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## Agroforestry Practices Prevailing in SAARC Countries: A Review

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### ABSTRACT

Agroforestry systems have been used from a long time ago. The traditional agroforestry concept and knowledge of integration of the trees in the farm have been passed from one generation to another, especially in the South Asian countries. The study is aimed at collecting information on agroforestry practices prevailing in SAARC countries. Information related to prevailing practices of agroforestry was collected from reviewing literature for each country differently. In Afghanistan, the Government has given the seedlings of trees to grow along with the agricultural land. Multistoried agroforestry system with integration of other plants in different spatial designs is mostly used in Bangladesh. Shifting cultivation is the traditional system, integration of crop production, grazing animals, and forest areas in Bhutan is practiced. Being the first and second country to formulate the Agroforestry policy, both India and Nepal respectively follows a traditional system along with some research-based agroforestry system. Pakistan mostly used the farm-based agroforestry system while in Maldives and Sri Lanka, Coconut based agroforestry system is used mostly. The communities of the SAARC countries have improved livelihood through the generation of the multi-product through the introduction of the new agroforestry systems. The different systems applied in the SAARC countries should be explored and the issues need to be resolved by the formulation of the policies, conduct research, extensions, and training related to the advancement of the Agroforestry. The knowledge and concept of the different agroforestry systems should be disseminated and other systems should be developed from the consultation with the farmers.

### INTRODUCTION

Agroforestry is a flexible, ecologically driven nature conservation approach that incorporates trees on fields and in cropping systems to broaden and maintain production for greater socio-economic, and ecological advantages for all land users (Alao & Shuaibu, 2013). Agro-forestry is gathering steam as a long-term solution that can assist socio-ecological systems to adapt to shifting weather patterns (Gurung and Temphel, 2015). Agroforestry is progressive, long-term food production and nature conservation system that is widely employed and approved in developing countries throughout South America, Central America, South Asia, and Southeast Asia (Dhyani et al., 2021). Despite global awareness and the existence of AFS, finding trustworthy and accurate information on the scope

of the condition in Southeast Asia remains a difficulty (Dhyani et al., 2021).

The South Asian Association for Regional Cooperation (SAARC) was founded in 1985 with seven countries Nepal, India, Bangladesh, Bhutan, Maldives, Sri Lanka, and Pakistan as founder members and Afghanistan joined later in 2007. The Cooperation was established to promote socio-economic, scientific, and technical development via ultimate self-reliance. The cradle of agroforestry is often referred to as the South and Southeast Asian region, owing to its long history of using a variety of systems under a variety of agroecological settings (Kumar et al., 2012). Historically, millions of smallholder farmers in South Asia have been supported by traditional agroforestry systems. Agroforestry has multiple benefits it is based on food security, source of

income and employment, raw materials for industries, medicinal herbs, plays a vital role in soil and watershed conservation, and helps to reduce global greenhouse emissions. Also, agroforestry practices through its multiple composition i.e. trees, crops, and livestock contribute to achieving global targets like SDGs, biodiversity targets, etc. South Asia is noted for its Agroforestry System and long tradition of adoption and implementation in a variety of agriculture-related ecological and climatic zones (Dhyani et al., 2021).

Agroforestry is seemed as a measure to improve people's livelihood, preventing soil erosion, refilling soils, storing carbon, and increasing productivity of both soil and agricultural crops. Agroforestry's role in climate change abatement is especially crucial in the current context, as countries are in hurries of reaching their targets for carbon emission and trading carbon through the reduction of emissions from deforestation and degradation (Gurung and Temphe, 2015). The overall goals of practicing agroforestry across all of the South Asian countries are to meet household firewood needs, animal feed, grazing requirements, and soil and water conservation by employing indigenous agroforestry tools and skills gained through their predecessors. Though the overall goal of practicing agroforestry is similar in SAARC countries, some of the agroforestry practices behaviors are fairly unique and intricate (Amatya et al., 2018).

In South Asian countries, farmers have been employing trees in their fields over decades ago. And the practices differ according to the suitability of different agro-ecological zones. SAARC Agriculture Centre, Bangladesh mentions the old practice of incorporating trees on the farms of the South Asian regions. In SAARC regions different consultation meetings were held in the past and present about agroforestry example meeting was conducted on Central Agroforestry Research Institute (CARFI) campus in close collaboration with SAARC Forestry Centre, SAARC Agriculture Centre, Central Agroforestry Research Institute (CARFI), ICAR, in 2015 in India. The meeting in 2015 discussed and identified the issues and challenges of agroforestry and identified the ways forwards about the challenges. Still, agroforestry has not been covered in the policies of many countries of the SAARC region. Farmers in the

region are still unaware about the benefits of agroforestry and there is a paucity of agroforestry extension professionals, poor communication of research, weak agroforestry agencies, the concept of taking it as a part of either agriculture or forestry, no separate identity to the agroforestry farmers, no separate market facility, lack of a network of agroforestry practicing societies are some common issues of the agroforestry in SAARC regions. And for the betterment of implementation of agroforestry in SAARC formulation of separate agroforestry policy, implementation agency, modern and technology-based research, development of models, facilitation of extensions, and training among farmers is a must (Gurung and Temphe, 2015).

Woody trees like *Populus*, *Eucalyptus* spp in combination with agricultural crops and vegetables, coffee and tea under trees like *Alnus*, *Albizia*, and coconut-based agroforestry, cardamom plantation under shade, Taungya plantation, home gardens are some of the major prevailing practices of agroforestry in SAARC region (Kumar, 1999; Kumar, 2005; Nath et al., 2011). One of the most common practices among SAARC countries is multilayered, multifunctional home gardens which enhance food supply, hardwood structures promote rural industrialization and employment; integrated tree-crop integration systems promote resource efficiency and forest ecosystems stabilize agrobiodiversity and reduce global warming. Other fast-growing species, such as *Eucalyptus* spp., *Leucaena leucocephala*, *Casuarina equisetifolia*, *Acacia mangium*, *A. auriculiformis*, *Ailanthus triphysa*, and *Melia dubia*, are getting prominence among farmers in various regions of the Indian subcontinent (Kumar et al., 2012). At present, with the formulation of separate agroforestry policies in countries like India and Nepal the whole region is progressing in the field of agroforestry (Guillermé et al., 2011).

South Asian communities rely on tropical home gardens for 70–84 percent of their commercial wood needs (Kumar and Nair, 2004). Local communities in India, Nepal, Bhutan, Bangladesh, Maldives, and Sri Lanka grow fuelwood, forage, and fruits on field bunds to meet energy and food demands, and these activities are key livelihood possibilities for the area's small farmers. Local farmers in Pakistan, on the other hand, are cautious to plant trees on farmland bunds

in order to minimize tree-crop rivalry. As a result, natural forests or wasteland vegetation provide the majority of their fuelwood and feed requirements (Dhyani et al., 2021). Agroforestry would be more successful if the economic worth of tree species, shrubs, and herbs, as well as their Silvicultural traits and local appropriateness, were recognized and managed appropriately (Amatya et al., 2020). The goal of this article was to look into different forms of agroforestry systems practiced in SAARC countries. The study aims to understand the differences in practices of integration of agriculture crops, trees, and animals in different countries. SAARC countries are located in similar climatic conditions so, information on agroforestry practices from one country could be lessons for other countries. This paper could be useful for farmers as well as foresters of all eight countries of the South Asian region. Also, policymakers, students, farmers, and researchers could get benefit from experimenting with different technologies and models from other countries.

## **MATERIALS AND METHODS**

The study was conducted covering eight SAARC countries which comprise 3% of the global area and 21% of the global population. SAARC countries cover about 4.21% of the global economy and are rich in forest resources that countries like India contain 18% forest area, Nepal (44.74%), Bangladesh (11%), etc. SAARC countries are rich in natural resources and the same resources are the major source of economy of the region. So, the Cooperation countries formulated the SAARC regional coordinated program on Agroforestry in 2016. Agroforestry is highly developed in the region as India and Nepal are the first and second countries in the world to formulate National agroforestry policies. Home gardens and cropland bunds are major agroforestry practices applied in South Asian countries like Nepal, India, and Srilanka. Agroforestry practices were widely practiced in India, Nepal, and Pakistan but in Afghanistan, and Maldives agroforestry was less focused.

The study involves an extensive literature review searching the traditional and new systems and practices of agroforestry in each of the SAARC countries in the online portal like Research gate, Academia, Springer, Scopus based on methods used

by other researchers (Hayat et al., 2020; Kumar, 2015; Amatya et al., 2018). We used Google Scholar, Springer, Scopus, and Academia for reviewing the papers (eg: Tejwani and Lai, 1992; Khan et al., 2017; Ahmed & Hazarik, 2007; Sahoo, 2007; Sood et al., 2007, etc.). And some of the information was collected from books (Kumar, 2015), and government documents (CBS, 2008; FRTC; 2019, etc.). Likewise, some information was collected from different agencies' documents like FAO, IFAD, World Bank, etc. The data were clustered for each country separately and were filtered based on category clustering. And then screening was done based on analyzing the abstract and then the full paper was viewed and literature was selected. Also, information was collected by using different keywords like Agroforestry, Home gardens, Multipurpose trees, Agrisilviculture, Shifting cultivation, Taungya, etc.

The study focused on the agroforestry system practiced in different countries of South Asian regions. The findings of the papers mainly focused on types of agroforestry practices applied in different parts of the countries of the regions. And plant species, vegetables, animals, and other components of the agroforestry practiced in each agroforestry system are also explained in the paper. The study highlights the major agroforestry practices applied in SAARC countries and their socio-economic and environmental advantages in each country.

## **RESULTS AND DISCUSSION**

Triangulation of agricultural crops, forestry species, and livestock in the same location in general terms is considered Agroforestry. Practices and systems of agroforestry are somewhat similar among the SAARC countries and little different respective of the needs of the people, the physical structure of the land, and weather conditions of the countries. Historically, millions of smallholder farmers in South Asia have been supported by traditional agroforestry systems (Dhyani et al., 2021). Carbon sequestration, biodiversity conservation, soil enrichment, and the maintenance of clean air and water quality are all ecological benefits of agroforestry systems (Atreya et al., 2021) as well as food security and economic upliftment is the primary goal.

### **Afghanistan**

Agroforestry in Afghanistan is in a growing phase. Agroforestry policies and laws are still not formulated in Afghanistan. Also, agroforestry research and techniques are in starting phase in the country. The Forest Directorate conducted some programs under Agroforestry to reduce heavy pressure on natural forests. It has started to distribute the seedlings of Pistachio (*Pistacia vera*), Pine (*Pinus* spp), and Badam Kohi (*Amygdalis communis*) in 17 provinces since 2013. These seedlings are planted next to the agricultural crops on their agricultural land. In the country, agrisilviculture and agrosilvopastoral systems were mainly practiced. In agrosilvopastoral system vegetables, and poplar trees are combined with animals and grasses (Hossinni, 2015). From these sources, it is confirmed that Afghanistan is being developed in the agroforestry sector.

### **Bangladesh**

In Bangladesh, Homestead agroforestry is an important source of economy and is the most practiced agroforestry system. Mainly woody species grown around the home are a good source of fuelwood, fodder, and building materials (Leuschne and Khaleque, 1987; Amatya et al., 2018). Likewise, Cropland Agroforestry is one of the traditional land-use systems used in Bangladesh. In cropland agroforestry practice tree species like Phoenix dactylifera (Date palm), Acacia nilotica (Babul), Mangifera indica (Mango), Dalbergia sissoo (Sissoo), etc. are planted on the borders of the crop field like rice (*Oryza sativa*), wheat (*Triticum aestivum*), pulse, jute (*Corchorus* spp), oilseed, sugarcane (*Saccharum officinarum*). There is also the practice of cultivating vegetables and shade-tolerant crops like Turmeric, Ginger under trees with high canopy coverage like Jackfruit, Mahogany (Miah et al., 2002). Also, Coconut based, Mango based, Sissoo based multistory agroforestry, trees with medicinal plants, alley cropping, bench-terracing, sloping land technology (SALT), strip plantings are some common agroforestry practices used in Bangladesh (Khan and Alam, 2015). In the majority, the market-based agroforestry system is prevalent in Bangladesh as per this literature due to which basic needs of the people are fulfilled along with their economic upliftment.

### **Bhutan**

In Bhutan, Shifting cultivation was a widely practiced traditional agroforestry system covering about 200,000 ha (Roder et al., 1992). In modern concepts, agroforestry is classified as farm-based and forest-based. Agrisilvicultural systems, Silvihorticultural systems, Agro-silvopastoral systems, aqua-forestry with *Moringa oleifera*, and *Leucaena leucocephala* in the border of ponds, homestead agroforestry are commonly practiced farm-based agroforestry system in Bhutan (Amatya et al., 2018). Likewise, the Silvopastoral system, Non-timber cultivation under forests, is quite common forest-based agroforestry practice. Also, practices like cardamom under the shade of trees like *Schima wallichii*, *Engelhardtia acerifolia*, *Ficus nemoralis*, *Alnus nepalensis*, etc. (Tomar and Bhatt, 2005) are practiced in the Himalayan region of Bhutan. Different agroforestry technologies, models, and practices like silvopastoral technologies are developed by a research center in Bhutan (Dhital, 2015). Non-Timber-based agroforestry has good opportunities in Bhutan especially Himalayan spices-based agroforestry can bring a good deal of market there.

### **India**

Agroforestry is well developed and advanced in India as compared to other SAARC countries. India had already developed a national agroforestry policy in 2014 which makes India the first country to formulate a separate policy and program for agroforestry. Also, different advanced technologies and market-oriented agroforestry research programs have been formed. The Indian government launched this policy to address bottlenecks that have arisen at the intersection of existing policies for agriculture, forestry, water, and the environment, realizing that land use by its very nature requires integration (Singh et al., 2016). And after the formulation and implementation of the policy, there was an increase in forest cover of about 2% (1.8% increase outside the forest) (CGIAR, 2020). Agroforestry practices in India are categorized as farm-based and forest-based according to the agro-ecological zones of the country (Amatya et al., 2018). In India, major agroforestry practices include traditional Jhum cultivation, live hedges, home gardens, shelterbelts, and reclamation plantations. Different agroforestry practices are applied in different states like in Tripura rubber plantation, sugarcane cultivation, a

multi-cropping system with pineapple, banana, fodder trees, vegetables, windbreaks, shelterbelts (Deb et al., 2014), in most of the states like Mizoram, Assam, Meghalaya, Arunchal large practice of shifting cultivation (Ahmed and Hazarik, 2007; Sahoo, 2007; Sood et al., 2007), in Punjab and Hariyana poplar-based agroforestry is popular to meet the industrial raw materials of match stick (Jain and Singh, 2000), in Kerala, West Bengal and Uttar Pradesh Taungya cultivation system were highly practiced and to a limited extent in Tamil Nadu, Andhra Pradesh, Orissa, Karnataka, as well as in the Northeast hill regions. Likewise, home gardens, tea plantations, woodlots (Basu, 2014), bamboo, palms, and rattans-based boundary plantations, Cardamom based agri-silviculture are widely practiced. Different advanced technologies and models are developed in the field of agroforestry in India for the suitable climatic region (Handa and Newaj, 2015). Being diverse in its people and structure, India is rich in cultures and their way of practicing the systems of production. India is developing the modern system for practicing agroforestry with the certain aims to fulfill the basic needs as well as to generate an economy for the people.

#### **Pakistan**

Agroforestry in Pakistan includes fast-growing trees in combination with agricultural crops with multiple benefits like high financial earnings, foods, raw materials, and least destructive outcomes to the agriculture crops (Zubair and Garforth, 2006). Agrisilviculture, windbreak, and shelterbelt, with species like Populus, Morus, and Salix are practiced in areas with water loggings and aridity (Foroughbakhch et al., 2009). A study on District Dir Lower, Pakistan found various Agroforestry practices like Agrosilvopastoral system (45.5%), Agrisilvi system (50.5%), and Agro-pastoral system (4%) and from the practices, the majority of farmers got returns from timber trees about 20,000-40,000, Pakistani currency (Hayat et al., 2020). Agroforestry practices highly fulfill the demand for fuelwood in Pakistan of 22.15 million m<sup>3</sup> total fuelwood demand of about 19.94 million m<sup>3</sup> of fuelwood comes from trees outside the forest (Zaman and Ahmad, 2011). And major tree species cultivated in farmlands include Morus alba, Populus nigra, Platanus orientalis, Ficus carica, Juglans regia, Broussonetia papyrifera, Salix tetrasperma,

Acacia modesta. Also, the purpose of planting trees in the boundary of fields in the country is to gain income through selling fruits like Juglans regia, Citrus species, and Prunus domestica (Hayat et al., 2020). In arid areas like Thal tree species like Eucalyptus camaldulensis and Tamarix aphylla with wheat, chickpeas were mostly preferred by farmers to protect the nearby crops from wind stress and dust storms (Khan et al., 2017). In Pakistan, some common forms of agroforestry are home garden, Taungya, fodder banks, hedgerow plantation, Acacia nilotica with Bombax ceiba, Poplar in Pesewar, fruit plantation in Swat valley, Block of Ipilpil, etc. In Pakistan, agroforestry practices are taken as a sink of the global carbon (Qamar, 2015). Having most of Pakistan in arid zones, it should develop the modern techniques to conduct modern systems of agroforestry for getting better results such that the places could be properly utilized as well as fulfill the needs of the people.

#### **Maldives**

The Maldives is a coastal country so it's one of the important species is coconut which plays a vital role in the economy of the country. Growing fuelwood, fodder, and fruit trees on bunds of crop fields are one of the common practice (Dhyani et al., 2021). In the country agroforestry practices are combined with coconut which includes coconut plantation combination with annual crops like Cassava, vegetables, coconut in combination with fruit trees like Mango, Custard apple, home-based coconut gardens, etc. Likewise, windbreaks, pastoral combination with coconut, etc are widely practiced. Previously, in Maldives coconut monoculture was practiced but with the advancement of technology and models in agroforestry coconut-based agroforestry is implemented to get multiple benefits from single lands (Moosa and Shimla, 2015). Being a coastal country, it has a huge opportunity to be more benefitted through tourism and that coconut-based agroforestry with the spices can be a good option there.

#### **Nepal**

It is a traditional Nepalese practice to plant trees, agricultural crops, and cattle within the same particular land. Agroforestry practices vary in Nepal, with traditional agroforestry systems being used primarily in the terai and mid-hills. In terai, mainly modern and commercial agroforestry is

practiced. Trees producing timber like Eucalyptus, Teak, and Poplar, Sissoo is highly preferred. Likewise, fruit and fodder and some agri-based commercial practices such as tea, coffee, and cardamom are practiced in mid-hills and mainly livestock rearing in pastoral is practiced in high mountain regions (FRTC, 2019). The study conducted in 44 districts of Terai and mid-hills identified 12 agroforestry systems and 41 agroforestry practices that were practiced in Nepal (Amatya et al., 2018). Home gardens, agri-silviculture, silvi-pastoral system, agro-Silvo-pastoral system, alley cropping, horti-silviculture system, and aquasilviculture are all common agroforestry approaches in Nepal. Many upland sections of the country still practice shifting agriculture, although it is on the declining trend (Amatya et al., 2018).

In Bara District and some parts of the Terai region, Taungya was practiced since 1972. Also, shelterbelts and river bank plantations are some common practices in the Terai region. In Nepal, various programs are being implemented to promote agroforestry, such as the Leasehold Forestry and Livestock Program, model agroforestry program in all seven provinces, fruit and fodder seedlings distribution have assisted farmers in promoting home gardens, agri-silviculture, agri-silvihorticulture in their lands. Also, agroforestry practices like alley cropping and SALT technology are piloted in mid-hills districts of the country (Joshi, 2015). Some studies (Tejwani and Lai, 1992; Gilmour et al., 2014; Amatya et al., 2018) have classified agroforestry as farm-based and forest-based. Home gardens, trees on or around agricultural fields, wood lots and commercial crops under shade trees, and intercropping of agricultural crops and commercial trees are all examples of forest-based practices, as are specific agricultural practices associated with forests where farmers collect food, fruits, and gums. Similarly, the Nepalese government is now using leasehold forestry or public land agroforestry to improve agroforestry implementation (CBS, 2008).

Likewise, Tea (*Camellia sinensis*) under Siris (*Albizia spp.*), Uttis (*Alnusnepalensis*); Cardamom (*Elettaria cardamom*) under Uttis (*Alnus spp.*), Khair (*Acacia catechu*); vegetables intercropping trees, woodlots, apiculture, sericulture etc. are major practices in the country (Amatya et al., 2018).

Despite being a small country, Nepal is practicing many kinds of agroforestry that differ within even the small area. People are adopting a modern system of agroforestry and much more research academic as well as institutional are being conducted. Nepal should extend its research further in a productive manner mixing the traditional knowledge with the modern one such that traditional knowledge could also be saved as well as more production would be gained.

In Nepal, agroforestry practices were indirectly supported by laws in past by the Master Plan for the Forestry Sector (1989), Agriculture perspective plan 1995 whereas different policy documents like the fifteenth five-year plan, government's budget framework, Agriculture Development Strategy (2015-2035), Forestry sector strategy (2015-2025), Agriculture Policy (2004), Forest Policy (2019), Forest act 2019 have directly included agroforestry as their important provisions. Likewise, recently in 2019 Nepal government formulated the National Agroforestry Policy (2019) recognizing agroforestry as a contributor to obtaining national prosperity (Atreya et al., 2021). The policy was formulated through a series of workshops and discussions with farmers, policymakers, donors, forestry and agriculture departments, and CGIAR Research Program on Forests, Trees, and Agroforestry (FTA) – through its partner World Agroforestry (ICRAF) - played a key role in the policy development (CGIAR, 2020). Nepal should adopt these policies and implement them effectively for a better result to fulfill the aim of making the country happy and prosperous.

### Srilanka

Srilanka is a coastal country and it consists of coconut-based agroforestry in which coconut is intercropped with Palms, Capsicum with Gliricidia, coconut mixed with cocoa, and coffee (Nelliat et al., 1974). One of the important practices in Srilanka is interculture of agriculture crops with perennial trees in the same area of land which includes the combination of tea with *Albezia chinensis*, rubber with *Desmodium ovalifolium*, coconut, spices, alley crops between leguminous trees, fish and bee culture is practiced in combination with trees (Newman, 1985). Cattle grazing under pasture grown under coconut, *Moringa oleifera* plantation in hedges around homesteads, growing *Sesbania grandiflorias* around the home are some common

practices in some parts of the country (Liyanage et al., 1984; Singh, 1987). Likewise, most parts of drier northern and eastern plains are under shifting cultivation called Chena. In Srilanka, two types of home gardens are practiced i.e. traditional and modern home gardens. Traditional home gardens consist of Jack fruit as a major component whereas modern home garden consists of cash-generating species that yields spices, beverages, and sap (Amatya et al., 2018). Other forms of agroforestry practices include Taungya, forest gardens, tea under the shade of trees, windbreak, and shelter belts (Tejwani, 1984). Alley cropping-based seasonal croplands have emerged in the Dry zone which is still in the early stages of development (Gurung and Temphel, 2015). Clove (*Eugenia carophyllata*) and Nutmeg (*Myristica fragrans*) combined with grasses are practiced which became the source of fodder, mulch, green manure, food, and income (Kendaragama and Kumarasinghe, 2015). Srilanka can grab the benefit of being a coastal country to integrate the coconut along with the other coastal tree species with herbs and spices in a modern way. Having a poor economy the country can somewhat fulfill the economic needs of the country. It needs proper planning to invest in the agroforestry sector.

## CONCLUSION

The agroforestry concept and practices are somewhat similar in the SAARC countries. The prevailing agroforestry system of SAARC countries is home garden, silvopasture, taungya, agrihorticulture, agrisilviculture, alley cropping, silvofishery, hedgerow tree planting or live fencing, commercial crop under the shadow of planted trees. Mainly shifting cultivation, taungya, agrisilviculture, poplar based agroforestry are practiced in India, Coconut based coastal agroforestry system are practiced in Maldives, Srilanka, Shifting cultivation, cardamom under shade, Home garden are common practices in Nepal, Bhutan, and Pakistan. Likewise, Homestead agroforestry and cropland agroforestry are common in Bangladesh and general practices of agrisilviculture are common in Afghanistan. Agroforestry practices are technologically advanced in India whereas agroforestry practices are very weak in Afghanistan. Agroforestry in the SAARC countries has been found to ensure livelihood security by providing fuelwood, timber, and construction material generating cash for various

purposes, controlling soil erosion, and also acting as insurance against risks of the crop. Agroforestry has been also considered the means of carbon sequestration and has been used as a key priority in climate change-related policies. Policies related to Agroforestry have been made in India and Nepal and are in the process of making policies in the other countries. The traditional practices of Agroforestry in the countries should be documented and the issues related to agroforestry should be identified.

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