Policy brief
on
Development and Management of Bamboo and Rattan species in Nepal

Forest Research and Training Centre

Babarmahal, Kathmandu

June, 2019

The views and opinions expressed in this reports are those of the contributor (s) and do not necessarily reflect the views or policies of FRTC

Contributors: (Green Governance Pvt. Ltd.)

Reviewer: Dr. Deepak K Kharal, Yam Prasad Pokharel, Dhirendra K. Pradhan, Sabitri Aryal, Bimal K Acharya, Milan Dhungana,Manju Ghimire, Bishnu Prasad Dhakal and Kiran K Pokharel

Required citation: FRTC, 2020, Policy brief on Development and Management of Bamboo and Rattan species in Nepal,Forest Research and Training Centre (FRTC), Babarmahal, Kathmandu, Nepal.

Publisher:
Forest Research and Training Centre, Babarmahal, Kathmandu, Nepal
P.O. Box: 3339, Tel: 977 1 5320482,
Email: info@frtc.gov.np
Web: www.frtc.gov.np

Forewords

Bamboos, the perennial fast growing woody grasses, are renewable an important non-timber forest product (NTFP) in Nepal. Bamboos are found both in natural forests and on farmlands whereas rattans are mostly found in natural forests. Rattan has been decreased due to population pressure, severe habitat destruction and unmanaged harvesting and it is now found in a very limited scale

Environmental aspects of bamboo, bamboos in farming systems, women in bamboo craft-making sustainable development goals (SDGs) and bamboo and rattan, bamboo and rattan in reducing the effects of climate change, bamboo and wildlife, potentiality of development of bamboo and rattan sub-sector, economic perspective of bamboos in Nepal. So, this policy brief will be milestone to know about Development and Management of Bamboo and Rattan species in Nepal, and guide to policy maker, forester and related line agency to develop and manage bamboo and rattan species in Nepal.

I would like to thank Green Governanace 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 and development of bamboo and rattan.

Yam Prasad Pokharel
Director General
Forest Research and Training Centre

Table of Contents

Summary

Bamboos, the perennial fast growing woody grasses, are renewable an important non-timber forest product (NTFP) in Nepal.. Bamboos are found both in natural forests and on farmlands whereas rattans are mostly found in natural forests. Rattan has been decreased due to population pressure, severe habitat destruction and unmanaged harvesting and it is now found in a very limited scale. Twenty-three genera and 81 bamboo species/varieties have been recorded in Nepal, in which ten genera and more than forty species are native. Two genera and ten rattan species have been reported in Nepal, but only seven rattan species have been recorded during the survey.

The 21-year Master Plan for the Forestry Sector (MPFS) (1989) had identified bamboo and rattan as major non-timber forest products (NTFP). The Herbs and NTFP Development Policy (2004), the National Forest Policy (2019), Forest Sector Strategy (2016-2025), Industrial Policy (2011), Trade Policy (2015), Forest Act (1993), Forest Regulation (1995), National Park and Wildlife Conservation Act (1973) and the government plans have given space directly or indirectly in development and promotion of NTFPs.

During the early 1980's, then Forest Survey and Research Office (FSRO) had started taxonomic study and research on bamboo propagation and then Department of Forest Research and survey (DFRS) followed the biological research on bamboo and rattan. Various national and international organisations (government, non-government), projects and institutes have been involved partly or fully in development of bamboo and rattan sub-sector in different countries.

Environmental aspects of bamboo, bamboos in farming systems, women in bamboo craft-making sustainable development goals (SDGs) and bamboo and rattan, bamboo and rattan in reducing the effects of climate change, bamboo and wildlife, potentiality of development of bamboo and rattan sub-sector, economic perspective of bamboos in Nepal, problems and constraints for development of bamboo and rattan sub-sector and policy implications are covered and briefly explained. The policy recommendations on bamboo and rattan development and management are based on the review of the past research and development works in Nepal.

Introduction

Bamboos, the perennial fast growing woody grasses, are renewable an important non-timber forest product in Nepal. They have intimately been associated with human being for a long time. They form an important part of the rural farming systems, as they play vital role in boosting up the rural economy and help sustain livelihoods of many rural people including socially and economically disadvantaged groups. It is difficult to imagine the rural economy without them (Das and Oli, 2001; Das, 2002a and 2002b). Bamboos are one of the most widely used products nowadays, already in everyday use by about 2.5 billion people in the world (Scurlock *et al.*, 2000). Bamboo has over 10,000 recorded uses - including construction, energy, pulp, textiles, furniture, crafts providing income to millions of people across the tropics and sub-tropics (INBAR, 2016).In Nepal, there are more than 300 uses of bamboos (Poudyal, 1992) and 37 product types (MDBRPP/DFRS, 2010)

Rattan is among the world's most traded NTFPs, with world markets that offer big potential to attract increased production from rural communities (INBAR, 2016).Rattan resources are depleting at an alarming rate and almost all rattan species are in great threat in Nepal. It is mainly due to population pressure, severe habitat destruction and unmanaged harvesting. At present, rattan is found in a very limited scale in the country; however, they are not of too good quality. The diverse ecological conditions may allow the introduction of good quality rattan to meet its growing demands. Only *Calamus tenuis* is found abundantly in community forests in Bardiya and Kailali districts, but they are heavily exploited in the eastern and central parts of Nepal.

Bamboo and rattan species

The family Poaceae and sub-family Bambusoideae consist of both woody and herbaceous bamboos with altogether 1575 identified species in 111 genera (Bamboo Import Europe) with 1,521 woody bamboos in the world (Vorontsova *et al*., 2016). China has the largest number of bamboo genera and species. China has 39 genera with around 500 bamboo species, which is followed by 19 genera with 136 bamboo species in India and 13 genera with 230 bamboo species in Japan (Maoyi, 1998).

The most widely distributed bamboo species belong to genera *Bambusa* and *Dendrocalamus* (locally called bans) in Nepal (Das, 1988). Bamboos are growing from Terai (flat plains) to the High Mountains (4000 m) and found both in natural forests and private farmlands (Das, 1988). Bamboos growing in natural forests are mostly in degraded condition due to over-exploitation (Das, 2003). Large diameter bamboos are found from Terai to Mid-hills below 2200 m whereas small diameter bamboos (*nigalo*) are mostly found in forests, generally in Mid-hills and High Mountains between 1200-4000 m, but more common in 2000-3000m. Similarly, another type of small diameter bamboo (*malingo*) is found in high altitudes usually in a range of altitude 2200-3100 m in Nepal and they have leptomorph rhizomes. Churia hills (Siwalik) are rich in solid and shoot producing bamboos, e.g. *Dendrocalamus strictus*.Occurrence of bamboo is more common in the eastern half of the country from Dhaulagiri to Sikkim Boarder (Stapleton, 1994).

Three types of bamboo available in Nepal are sympodial/pachymorph/clumper (e.g. *Bambusa bambos*), amphipodial or intermediate (e.g., *Arundinaria racemosa*, *Melocanna baccifera*) and monopodial/leptomorph/runner (e.g., *Phyllostachys nigra*).Twenty-three genera and 81 bamboo species/varieties have been recorded in Nepal (Poudyal, 2006), in which ten genera and more than forty species are native. The bamboo species of eleven exotic genera are planted in a very small scale and in scattered form in the hotels, compounds and home gardens for beautification. The ten native bamboo genera are Ampelocalamus, Arundinaria, Bambusa, Borinda, Cephalostachyum, Dendrocalamus, Drepanostachyum, Himalayacalamus, Thamnocalamus, and Yushania. The exotic bamboo species in two genera (Melocanna and Phyllostachys) are planted in a small scale in different parts of the country.

The family Arecaceae and sub-family Calamoideae consist of 14 genera and over 600 rattan species in the world (Dransfield, 1981), a great diversity of which is distributed in Southeast Asia.The genus *Calamus* is regarded as the most widespread genus with about 400 species. Two genera and ten rattan species have been reported in Nepal but only seven rattan species have been recorded during the survey (Table 1). The unrecorded species might have been extinct from Nepal due to heavy exploitation.

Rattans are found in natural forests in association with the evergreen, semi-evergreen and mixed Terai hardwood forests. It has been locally used for various domestic purposes but for making baskets and furniture in large scale. Lack of conservation initiatives, improper management and unscientific

harvesting has resulted into degeneration of rattan forests (Paudel and Chowdhary, 2005). There are some Community Forest User Groups (CFUGs) in Far-western and Mid-western Nepal who have taken significant step towards conservation and management of naturally occurring rattans such as *C. tenuis* in their local community forests. One most successful example is Sati Kailai CFUG in Kailali district and others are Shiva and Saraswati CFUGs in Bardiya district.

Table 1: Rattan species recorded in Nepal

SN	Latin name	Vernacular name	Sources
1	*Calamus acanthospathus*	Gauri bet	Brandis, 1906; INBAR, 1996;Poudyal, 1985; Hara *et al*., 1978
2	*C. leptospadix*	Dangre bet	Poudyal, 1985; Hara *et al*., 1978
3	*C. latifolius*	Phekre bet	INBAR, 1996;Poudyal, 1985; Hara *et al*., 1978
4	*C. inermis*	Putali bet	Brandis, 1906
5	*C. tenuis*	Pani bet	Brandis, 1906
6	*C. erectus*	Tokri bet	Brandis, 1906
7	*Plectocomia himalyansis*	Himali bet	Brandis, 1906; INBAR, 1996
8	*C. gracilis**		Brandis, 1906
9	*C. khasianus**		Brandis, 1906
10	*C. rotang**		Brandis, 1874

Source: Paudel and Chowdhary 2005; * not recorded

Policies and legal provisions in bamboo and rattan sub-sector

The bamboo and rattan sub-sector policy of Nepal starts with the Master Plan for the Forestry Sector(MPFS) (HMGN, 1989). The 21-year MPFS (1989) identified bamboo and rattan as major non-timber forest products (NTFP) and their promotion through research and development. The Herbs and NTFP Development Policy (2004) has stated bamboo and rattan in the NTFP category and spells out its development through inventory, processing and technological development, however, its implementation is very weak. The conservation, cultivation expansion, collection, processing, certification, commercialization and export promotion of NTFPs are stated in the national forest policy (2019). Expansion of NTFPs/MAPs both inside and outside forest areas, the role of private sub-sector to encourage investment in cultivating forestry crops including trees and NTFP/MAP are stated as outcomes in forest sector strategy (2016-2025). In industrial policy (2011), out of 23 industries based on agriculture and forest products, nursery enterprise, establishment and management of cooperative/leasehold/community/private forests and rattan, bamboo farming and products from rattan and bamboo are related to promotion of bamboo and rattan sub-sector. In trade policy (2015), out of exportable possible 26 goods and seven services, handicraft products are included which covers bamboo products also. The Forest Act 1993, Forest Regulation 1995 and their amendments have provisions of management, control, utilization, and sale of community forest resources including NTFPs. The National Park and Wildlife Conservation Act,1973 is mainly for protection and management of fauna and flora including bamboos and rattans found in national parks and wildlife reserves. Since government ninth plan (1997-2002), The periodic government plans since ninth plan (1997-2002) have given emphasis to poverty reduction programmes and promotion of NTFPs including bamboo through managing NTFPs within the framework of community forestry for generating income and employment at the local level.

Research and development in bamboo and rattan sub-sector

During the early 1980's, then Forest Survey and Research Office (FSRO) had initiated taxonomic study followed by research on bamboo propagation. The then Department of Forestry and Plant Research /Forest Research and Survey Centre (FORESC)/Department of Forest Research and survey (DFRS) carried out establishment and management trials of various bamboo species in different parts of the country and continued studies on vegetative propagation. After 2000, rattan research has been initiated by then DFRS using indigenous and exotic species; however rattan research is still in low priority in government programme. Some projects involved in bamboo research were Pakhribas Agriculture Centre (PAC), Lumle Agriculture Centre (LAC), Tinau Watershed Project (TWP), Nepal/UK Forestry Research Project, and Eastern Region Roads Maintenance Project.

The types of bamboo research in Nepal are as follows:

- Taxonomic study
- Propagation and establishment trial using single node culm cuttings
- Bamboo seed production, collection and storage studies
- Study of bamboo shoot borers
- Bamboo survey
- Bamboo growth plot
- Demonstration of bamboo plantations
- Management of bamboo clumps
- Slope stabilisation
- Biomass studies and development of models
- Growth and production trial
- Bambusetum
- Socio-economic studies
- Development of tissue culture techniques
- Utilisation and marketing practices
- Review and documentation of traditional designs of bamboo and rattan products

The types of rattan research in Nepal are as follows:

- Ecological survey of rattan
- Nursery techniques
- Establishment and growth trial

The species used in the bamboo research are *Bambusa nutans* subsp. *cupulata*, *B. nutans* subsp. *nutans*, *B. nepalensis*, *B. balcooa*, *B. tulda*, *Dendrocalamus hamiltonii* var. *hamiltonii* and *undulatus*, *D. giganteus*, *D. hookerii*, *D. strictus*, *D. patelleris*, *Drepanostachyum intermedium*, and *Arundinaria* sp., *Oxytenanthera* sp. The species used in rattan research are *Calamus tenuis*, *Calamus* sp. (moto bet), and *Calamusviminalis* (kerak bet)

Involvement of international and national Institutions (government and non-government)/projects in bamboo and rattan sub-sector

Each bamboo and rattan growing country has its own mission for their development in their respective countries. Such mission/ programmes exist in Asian, African and Latin American Countries. The bamboo

and rattan sub-sector has been developed and promoted by mostly forest and agriculture related ministries in different countries. Despite the government sector, NGOs (both national and international) and Institutes have been involved in bamboo and rattan sub-sector in different countries in the world. International Network for Bamboo and Rattan (INBAR) is the premier institution for the development of bamboo and rattan resources in the world. A number of countries such as India and Kenya have followed bamboo and rattan policy and strategies in development and promotion of this sub-sector, however, policy along with strategy in this sub-sector is lacking in Nepal and the programmes related to this sub-sector are made and implemented on their own ways.

Up to now, 26 types of bamboo and rattan products with individual Harmonized System (HS) codes are classified and recorded by Customs when they are traded between countries. Of these products, China has exported 15 types of bamboo and rattan products in 2017 which are bamboo tableware, bamboo sticks, bamboo board, bamboo shoots, woven bamboo products, bamboo furniture, bamboo poles, woven rattan products, bamboo flooring, bamboo fibre, bamboo charcoal, bamboo pulp/paper articles, rattan furniture, rattan plaits and Bamboo carvings (INBAR, 2017). The trade of bamboo and rattan products from Nepal is insignificant. For instance, in fiscal year 2005/2006, Nepal had exported bamboo products (tea-cup pad, tea-cup, photo frame, and watch frame, tray and pen holder) with an amount of 90 million rupees and rattan products (hanger, chair, table, sofa set and handicraft) with an amount of 34.8 million rupees (MDBRPP/DFRS, 2010)

A clear structure related to development and promotion of this sub-sector is from India, where National Agroforestry and Bamboo Mission (NABM), previously it was National Bamboo Mission (NBM), is under the Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers' Welfare. The NABM is structured from national level to the district level. There is one high level national committee including national executive committee, and national bamboo cell at the centre and provincial bamboo executive committees. The funding pattern is 60:40 between Centre and the State Government for all states except North-East and Hilly states, where it is 90:10 and 100% in case of Union Territories/ R&D Institutes/ Bamboo Technology Support Groups (BTSGs) and National Level Agencies.

Major international NGOs and donors involved in bamboo and rattan sub-sector are as follows:

- International Network for Bamboo and Rattan (INBAR) (45 member countries in the world)
- International Center for Bamboo and Rattan (ICBR), China
- Centre for International Forestry Research (CIFOR)
- International Development Research Centre (IDRC)
- Common Fund for Commodities (CFC)
- Food and agriculture Organization of the United Nations (FAO)
- International Tropical Timber Organization (ITTO)
- United Nations Development Programme (UNDP)
- Australian Centre for International Agriculture Research (ACIAR)
- Bamboo and Rattan Development Programme (BARADEP)
- The International Plant Genetic Resources Institute (IFGRI)

Some national NGOs and institutes are working in bamboo and rattan sub-sector in their countries, some of which are given below:

- China National Bamboo Research Center (CBRC), China
- Nanjing Forestry University, China
- Kasetart University, Thailand

- Bamboo Society of Australia
- Japan Bamboo Society
- Japan Bamboo Association
- Cane and Bamboo Technology Development Centre, India
- Indian Council of Forest Research and Education (ICFRE), India
- The Environmental Bamboo Foundation (EBF), Indonesia
- Forestry Research Institute, Myanmar
- Central Agroforestry Research Institute (CAFRI), India
- Bamboo Research Institute, China
- American Bamboo Society
- Kerala Forest Research Institute (KFRI), India
- Forest Research Institute of Malaysia
- Bamboo and Rattan Network (BARNET), Ghana

The following institutions (government and non-government) and projects along with industries in Nepal are involved partly in development of bamboo sub-sector and the major activities include research; capacity enhancement in nursery techniques, bamboo cultivation and management, making products (woven, furniture, handicrafts), designing of products, organizing trade fair and exhibitions; awareness programme and campaign; construction of cost effective bamboo houses (pre-fabricated), production of bamboo flooring, mats, curtains, furniture, bamboo parquet, pre-fabricated bamboo houses, bamboo products from rhizomes, bamboo knot products, entrepreneurship development and marketing aspects. Some projects such as Micro-enterprise Development Program (MEDEP), Nepal Swiss Community Forestry Project (NSCFP), are not at present; however, they had worked earlier in this sub-sector.

The institutions and projects involved in bamboo and rattan sub-sector in Nepal lack coordination and cooperation, all are working on their own ways.

Government Sector

- Forest Research and Training Centre (FRTC) (then Department of Forest Research and Survey)
- Department of Forests and Soil Conservation (DoFSC)
- Department of National Parks and Wildlife Conservation (DNPWC)
- Department of Plant Resources (DPR)
- Department of Cottage and Small Scale Industries (DCSI)
- Cottage and Small Industries Development Board (CSIDB)

NGO Sector

- Community Forestry User Groups
- Bamboo and Rattan Society of Nepal
- Adobe and Bamboo Research Institute (Abari)
- Resource and Environmental Conservation Society, Nepal (RES-Nepal)
- Re-animation of Silent Echoes Nepal (ROSE Nepal)
- Handicraft Design and Development Centre (HANDECEN)
- U-NAS Interiors Wood Seasoning
- Handicrafts Association of Nepal

- Habitat for Humanity Nepal (HFHN)
- Various bamboo and rattan-based firms

Private Sector : Bamboo growers; craft-makers; entrepreneurs and traders

INGO/Projects/Industries

- Development Services-Marketing Production and Services (BDS-MaPS)
- Canadian Centre for International Studies and Cooperation (CECI)
- Nepal Swiss Community Forestry Project (NSCFP)
- German Technical Cooperation (GIZ)/Private Promotion Center (PSP)
- Save the Children US (SCUS)
- Industrial Enterprise Development Institute (IEDI)
- Hariyo Ban Program, WWF
- Biodiversity International
- United Nations Development Programme (UNDP)
- International Union of Conservation Nepal (IUCN)
- Plan Nepal
- Micro-enterprise Development Programme (MEDEP)
- A Himalayan Bamboo Pvt. Ltd. (HBPL)
- Bamboo-based industries
- Action Aid Nepal
- CARE Nepal
- German Technical Cooperation (GIZ)/Private Promotion Centre (PSP)
- International Union of Conservation Nepal (IUCN)

Environmental aspects

Bamboos and rattans have significant role in environmental conservation. The following points support in environmental conservation directly or indirectly.

- Bamboo was the only plant to survive the radiation of the atomic bombings in Hiroshima**,** Japan in 1945. The incinerating heat destroyed all trees and other plant life, except for one bamboo grove. The grove has since been removed, but culms from the grove are preserved in a museum in Hiroshima.
- The profuse rooting system of bamboo binds the soil more than any plant and checks soil erosion on hillsides and river banks effectively, helping to prevent landslides and silting of water bodies (Paudel, 2003).
- Dense foliage of the bamboo provides shade, preventing evaporation from soil and water bodies. The foliage breaks the fall of tropical rain preventing compacting of soil. Finally, about 17 tons of fresh leaves are shed per hectare per year. This decomposes relatively rapidly and builds the topsoil and also mulches the soil, preventing erosion (Paudel, 2003).

- Unlike tree species, harvesting does not kill the bamboo, so top soil erosion and other adverse effects of tree felling are kept to a minimum.
- Bamboo not only grows faster than any other plant, but it produces more than 35 % Oxygen than hardwood trees (Consider global warming and CO_2 emission).
- Bamboo absorbs four times as much carbon dioxide from the environment as trees do (McCoy, 2009).
- Research in Japan has found that bamboo can absorb up to 12 tons of carbon dioxide per hectare per year.
- Bamboo can be harvested sustainably, new shoots appear from rhizome every year and growing to harvestable condition in just four or five years, far faster than slow-growing hardwoods.
- Bamboos are one of the best species for soil conservation due to their massive rhizome structure and they help to prevent soil erosion that occurs due to monsoon rain in the fragile Midhills of Nepal.
- Plyboo (Bamboo Ply) can be produced in small factories and is more eco-friendly.
- A sixty foot tree cut for market takes 60 years to replace. A sixty foot bamboo cut for market takes 59 days to replace.
- Rattans are one of the few plant species which can grow well even in moist sites and withstand seasonal water logging.

Bamboos in Farming Systems

Rural people in Nepal know the importance of bamboos and most of them are growing bamboos for their own needs. However, land availability for bamboo plantation is a big problem for the small farmers which prevent those growing bamboos on a larger scale. Rich and middle class farmers of the Terai are more interested in bamboos now than in the past. This is particularly due to the growing market for bamboos and the low cost of maintenance and the higher benefits that accrue from bamboo plantations whereas rice cultivation is a very labour intensive operation and gives smaller financial returns than from bamboos. In Mid-hills, besides the use of bamboos for house construction and for making woven products, they are grown for fodder and soil conservation (Das, 1989;Das, 1992).The edible shoots of bamboos are popular as vegetables.

Bamboo craft-making: Income generation potential

Most of the bamboo-based enterprises are family based and are mainly in rural areas or small market centres with a relatively poor transport infrastructure. Bamboo craft-making requires very low capital and skill requirements. So there are many more family based bamboo cottage enterprises than can be supported locally. There is no specific government programme for lifting the living standards of these craft-makers. The problems with bamboo craft-making, like other small enterprises are well known: credit, marketing, technology and raw materials. Successive policy statements never take the form of precise blueprints but rather statements of pious intentions.

Women in bamboo craft-making

Bamboo craft-making is one enterprise where a considerable number of women are involved (Das, 1999a). Given their small size, full time or frequently part time and seasonal and the fact that many are household based family operations, bamboo craft-making is often important to many poor women in eastern Nepal. The socioeconomic and cultural environment determines the involvement of women.

The fact that bamboo craft-making can often be done at home in harmony with domestic tasks is particularly important and therefore can be taken as an extension of household activities. Despite the considerable number of women involved in the bamboo craft-making profession in Nepal, there is no explicit mention of such women in government policies.

Sustainable development goals (SDGs) and Bamboo and Rattan

Bamboo and rattan can play a significant role in attaining several of the global sustainable development goals (SDGs). Some goals linked with bamboo and rattan sub-sector identified by INBAR (2016) are given in Box 1.

Box 1: Sustainable development goals and bamboo and rattan sub-sector

Goal 1: End poverty in all its forms everywhere.
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all including the aim to double the share of renewable energy by 2030.
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive Employment and decent work for all.
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable cities and human settlements, including access to adequate and affordable housing.
Goal 12: Promote sustainable consumption and production patterns, which include sustainable management and efficient use of natural resources by 2030.
Goal 13: Promote actions at all levels to address climate change and its impacts
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably managed forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Bamboo and Rattan in reducing the effects of Climate change

Bamboo and rattan bring people significant benefits for climate change adaptation, mitigation, livelihoods, and the green economy (INBAR, 2016).Out of 29 Articles set in the Paris agreement, the INBAR (2016) has identified the entry points in five articles related to climate change.

The entry points are as follows:

Climate change mitigation – Article 5 (specific reference to forests)

- Bamboo & rattan as sustainable replacements for higher carbon emission materials
- Bamboo as carbon sinks
- Bamboo-based renewable energy
- Bamboo & Rattan for forest expansion, management and land restoration

Climate change adaptation – Article 7

- Climate-smart agriculture – innovative uses of bamboo & rattan
- Disaster Resilience – bamboo housing and structures
- Sustainable livelihoods – bamboo has 10,000 documented uses for products that create jobs (from community enterprises to industrial production) and can replace wood, plastics and metals.
- Bamboo- based renewable energy

Technology Development and Transfer – Article 10

- Several countries, such as China, have a wealth of expertise in bamboo environmental, market and technology development. Indonesia is a leader in rattan development.
- A new south-south-north partnership transfers bamboo development and business know-how to Ethiopia, Kenya and Uganda from China and The Netherlands. This model is an effective approach to transfer know-how on bamboo and rattan development for climate change, many countries can apply.
- GABAR-The Global Assessment of Bamboo and Rattan, facilitated by INBAR, provides access to global know-how and information on bamboo and rattan development. Technologies and approaches in the future GABAR knowledge base will support climate change action.

Capacity building; education training, public awareness – Article 11 and Article 12.

- The increased urgency and investment in the global climate change agenda open many opportunities to bamboo and rattan resource countries for partnership and financing, national capacity building and know-how transfer programmes.
- INBAR and its Chinese partner, the International Center for Bamboo and Rattan, lead capacity building on bamboo and rattan development and the sharing of expertise, on forest management, technology development and business approaches, to partner countries across Asia and South Asia, Africa and in Latin America.

Bamboo, as the fastest growing plant on the planet, has a crucial role to play in restoring balance to the Earth's climate system (Sands, 2009). It is only effective for long-term carbon sequestration if it is regularly harvested and that harvest turned into durable goods or biochar. Unlike most trees, bamboos are not killed in harvesting, the mat of rhizomes expands every year, sequesters additional carbon for the life of the bamboo plant. Also unlike trees the bamboo plant produces microscopic plant stones that encapsulated carbon in silica and sequester an additional half ton per acre of carbon for possibly thousands of years. The growth rate of bamboo is up to 20x the production rate of trees commonly used for lumber and nearly 3x that of the very fastest growing trees. The result is that a tremendous amount of building material is produced by each acre of bamboo (Sands, 2009).

Bamboo and wildlife

Bamboo provides support to many species of wildlife. Some of these are elephants, the wild cattle, various species of deer and primates, wild pigs, mice,porcupines, rodents and squirrels (Lekagul and McNeely, 1977). Schaller *et al*. (1985) report that in China, sambar deer, serow, and tufted deer all feed on bamboo. In Borneo and Sumatra, even orangutans go into bamboo forests to eat the young culms. In the Himalayas, Himalayan black bears feed on several small species of bamboo in high elevation forests close to the tree line. The impact of these species on bamboo can be considerable.

The most famous of these is certainly the critically endangered giant panda, whose distribution is determined by bamboo, though pandas prefer living in forests with a canopy coverage of 70% or more (Schaller *et al*., 1985). A closely related species which is equally dependent on bamboo is the red panda found from Nepal to Sichuan. Many species of bats feed around bamboo clumps in various parts of Asia. These are primarily insectivorous bats (Lekagul and McNeely, 1977). With such high productivity, bamboo also supports many species of birds. In addition to the hundreds of species that may feed incidentally in bamboo forests, numerous species favour bamboo or are confined to this habitat. It is

clear, therefore, that many species of wildlife depend on bamboo, either partially or entirely. Conserving bamboo will help conserve these species as well.

Potentialityof development of bamboo and rattan sub-sector

The potentiality of development of bamboo and rattan sub-sector is as follows:

- Favourable diverse climate is available for cultivation of various indigenous and exotic bamboo and rattan species in Nepal.
- There is a tremendous scope of bamboo and rattan plantations in large scale in community forests, Leasehold Forests (LFs) and private lands, as there are more than 22,000 Community Forest User Groups (CFUGs) and lot of unused private lands in the country. Plantations on these types of lands and establishment of arboretums/gardens including threatened, endangered and rare species act as *ex-situ* conservation of bamboo and rattan species; however, their protection is a challenging task.
- National parks, wildlife reserves and conservation areas have played a significant role in *in-situ* conservation of rattan and bamboo species.
- Many suitable large and small sized indigenous bamboo species are available in Nepal for cultivation in community forests and private lands.
- There is a high potentiality of bamboo and rattan cultivation in marginal area, river and stream banks, and corridors of Koshi, Narayani, Karnali and Mahakali rivers. They play a significant role in stabilization of slopes and control erosion.
- The damage of agricultural crops by monkeys has been a major problem in a number of hilly districts in Nepal. Bamboo planting in those affected areas may be one of the alternative solutions to get rid of monkeys. Ultimately, farmers will be benefitted regularly from such bamboo plantations in a shorter time.
- A multipurpose species, which provides building materials, food, fodder, and fuelwood at the shortest possible time and can reduce pressure on national forests.
- Increase in number of cottage industries, which use bamboo for making furniture, handicrafts and woven products and can help generate employment (Das, 2002b). The machines are available at affordable price in India and China that can be used for making higher end products.
- Bamboo shoots are largely consumed in the country and are very popular as a source of nutrition so there is potential to grow them as a commercial crop for local consumption as well as for export (Das, 2002b).
- Bamboos are highly productive even on those sites where other fast-growing tree species cannot be grown.
- Once bamboo clumps are well established (5–8 years), sustained annual production can be achieved without any further intervention for a long period of time till they flower gregariously.
- Most of the commercially important bamboo species can be successfully propagated from single node culm cuttings, which are cost effective and can be the basis for large-scale bamboo planting in future (Das, 1992; Thapa *et al.*, 1998).
- There is an increased interest towards use of bamboo as an environmental friendly product.
- Some bamboo species in Nepal are tested at international laboratories for strength and quality for making plyboo and mat boards. They have been found very best for such uses. So there is no need to introduce any exotic bamboo species for industrial/commercial plantations.
- The pulp and paper industry in Nepal may also use bamboo in future.
- The demand for bamboo products is increasing at local and international levels and so the markets. This has raised the level of interest towards bamboo planting amongst private growers,

communities and forest managers, which can be a driving force for its development in Nepal (Das, 1999b).

- Increased number of NGOs is promoting bamboo planting programmes and cottage industries based on bamboos in Nepal.

Economic Perspective of Bamboos in Nepal

The economic perspectives of bamboo are given below:

- Based on the discount rate of 10%, the net present value (NPV) of *Bambusa nutans* subsp. *cupulata*-mal bans) plantation managed for 25-years is found to be Rs. 783, 377 (case 1: barbed-wire fencing and watchers up to 25-years), Rs. 870,190 (case 2: no fencing but watcher up to 25-years) and Rs. 1,070,171 (case 3: no fencing but watcher up to three years). The benefit cost ratios for this species for the above mentioned three cases are 1.2, 1.6 and 2.9, respectively. The profit is based on selling of culms of this species from 4-years to 25-years. The data related to culms production up to 6 years were taken from bamboo plantation at Belbari, after that the annual production of culms was estimated (Thapa and Subedi, 2000). Up to 25-years managed *B. nutans* subsp. *cupulata* plantation, the cumulative net income for the above three cases is Rs. 4,776,693 (Rs. 191,068 per ha per year), Rs. 4,858,293 (Rs. 194,332 per ha per year), and Rs. 5437518 (Rs. 217,501 per ha per year), respectively (Thapa and Subedi, 2000).
- In Bhutan, the benefit cost ratio of bamboo plantations (20-years period) with fencing is 1.27 for one hectare and 1.51 for five hectares plantations and the net present value (Discount rate:14%) is NRs. 77,915 for one hectare and NRs. 551,827 for five hectare plantations (NRs.1 = Nu 0.6) (Oliver *et al*., 2013).
- It has been estimated that production, consumption and export of bamboo culms are 3 million stems, 2.64 million stems and 0.46 million stems (Das, 2007).
- Diversified Bamboo products are marketed in Nepal but limited efforts are being made in trapping the international markets. More than 3 million culms and more than 2000 tons of edible bamboo shoots are sold in market places (Das, 2007).
- It has been estimated that bamboo market in Nepal is around Rs 1 billion (Das, 2007). There are nearly 600 processors and traders involved in bamboo sector in Nepal. It has also been Estimated that approximately 3.3 million households are involved in bamboo farming activities (Das, 2007).
- More than 25,000 households from poor and ethnic groups are involved in bamboo craft-making and trading of products for sustaining their livelihoods (Das, 2007).
- For about 100 Pahari households at Badikhel village in Lalitpur, bamboo craft-making is the main source of livelihoods (Das, 2007)
- Average annual household income from winnows of Homtang craft-makers (100 households) in eastern Nepal was Rs. 18,000, which is 56% of the total annual household income (Das, 2002a).
- Bamboo leaves are considered one of the five best fodder species in eastern Midhills and rural people keep it for dry winter months when fodder is scarce (Das, 2000).
- The total income from the sale of bamboo crafts on an average is Rs 45,000, for *Dom* and *Mahali* households, which is around 74% of their annual household income (Das, 2002a).

- The bamboo-flooring factory at Hetauda in Central Nepal alone consumes 250,000 culms annually and the supply of bamboo culms is mostly from the farmlands of eastern Nepal (Das, 2007).

Problems and constraints for development of bamboo and rattan sub-sector

The problems and constraints related to development of bamboo and rattan sub-sector are as follows:

- At present, there are no large bamboo forest/plantations in Nepal as in China and some Asian countries. They are found in scattered patches, so any bamboo-based industry will need to purchase raw material from many private growers.
- Large sized bamboos found mainly in Chure region are in great threat, which needs immediate actions for their conservation.
- The detailed inventory on available bamboo and rattan resources has still not been done.
- Due to the long flowering cycle in bamboos, getting viable seed is difficult and hinders large-scale planting. The traditional propagation method is difficult to apply due to high costs and the unwillingness of bamboo owners to sell rhizomes as that may reduce production of new shoots in the following years. Not all useful species in Nepal have been successfully propagated from culm cuttings and it is difficult where water availability is limited (Stapleton, 1985; Das, 1992).
- If gregarious flowering occurs, then all clumps of a particular species having the same genetic base will die, irrespective of their age classes. At present, very little is known about flowering cycle of many bamboo species in Nepal. This causes a serious problem and will involve risk of a serious set-back (Liese, 1986).
- Bamboos can grow on a wide range of soil types, but they prefer well-drained sandy loam to loamy-clayey soils. The optimal soil acidity lies between 5 and 6.5 (Liese,1986). The soil of the Terai (pH usually >6.5) is less suitable than the hills of Nepal.
- The protection of bamboo against theft is difficult as they are lighter and easier to harvest than trees.
- As bamboo roots form a mat-like structure in the ground, it inhibits the growth of other plants and is therefore not suitable for intercropping / agroforestry. In general, farmers do not prefer bamboo planting on their lands as it may reduce crop yield and dry up the land.
- Congestion is another common problem in bamboo clumps of some important species in Nepal (Das, 1992). Bamboo species which are thorny require regular thinning and pruning operations which are costly and time consuming manual operations (Chaturvedi,1986; Banik,1988).
- The felling of culms along with extraction is done manually and is a highly labour-intensive operation. This is because the clump forming bamboo species have culms of different age classes and only the mature culms should be harvested (Liese, 1986).
- Bamboo has a low natural resistance compared with wood. The culms are susceptible to attack especially by insects (beetles, termites) and fungi (brown rot, white rot, soft rot). Untreated bamboo has an average life of less than 1–3 years when they are in contact with soil or exposed to the atmosphere (Liese, 1986).
- There are considerable taboos, beliefs and superstitions associated with bamboo in Nepal and that inhibits large-scale bamboo planting among many rural communities (Das, 1999a).

- There is yet no concrete policy framework and action plan for the development of bamboo resources in Nepal. Financial resources for bamboo and rattan research and development (R & D) are lacking.
- Poor infrastructure and continuous use of traditional tools results in poor finishing of products to meet the demand of international markets.
- Producers and processors are poorly organized with weak horizontal linkages.
- Lack of dissemination of bamboo products information such as booklets, leaflets, posters and video films, etc in Nepali and local languages.
- Inadequate skill oriented training and research on bamboo production, management, processing, utilization and marketing.
- Modern technology has not been entered in this sector yet in Ethiopia in all aspects like Production, processing and manufacturing of various products.
- Lack of knowledge among entrepreneurs about the marketing prospect of their products
- Lack of small machineries and tools to improve the quality of bamboo and rattan products.

Policy implications

Many of the endemic bamboos and rattans in the forests are under severe threat of extinction due to destruction of their habitat and overexploitation. The Nepalese bamboos (mainly small sized bamboos) and rattans are very little known taxonomically, and morphologically. This is particularly due to insufficient representation of the herbarium materials and difficulties in collection of specimens from the inaccessible bamboo and rattan forests and due to rarity. Due to the inadequate field surveys, the biology and ecology of rattans in Nepal are little known or unknown. There is every possibility that more bamboo and rattan species may be recorded if nationwide inventory is carried out.

Although bamboo and rattan have good marketing potential they have been neglected for a long time in Nepal. Both bamboos and rattans were reported to be distributed from east to west of Nepal, both in the Terai and Mid-hills. However, due to high negligence towards the protection and management, it is in very poor condition now. Still the actual distribution, status and identification are not completely known for available bamboos and rattans in Nepal.

The reflection of the recommended areas given in this policy brief in the national bamboo and rattan policy including strategies, laws and their effective implementation is necessary to develop and promote bamboo and rattan sub-sector in the country. For successful implementation, related responsible institutions at the central, provincial and local levels can play a significant role. Further, coordination, cooperation and support among the institutions involved in development of bamboo and rattan sub-sector is essential. Establishment of responsible institution in government sector, as in India, is necessary at the central, provincial and local levels to develop and promote this sub-sector.

Conclusions

Bamboo has a significant contribution in improving rural livelihood in the country. Similarly, rattan has a tremendous scope in making furniture and baskets. The promotion of bamboo and rattan plantations and their innovative product development can be a powerful tool for the government to foster rural

development. Bamboo farming favours the development of small landholdings and the use of intensive labour suited to the Nepalese quest of eliminating poverty by improving the means of livelihood of the rural poor. Bamboo and rattan resources in the forests are important source of livelihood and income for many rural households and are also important form of environmental aspects. Bamboo and rattan can be important for programmes to be initiated for adaptation and mitigation of climate change. Government support for the intensive development of small bamboo farms owned by small farmers and the rural poor can be a strategic move in upgrading the quality of life of rural people.

The main policy action that is required is provision of technical and financial assistance in the form of training and soft loans for establishing bamboo and rattan plantations and also for cottage enterprises based on them so that they can remain viable in the long term and be able to meet the changing patterns of bamboo use.

Recommendations

- The national bamboo and rattan policy including strategies along with laws, guidelines, and manual should be developed to promote bamboo and rattan sub-sector in the country with an ultimate goal of contributing to environmental conservation and economic development.
- National inventory of bamboo and rattan should be carried out to identify species and varieties (mainly small sized bamboos), know their current status, distribution, growth pattern and stocking. Threatened, endangered and rare species of rattans should be identified through survey for their promotion.
- Marketable bamboo and rattan species should be used in cultivation in CFs and private land in a wider and larger scale. Similarly, bamboo and rattan species should be planted in degraded areas, along the banks of streams and rivers and the corridors of Koshi, Narayani, Karnali and Koshi rivers.
- Bamboo planting is one of the alternative solutions in those private lands where monkeys have been a problem in damaging agricultural crops.
- Non-availability of bamboo and rattan planting stock is one of the major constraints for bamboo and rattan planting. Massive production of quality bamboo cuttings and rattan seedlings should be done in private and community nurseries for their large-scale plantation.
- Management guidelines of the rattan species should be prepared for rattan species grown in community forests. For instance, CF in Kailali and Shiva CF in Bardiya district have already managed *Calamus tenuis* in their CFs following management guidelines.
- *In-situ* and *ex-situ* conservation of bamboo and rattan species should be done for their gene conservation in different ecological zones of the country. *Ex-situ* conservation can be done through establishment of arboretums/gene banks and plantations. First priority should be given to the threatened, endangered and rare species of rattans, large bamboos in Chure region; small sized bamboos(*nigalo, malingo*) in Middle Mountains, High Mountains and High Himal physiographic regions.
- Seed orchards of rattans should be established to assist in plantation programmes in different parts of the country.
- Bamboo and rattan development should be carried out in mission mode to get optimum benefits like in China, Taiwan, Thailand, Indonesia, India and Bangladesh. Bamboo and rattan development Authority/Board is desirable in this context and should be formed.
- There should be support for a network of organizations and individuals from the government, development and private sectors to promote the bamboo and rattan sub-sector. It is further

imperative to formalize, capacitate and strengthen this network in the functional areas of training, consultancy and information services to serve the bamboo industry to ensure sustainability.

- A networking of all the stakeholders (researchers, bamboo and rattan growers, collectors, CFUGs, craft-makers, entrepreneurs, industrialists, middlemen, wholesalers, retailers, and exporters) involved with bamboo and rattan sector should be established.
- It is recommended to upgrade the technology with a view to increase productivity and improve the quality. This sub-sector needs to move towards strategies based on differentiation (quality, unique designs, etc.) The sub-sector needs to promote application of new design concepts, skills and technology aimed at satisfying changing needs of customers. The special focus should be given to provide such training to rural women and occupational ethnic groups like Dom, Pahari, Musahar and other ethnic groups involved in making bamboo and rattan products.
- Generally, craft makers are using traditional tools and techniques for making bamboo products. There should be an integration of modern tools and techniques to increase efficiency, reduce the production costs and improve the quality of products.
- The training should be provided to the growers in cultivation and management aspects and craft-makers on making high quality bamboo and rattan products. The entrepreneurs need to be trained on marketing and managerial skills. Immediate steps should be taken in order to improve consumer awareness and perceptions to increase consumption of bamboo products. Furthermore, the entrepreneurs involved in this sub-sector need to be educated on the potentials and the multiple applications of bamboo products.
- Interventions are needed at the grassroots level to ensure sustainable supply of bamboo and rattan raw materials.
- Regulatory policies on tenure, permits to harvest and trade, transit/export restrictions needs to be simplified. There local government taxations on bamboos and rattans raw materials and products should be relaxed and simplified as it will enhance competitiveness of the sub-sector.
- A mapping of bamboo area in Churia forests, Mid-hills and high mountains needs to be prepared and conservation measures need to be applied. Similarly, rattan species found in the forests need to be conserved.
- There is a need to establish at least one big high tech nursery at provincial level to produce bamboo and rattan plants for planting in forests and cultivated lands as bamboo and rattan plants of desirable species are not readily available. One district level bamboo and rattan nursery should be established.
- Research on bamboo and rattan species found in Nepal and potential exotic species needs to be introduced. Extension materials (leaflets, booklets, posters, etc.) preferably in Nepali and local languages, providing information on bamboo and rattan propagation, productivity, management and marketing should be produced and media (TV, Newspaper, etc.) also should be used for this purpose. Forest Research and Training Center (FRTC) should take a lead role in this matter. A special cell of technical professionals needs to be created for this purpose within the FRTC.
- Extensive awareness programmes should be carried out on cultivation and management of bamboo and rattan species, protection and conservation aspects, the use and application of bamboo and rattan products in place of plastic and wooden products and to reduce beliefs, taboos and superstitions against bamboo planting.
- Research areas of bamboo and rattan sub-sector should be identified and prioritized. Similarly, areas of collaboration with national and international organizations and international support (technical,

financial, etc.) are essential in resource creation and development of bamboo and rattan based industries

- Regular trade fair and exhibitions of bamboo and rattan products should be organized by concerned institutions at the central, provincial and local levels for marketing and publicity.
- Bamboo growers and craft-makers should be organized into groups to play an important role in bargaining prices and seeking support from Government and non-Government agencies. Several groups can form a cooperative which can be registered and functioned properly for the benefit of the members.
- Common facility centres should be established in pocket areas/zones where the simple equipment and machines along with space can be arranged for interested individuals for making bamboo products.
- Cluster approach should be applied for making a particular type of bamboo products, for instance one cluster is for making baskets including other woven products and next cluster is for making furniture and another cluster may for making handicrafts.
- Financial support in terms of soft loan for the actors involved at all levels of bamboo value chain should be provided. The Government should facilitate and make a favourable environment for soft loan from financial institutions. There should be provision on subsidy/grant from the government in resource creation, management, products development and marketing.
- The land used for planting of bamboo and rattan should be made free of any taxation like land tax, property tax etc.
- There should be tax rebate for imported machineries to be used in bamboo and rattan based industries**.**
- Emphasis should be given to construction of low cost houses, especially in rehabilitation in earthquake and flooded areas from the concerned institutions. Physical and mechanical properties of those bamboos used in constructing houses should be identified.
- Bamboo and rattan museum (at least one in each province) consisting of various types of products should be established to provide knowledge on bamboo and rattan products made in the country.
- Good marketing infrastructure and reliable information system should be developed Mainly to address the competitiveness of bamboo and rattan products.
- Private sector initiatives should be supported by the Government and international funding agencies to find new markets and promote Nepali bamboo products, processing, utilization and marketing.

References

Bamboo Import Europe. Amazing facts about bamboo. Website: http://www.bambooimport.com/en/blog/facts-about-bamboo, retrieved on 20 June, 2019.

Banik, R. L. 1988. Investigation on the culm production and culm expansion of Bamboo species of Bangladesh. *Indian Forester***114**: 576–583.

Chaturvedi, A. N. 1986. Bamboos for Farming. Forest Bulletin No. 52. Forest Department, UP, India.

Das, A. N. 2003. Bamboos in rural farming systems in the Terai and Mid hills of Nepal. *Banko Janakari***13 (2)**: 34–41.

Chowdhary, C. L. and Paudel, S. K. 1996. Distribution, Availability and Economic Significance of Rattan in Nepal. A Case Study of Surkhet, Bardiya, Kailali and Kanchanpur Districts. Reportsubmitted to ANSAB, Kathmandu .

Das, A. N. 1988. Bamboo research in Nepal. In *Bamboos: Current Research* (eds.) Rao, I. V. R., Ganaharan, R.and Sastry, C. B. Proceedings of the International Bamboo Workshop, 14–18 November 1988, Cochin, India, 1–5.

Das, A. N. 1989. Annual Report, 1989. Field Visits for Bamboo research. Forest Research Division, Kathmandu, Nepal.

Das, A. N. 1992. The Potential of Bamboo Growing in Rural Development Forestry in Nepal. MSc. Dissertation. University of Aberdeen, UK.

Das, A. N. 1999a. Socioeconomics of Bamboos in Eastern Nepal. PhD Thesis. University of Aberdeen, UK.

Das, Annapurna N. 1999b. Perception and attitude towards tree growing in east Nepal. *Banko Janakari***9 (2)**: 3–9.

Das, A.N. and Oli, B.N. 2001. Tree Growing Practices on farmland: an Option for Sustaining Rural Livelihoods. *Banko Janakari*, **11** (2): 8-12.

Das, A. N. 2002a. Bamboo growing and its market development potential for sustaining rural livelihoods and poverty reduction in eastern Nepal. *Banko Janakari***12 (1)**: 8–19.

Das, A. N. 2002b. Bamboos for environmental conservation and poverty alleviation (in Nepali). *Jeevan* **2 (12)**.

Das, A. N. 2007. Status of bamboo research and development in Nepal. A paper presented in the International Workshop on Bamboo held in Kathmandu, 10–12 April, 2007.

Dransfield,J. 1981. The biology of Asiatic rattans in relation to the rattan trade and conservation. In *The Biological Aspects of Rare Plant Conservation*, (ed.) Synge, H., Wiley, London, 179–186.

Frith, Oliver, Adhikary, Nirpa, Peldom, Sonam, Mukhiya, Prabhat Kumar and Dukpa, Gyltshen. Bamboo Construction in Bhutan: a Feasibility and Market Study. INBAR Working Paper No. 75.

GoN. 1993. Forest Act. Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

GoN. 1995. Forest Regulation. Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

GoN. 2011. Industrial Policy. Ministry of Industry, Commerce and Supplies, Kathmandu, Nepal.

GoN. 2015. Trade Policy, 2015. Ministry of industry,Commerce and Supplies, Kathmandu, Nepal.

GoN. 2019. National Forest Policy. Ministry of Forests and Environment, Kathmandu, Nepal.

HMGN. 1989. Master Plan for the Forestry Sector (MPFS). Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

HMGN. 2004. The Herbs and NTFP Development Policy. Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

INBAR. 2016. Bamboo and Rattan is our Business. International Network for Bamboo and Rattan, Beijing, China.

INBAR. 2016. Position Paper.Briefing to INBAR Member States - December 16, 2015 .Summary of results of Paris Agreement on climate change related to bamboo and rattan. Bamboo and Rattan for Climate Change, Beijing, China.

INBAR. 2017.International Trade of Bamboo and Rattan in China in 2017. International Network for Bamboo and Rattan (INBAR), Beijing, China.

Lekagul, B. and McNeely, J.A. 1977. Mammals of Thailand. Kurusapha Ladprao Press.

Liese, W. 1986. Bamboos: Biology, Silvics, Properties and utilisation. GTZ, Germany. 132 pp.

McCoy, Stewart. 2009. The Magic (Bamboo) Bullet?.http://go-explore trans.org/go/gonew/?/main/articles/the-magic-bamboo-bullet

McNeely, Jeffrey A. 1995. Bamboo, Biodiversity and Conservation in Asia. In *Bamboo, People and the Environment, Volume 2Biodiversity and Genetic Conservation*(eds.) Rao, V. Ramanatha and Rao, I. V. Ramanuja, Proceedings of the Vth International Bamboo Workshop and the IV International Bamboo Congress Ubud, Bali, Indonesia 19-22 June 1995, 1–22.

MDBRPP/DFRS. 2010. Market Opportunities and Constraints for Bamboo and Rattan Products in Nepal. Market Development of Bamboo and Rattan Products with Potential Project, Department of Forest Research and Survey, Kathmandu, Nepal

Paudel, Shyam, K. 2003.Proceedings of the Bamboo Housing Workshop, March 31 to April4, 2003, Kumasi, Ghana. International Network for Bamboo and Rattan and Bamboo and Rattan Development Program (BARADEP).

Poudyal, P. P. 1992. Bamboos. Field Manual for Community and Private Forestry in Nepal.(Compiled and Edited by I.J. McCracken). Part II Field Document No 20, HMG/FAO/UNDP, Community Forestry Development Project (Phase II). Kathmandu,Nepal.

Poudyal, P.P. 2006. Bamboos of India (Sikkim), Bhutan and Nepal. New Hira Books Enterprises, GPO Box 2680, Kathmandu, Nepal.

Paudel, S.K. 2003.The glory of a common effort: A successful story of community rattan management in Nepal. *INBAR Newsletter* **10 (2)**.

Paudel, S. K. and Chowdhary, C. L. 2005. Managing rattan as a common property: a case study of community rattan management in Nepal .*J. Bamboo and Rattan***4 (1)**: 81–91.

Sands, David, E. 2009. Bamboo and Climate Change. In *Eighth World Bamboo CongressProceedings (ISSN 2150-1165),* 16-19 September 2009, Thailand.

Schaller, G.B., Jinchu, H., Wenshi, P. and Jing, Z. 1985. The giant pandas of Wolong. The University of Chicago Press, Chicago, USA.

Scurlock, J. M., Dayton, D. C. and Hames, B. 2000. Bamboo: An Overlooked Biomass resource? ORNL/TM-1999/264. Oak Ridge Laboratory, Oak Ridge, Tennessee, 34 pp.

Stapleton, Chris. 1994. Bamboos of Nepal: an Illustrated Guide. Royal Botanic Garden, Kew, UK.

Stapleton, C. M. A. 1985. Studies on vegetative propagation of Bambusa and Dendrocalamus species by culm cuttings. In recent Research on Bamboos (eds.) Rao, A. N., Dhanrajan, G. and Sastry, C. B., Proceedings of the International Bamboo Workshop, 6-14 October, 1985, Hangzhou, China, 146–153.

Thapa, H. B. and Subedi, N. 2000. Bamboo Resources Consumption, Supply in Refugee Camps of Eastern Terai and Future Strategy for the Bamboo Resource Promotion and Development. Report submitted to Swechha Bio Engineering Consultancy and Construction. Unpublished Report. Kathmandu, Nepal.

Thapa, H. B., Das, A. N. and Oli, B. N. 1998. Growth performance and culm production of bamboo at the eastern Terai, Nepal. *Banko Janakari***8 (1)**: 13–18.

Vorontsova, Maria S., Clark, Lynn, G., Dransfield, John, Govaerts, Rafael and Baker, William J. 2016.World Checklist of Bamboos and Rattans. INBAR Technical Report No. 37, Beijing, China.