to promote agroforestry, urban forestry, family forests etc.
Forest Act, 1991	• In Article 31 D, "national forest can be handed for the conservation and development through operation of agroforestry."
National Land Use Policy	• Recognizes the pressure on lands and unmanaged lands due to internal migration to other commercial purpose.
National Agroforestry Policy, 2076	• Outlines policies, strategies, institution and its roles, responsibilities and authorities • Provisions Agro-forestry Inter-ministerial Coordination Committee to plan, implement, coordinate and, monitor and evaluate the programs
Forestry Sector Strategies (2016-2025)	• One of key interventions regarding private lands has been assumed to be agroforestry. • One of strategies focus is: Promote agroforestry and farm forestry in Tarai district and Inner Tarai.
Guidelines for Lending Leasehold Forest to Commercial Purpose, 2068	• One of the objectives is providing leasehold forest for biological diversity, agroforestry and NTFP enterprises

Nepal Biodiversity Strategies and Action Plan (2014-2020)	• One key management intervention could be agroforestry for conserving trees outside protected areas. It has also emphasized that if properly managed, the initiatives could substantially contribute to conservation of local biodiversity.
Agroforestry Implementation Guidelines, 2073 (Prime Minister Agriculture Modernization Project)	• Zone and super zone were declared and various programs are proposed. • To encourage and promote agroforestry program, improve livelihoods by focusing in fruit trees. • Responsible agencies identified to implement program i.e. Division Forest Offices and Soil Conservation Offices. Likewise, monitoring and coordination agencies were also identified.
Private Forestry Directive, 2068	• One of areas where forest technicians can provide technical assistance in private forestry is agroforestry, mentioned in Section 6 of the directives.

MOFE

- **6 Divisions**
  - **FWS**
    - **3 Sections**
      - NF and FLU
      - WS and SC
  - PMC, Admin, CCM, EBD, PF
- **4 Departments**
  - **DoFSC**
    - **4 Divisions**
      - NF, FS, PM
      - **CD**
        - **4 Sections**
          - LHF, PTS, FES
          - P & AF
  - DNPCWC, DPR, DOE
- **2 Centers**
  - **REDD**
  - **FRTC**
    - **4 Divisions**
      - TE, FSCM, FPRP
      - **FTDD**
        - **4 Sections**
          - Silvi, FPU, BM
          - Urban & AF

Annex-4: Flow chart of government institutions

MOFE: Ministry of Forests and Environment
PMC: Planning, Monitoring and Coordination Divisions
PF: Participatory Forest Division
CCM: Climate Change Management Division
EBD: Environment and Biodiversity Divisions
Admin: Administrative Division
FWS: Forest and Watershed Division
NF: National Forests
FLU: Forest and Land Use
WS and SC: Watershed & Soil Conservation
DoFSC: Department of Forests and Soil COnservation
NF: National Forests
FS: Forests Silviculture
PM: Planning & Monitoring
DNPWC: Department of National Parks and Wildlife Conservation
DPR: Department of Plant Resources
DOE: Department of Environment
REDD: REDD Implementation Center
FRTC: Forest Research and Training Center
TE: Training and Extension Division
FSCM: Forest Survey and Carbon Measurement
FPRP: Forest Research and Planning
FTDD: Forest Technology Development Division
Silvi: Silviculture Division
FPU: Forests Products Utilizations
BM: Biometry
CF: Community Forest Division
NF: National Forest Division
PMD: Planning and Monitoring Division
FSD: Forest Silviculture Division
P and AF: Private and Agroforestry
LHF: Leasehold Forestry
TI: Tree Improvement
PTS: Plantation Technology Section
FES: Forest Entrepreneur Section