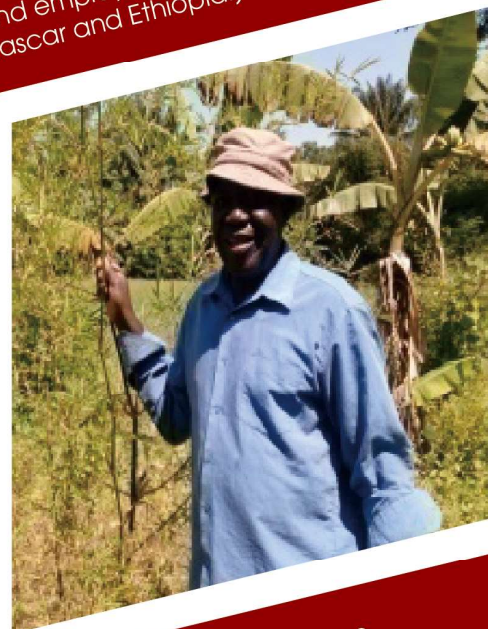


# Bamboo in Homestead Farming System Development

(This transfer of technology model is an outcome of the IFAD-EU-funded South-south knowledge transfer strategies for scaling up pro-poor bamboo livelihoods, income generation and employment creation, and environmental management in Africa (Phase II) Project in Tanzania, Madagascar and Ethiopia.)



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## International Bamboo and Rattan Organisation

INBAR, the International Bamboo and Rattan Organisation, is an intergovernmental organisation bringing together some 44 countries for the promotion of the ecosystem benefits and values of bamboo and rattan.

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# Foreword

Including bamboo in homestead farming has the potential to create employment opportunities, a business livelihood and ecological security. Increasing numbers of bamboo on homestead plantations are sure to contribute to the well-being of rural households and the environment in a multi-faceted way.

Farming systems can be adapted in very small arable areas, even if they are not usable for agriculture and have limited management input. Bamboo shoots provide supplemental nutrition, feed and fodder for livestock and raw materials for home construction, as well as materials for various agricultural implements. Excess supplies can be sold to meet local market demands. In these ways, bamboo has the potential to enhance rural livelihoods and incomes.

The technical manual on 'Bamboo in Homestead Farming Systems Development' is an outcome of INBAR's IFAD-EU-funded South-south knowledge transfer strategies for scaling up pro-poor bamboo livelihoods, income generation and employment creation, and environmental management in Africa (Phase II) Project in Tanzania, Madagascar and Ethiopia.

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# Acknowledgements

Globally, cropland represents around 1.53 billion hectares (ha), of which 0.4–0.48 billion ha are abandoned farmland. The Joint Research Centre of the European Commission reports that productivity has decreased in 20 percent of the world's croplands, 16 percent of forest lands, 19 percent of grasslands and 27 percent of rangelands. This decline creates a situation where agricultural cultivation becomes increasingly adverse for the poor and is the main constraint to achieving global food security challenges.

The solution, therefore, lies in SMART agricultural practices in these small parcels that prevent structural disturbances to the soil by proven crop combinations that ensure that the soil retains organic matter and irreversible degradation is prevented.

One of the most effective approaches is agroforestry: an approach that combines crop cultivation, livestock farming and the planting of forest species in an integrated manner. This is a traditional, age-old method commonly practiced in homestead areas in tropical climatic geographies. The focus has also shifted to sustainable development through agroforestry worldwide; this practice can provide environmental, economic and social benefits from on very small parcels of land.

The present technical manual, 'Bamboo in Homestead Farming Systems Development', is an attempt to popularise bamboo as a resource for the 21<sup>st</sup> century for homestead farming systems development. This manual has been prepared based on project implementation experiences in the East African region. The International Bamboo and Rattan Organisation has put in cascading efforts to improve livelihoods and encourage environmental management by promoting bamboo in homestead farming. The manual met the requirements of bamboo cultivation as a farm crop to improve the socio-cultural and economic benefits of the rural community in Africa and elsewhere and also to serve as a livelihood safety net.

It is our immense pleasure to express sincere gratitude to Dr. Fu Jinhe, Tesfaye Hunde, Fiker Assefa, Wondimagegn Bekele, Biruk Kebede and Zerihun Tsigaye of INBAR, East Africa Regional Office, Addis Ababa, Ethiopia, for their enormous support and cooperation.

We owe our heartiest thanks to Bedilu Kilfe, National Coordinator of Ethiopia, Njaka Rajaonarison, National Coordinator of Madagascar and Donald D.Kibhuti, National Coordinator of Tanzania (INBAR, South-south Phase-II project) for providing endless field support and cooperation.

Last but not least, we sincerely express our gratitude to our communication team at the INBAR headquarters for seeing this manual through to a timely publication.

**The Authors**

# 1. Bamboo in Homesteads– A Livelihood Safety Net

Agriculture is the main driving force of rural community livelihoods for most of the world's poorest people living in rural areas. However, it only accounts for 5 per cent of the global gross domestic product (GDP) contributed by 1.5 billion people on 500 million small farms, which constitute nearly 80 per cent of all farming households who are central to food production (FAO,2014). Nevertheless, homestead and family farming, if done well by a community of small family farms, can be a self-sufficient, integrated and even efficient and productive land use and economic system where the entire family provides the labour for agricultural produce cultivation, and poultry, livestock and/or fish rearing for self-consumption or trade. It is an integrated approach to the aforementioned diversified activities with general market awareness that can provide adequate family income and nutrition intake.

Most family farms are engaged in subsistence and pastoral agriculture. Almost all are small (less than 2 ha). Since the cultivable land area in the world is steadily declining due to over-cultivation, and overgrazing is degrading pastoral lands and forests, family farm outputs are also decreasing their size mainly due to subdivision of lands among grown children. Therefore, models must evolve pilot programmes in Africa and Asia at the local level that provide small farms with the opportunity to: a) improve environmental quality (increase soil fertility and water retention and conservation); b) increase biological benefits (healthier and more diverse animal, plant and human populations); and c) enrich social, economic and institutional (greater social equity, cohesion, peace/stability and well-being) components. These objectives may be achieved by integrating certain natural resources into the small farming model to supplement incomes through increased productivity levels. Bamboo is one such resource. The scope for bamboo to play an important role in forest and landscape restoration is enormous. The 2011 Bonn Challenge calls on governments to restore 150 million hectares of degraded and deforested land by 2020 and 350 million hectares by 2030. As a native species (and a pioneer species at that) across tropical, sub-tropical and some temperate areas, bamboo could contribute significantly to restoring degraded landscapes.

Likewise, forest landscape restoration aims to regain the ecological functions of the degraded forest while also enhancing human well-being through more sustainable production-to-consumption systems where many lands used to interact. This method includes recovering biological productivity to achieve benefits such as improved soil fertility and food security, increased natural forest cover for watershed protection, mitigation of climate change, protection of biodiversity, creation of green jobs and contributing to green economic growth and development.

Bamboo can integrate poverty reduction into ecological conservation. A homestead bamboo planting can be created in a very small area, even one not usable for agriculture. On a larger scale, bamboo could be planted along farm boundaries and, depending on the market, as a block planting on farmland. These plants would provide bamboo shoots for household consumption feed and fodder for livestock, raw materials to construct houses or strengthen them, baskets and mats and various agricultural implements.

Bamboo culms are in demand in rural markets. Value-added products include woven bamboo products – mats and baskets – incense sticks, handicrafts, furniture and other products that can be sold at rural and urban markets. Homestead bamboo farming has the potential to create many employment opportunities.

This technical manual explores these aspects and the opportunities that bamboo provides to members of small rural farming households to increase their incomes while also addressing ecological and climate concerns.



It outlines new opportunities, which can: a) provide women with additional income; b) generate bamboo biomass for household energy; c) enhance soil fertility and the soil's water holding capacity and d) enhance the microclimate as shelterbelts.

## 1.1 Homestead farming

Homestead farming is an integral part and parcel of family life. It is a stable micro-agro ecosystem as well as a traditional cultivation system that has evolved over time as subsistence method of crop production for rural households. Homestead farming plays an important role in sustainable agriculture by conserving the natural resource base, protecting the environment and providing food and livelihood security to families over time. It is a food security basket for the rural masses. Homestead bamboo farming systems will create access to bamboo resources easily within 'physical reach' and reduce the bottleneck of 'legal reach' from forest administration agencies.

Box: Homestead or compound farms have been described as multi-layered stands of annual and perennial plants adjoining living houses and managed sometimes with some small livestock, by household labour for food, cash incomes, and social and cultural needs of the family, all of which play strategic nutritional roles. Soemarwoto (1984) defines a home garden as an agroforestry system that is 'ideal' in that it combines the ecological functions of forests while also ensuring the socio-economic needs of people.

### Challenges: Homestead farming

- Homestead farming is mainly dependent on rain. Problems may arise due to droughts and unpredictable monsoons.
- The size of productive land is decreasing due to over-cultivation that has led to soil erosion, land degradation and deforestation. Marginal/small farmers face a very high risk of crop failure, and many have found farming activity unviable. Over 1.3 billion people live on degraded land, and farmers are unable to find alternative livelihoods in these areas. They have been forced to abandon their farms and move to the slums of cities.
- Even during normal harvests, challenges include the perishable nature of most food products and a lack of storage facilities; increasing costs of inputs and expenditures; and low price realization.

In spite of these challenges, homestead farming has enormous potential to increase incomes through multiple activities while also rejuvenating degraded lands and protecting the soil from erosion. Homesteads provide all the benefits of agroforestry.

Fernandes and Nair (1986) evaluated the structure and function of home gardens in different ecological regions of the tropics and concluded that different annual or perennial crops are grown in these homesteads along with trees, shrubs and ground-cover plants to promote nutrient recycling, soil conservation and optimal protection and use of the land both above and below the ground. However, these layers, which are common in small landholdings, have varied components depending on their location.

The diversity in species, varied outputs and wide genetic variability of homesteads offer innovative technological solutions for improving the productivity and outputs of homestead plantation systems.

## 1.2 Bamboo in homestead farming

Bamboo is an indigenous woody grass and the fastest growing plant species in the world. A well-managed bamboo stand, planted on marginal land where nothing else will grow, can become a reliable and cheap source of food, fuel and feed. The same bamboo can

## BAMBOO IN HOMESTEAD FARMING SYSTEM DEVELOPMENT

also shield farms from destructive winds and help in managing floods and soil erosion. Apart from ecosystem services, it also provides poles and/or value-added products for which there is market demand. Homestead/family farmers have to deal with scarcity of water and green pastures during the dry season. During monsoons, the topsoils that have been exposed by overgrazing become eroded and are deposited in rivers, lakes, dams and ponds, leading to silting and flooding. By planting fast-growing bamboo on their land, farmers can restore lost vegetation cover and keep soil erosion in check. Once established, bamboo becomes a perennial source of nutritious feed for their animals, offers poles for construction and provides a source of fuel. In hilly terrain, farmers can plant bamboo, which is known to prevent landslides. Without bamboo to check their momentum, rivers originating from the mountains rush straight into the valleys, causing massive soil erosion and flooding. Planting bamboo along these steep slopes is the only sustainable solution to the problem.

The rural poor and rural women in particular are able to develop the skills required for establishing and maintaining a homestead bamboo plantation and use it as a source of fuel and food. There are also many opportunities for using the harvested bamboo in further processing activities, such as woven mats or goods including toothpicks, incense sticks, chopsticks, handicrafts and containers, which generate income for the family. These activities directly influence the economy of rural regions. This impact offers socio-economic benefits to people by supplying housing material, agricultural implements, raw materials for handicrafts and furniture at a cheap rate and also generating employment both in the harvesting and cottage industries.



**Bamboo on a homestead**

Courtesy: INBAR South-south Phase-II Project



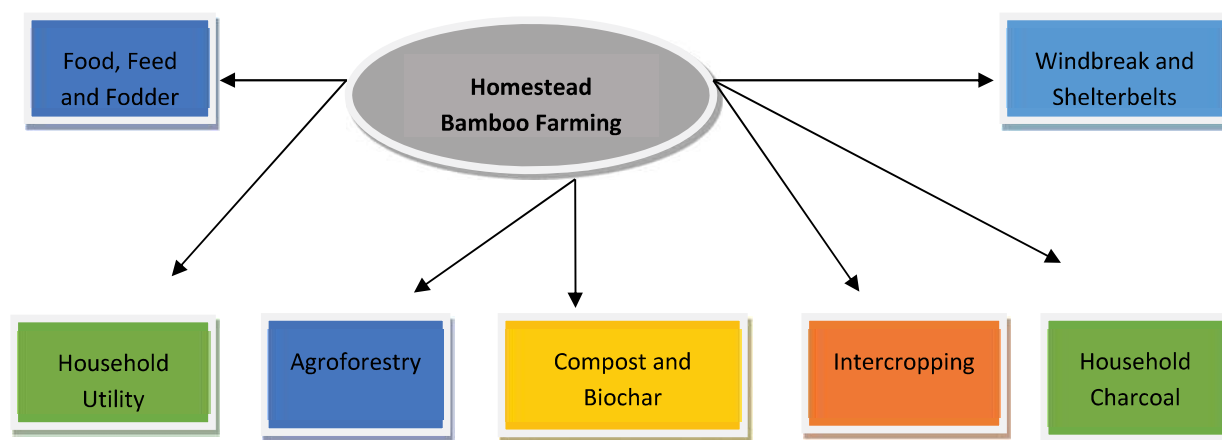
## 2. The Significance of Bamboo in Homestead Farming

Homestead farming takes place at a plantation owned and run by one family. Its size is determined by the amount of time various family members are able to devote to it aside from their other responsibilities. Homestead/family farms that grow bamboo, like all others, are characterised by crop cultivation, rearing poultry, livestock and fish and harvesting of poles for use within the homestead or for sale.

Bamboo provides many important services – ecosystem and economic – when it is integrated into a homestead farming system(Chart-I). It requires little space to grow since tropical clumping (also called sympodial) bamboos are compact and do not spread much horizontally.

The development attributes of homestead bamboo are as follows:

- It creates income generation for poor rural communities, and particularly women.
- It improves and broadens farmers' planting and cultivation skills base, making them more able to handle shocks and to cope with new situations.
- Homestead bamboo is growing as a new area of managed bamboo resources because it rapidly rejuvenates degraded land and protects against soil erosion.
- Raw materials can be supplied to industries and enterprises.
- Homestead bamboo farming requires minimal investment.
- Bamboo plants may easily be intercropped.



(Chart 1: Bamboo homestead farming benefits)

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## 2.1 Bamboo as windbreaks, shelterbelts and farm boundaries

Bamboo forms a windbreak or shelterbelt when it is planted in the wind's path by reducing wind speed on the leeward side and creating a microclimate around crops by moderating their soil and air temperature, increasing the relative humidity, reducing evaporation and increasing soil moisture. These windbreaks prevent soil erosion, increase crop yields and protect livestock from heat and cold. Bamboo windbreaks also prevent physical damage to crops.

All these factors help improve crop quality and increase the yield in sheltered areas. However, the benefits crops receive from a bamboo windbreak depend on the site, windbreak design and crop variety. Shelterbelts reduce the effects of winds, which remove moisture from the soil. For example, a 10–11 metre (m) tall bamboo windbreak reduces wind travelling at 45–50 km/h wind to a speed of 20–30 km/h on the windward side and about 10 km/h on the leeward side. The windbreak reduces the wind speed 200 m away from the leeward side by up to 20 per cent only; in an area 300m away, there is no effect at all.

Shelterbelts should be formed in a northwest direction. These structures secure crops and livestock against cold waves. Farm boundary and windbreak systems reduce crop failure possibilities and demarcate farm boundaries. Bamboos clumps planted around water bodies are a riparian buffer to aid in water resource conservation while providing a habitat for wildlife.



Bamboo in homesteads for windbreak and shelterbelts protection. Photo: South-south Phase-II

## 2.2 Bamboo Food, Feed and Fodder

The bamboo leaf contains appreciable quantities of carbohydrates and high values of protein and macro-mineral and micro-mineral elements. Since poultry and livestock are integral to homesteads, bamboo is an important food supplement in poultry feed, livestock fodder and fish food. Bamboo leaves contain chlorophyll, which fights infections; lactones are good for the cardiovascular system, and chlorophyll helps red blood cells form and builds a stronger immune system. Chicken fed powdered bamboo extract show rapid body weight gain.



Courtesy: INBAR South-south Phase-II project in East Africa

Bamboo charcoal (BC) and bamboo leaf (BL) dietary supplementation improve growth performance, feed intake, feed conversion efficiency and quality of meat while reducing chicken mortality rates.

Meat from chickens that have consumed feed supplemented with bamboo has lower cholesterol levels and is higher in unsaturated fats. Therefore, bamboo plantations are an inexpensive feed source for the increasing number of organic chicken producers catering to markets that are driven by health benefits. Bamboo clumps provide shelter for chickens and are a home for insects and worms which, in addition to leaves and twigs, are nutrient-rich feed for chicken. Bamboo shoots have a greater nutritive value than leaves but are mainly harvested for human consumption and very rarely used for feed. Bamboo leaves may be mixed in livestock grain feeds, such as barley. Like all grasses, bamboo is an important forage plant; many livestock owners use it as a hay crop. Bamboo is thinned when green by trimming the tops about two feet from the ground, and animals can graze on this bamboo.

Homestead bamboo can evolve into poultry, livestock and fish rearing as a standalone economic activity separate from the existing crop cultivation practiced in conventional homesteads.

#### Techniques used to collect bamboo leaves as feed

**Step-1: Pruning:** Bamboo is pruned at a height of 75 centimetres (cm) to form a 'table top', which makes the picking of leaves for poultry and livestock feed easier.

**Step-2: Hedging:** Most bamboo species may be pruned into a hedge. This causes more branching and leaf production with a hedge height suitable for livestock to eat.

**Step-3: Cut and carry:** This method is used when bamboo is planted for multiple purposes. Multi-purpose bamboo plants encourage farmers to improve clump management and lead to better yields and increased leaf production. Bamboo leaves can be gathered, dried, stored and fed to ruminants. Dried leaves that fall on the ground can also be swept together and fed to animals.

## 2.3 Bamboo Compost and Biochar

Compost contributes greatly to improving soil fertility. Bamboo is a naturally occurring composite material that grows abundantly in most tropical countries. It consists of cellulose fibres imbedded in a lignin matrix along the length of the culm, which provides bamboo with its tensile flexural strength and rigidity. Bamboo's ash content consists of inorganic minerals (primarily silica, calcium, and potassium), and its leaf litter is very good manure after decomposition.

## BAMBOO IN HOMESTEAD FARMING SYSTEM DEVELOPMENT



Photo: INBAR South-south Phase-II Project



Using Biochar in a Bamboo Nursery at Bahir Dar  
University in Ethiopia

Photo: INBAR South-south Phase-II Project

Bamboo decomposes slowly as it is silica-rich and has the potential to produce compost commensurate to the quantity of leaf litter on bamboo plantations. Farmers may also sell some of the compost harvested for additional income.

Like charcoal, bamboo biochar has both demand and utility in agri-farming systems. It helps to improve soil textures and the overall growing environment of plants. Bamboo biochar is created using a pyrolyser process, which heats a bamboo biomass under controlled oxygen conditions in a kiln. The type of biochar comes in powder, granular and nugget forms. This highly porous substance contributes to the long-term nutrient value and water holding capabilities of soil in an organic form. It also fosters the development of microorganisms in the soil, helps with carbon sequestration and lowers pH levels.

### 2.4. Bamboo Charcoal – Household Energy

Mitigating the conflict between deforestation from wood charcoal production and conservation of forest resources, bamboo charcoal has been invented as a substitute for wood charcoal. Bamboo charcoal is a better option to protect the ecosystem, ensure the livelihoods of millions of rural households and sustainably supply a chain of fuel wood for rural and urban households. According to conservative records, almost 4.5 million people die every year from health problems related to using unmanageable solid wood as a biomass for cooking that generate smoke that is inhaled; in African countries, the major sufferers are women and children. During the cooking process, the bamboo biomass decomposes into volatile gases and vapours until about 400°C, where it is completely turned into charcoal. This process can be carried out in a kiln, of which there are many kinds – earthen pit, mound, brick, and steel drum.

When bamboo is farmed on a homestead, the household could produce bamboo charcoal for household cooking and sell any surplus at the market. This action will allow the family to earn income while protecting its own health and the forest.



#### Bamboo Charcoal-Benefits

- ✓Providing additional income for rural households .
- ✓Allowing women's participation.
- ✓Offering a positive development for the health of women and children.
- ✓Addressing energy poverty.
- ✓Reducing the pressure on forests.
- ✓Developing human capital through south-south knowledge transfer.
- ✓Identifying doable community-driven enterprises.

#### Bamboo Charcoal vs Wood Charcoal

Type of Bio-fuel	Volatile Matter(%)	Calorific Value(Cal/g)
Bamboo Charcoal	17	6959
Alacia Charcoal	24	7780
Prosopis Charcoal	27	6756
Bamboo Charcoal Briquette	13	7100
Cotton stalk charcoal briquette	18	4588
Chat stalk charcoal briquette	31	5100

Source: INBAR,2012

#### Techniques to produce homestead bamboo charcoal

Step I: Plant a heavy biomass bamboo (i.e. *Bambusa balcoa*; *Bambusa tulda*, *Bambusa vulgaris*; *Bambusa bambuse*).

Step II: Manage the clumps scientifically and use compost as a fertiliser to mulch, prune and protect from pests and diseases.

Step III: Harvest quality bamboo (4+ years) for optimum biomass.

Step IV: Cut the bamboo into small pieces, preferably 1 m or 2–5 cmin length and dry it(open sky/sundry) and keep it in a gunny bag or stored in a dry place to maintain moisture at a maximum of 20°C for a speedy pyrolysing process.

Step V: Place the burning/pyrolysing bamboo materials into a kiln for producing charcoal via a pyrolysing process.

StepVI: The charcoal is made into a powder in a pulverising machine (60–80 mess size).

Step VI: The powdered charcoal is mixed with 6–10 per cent adhesive (preferably waste maize powder or cassava) as a binding material to make the dough.

Step VII: The dough is placed into a charcoal ball, screw charcoal machine, hand press or hydraulic press machine to make charcoal.

Step VIII: The produced charcoal is allowed to dry in the sun (for 7–8 hours) and then is packed or stored for household cooking.

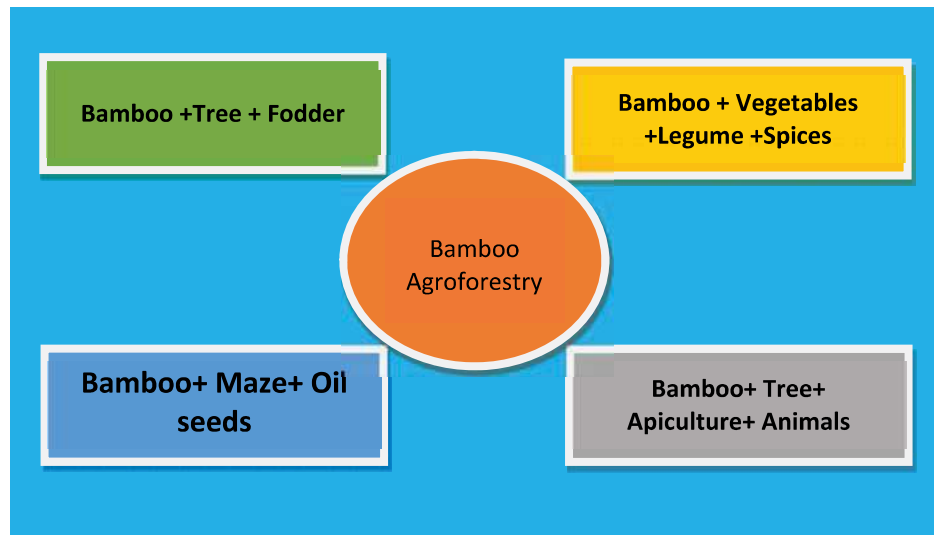


A kiln for charcoal production in the INBAR South-south Phase-II Project in Tanzania, Ethiopia, and Madagascar

# BAMBOO IN HOMESTEAD FARMING SYSTEM DEVELOPMENT

## 2.5 Bamboo Agroforestry

Agroforestry is a sustainable land-use system. It involves planting trees with arable crops (including animals) as per local environmental conditions or the chosen ecological zone. The bamboo agroforestry approach is a new area of sustainable livelihood for rural farmers. The homestead bamboo farming system is a new domain area and is encouraging farmers. It enhances the income of rural households. Bamboo agroforestry may also be carried out in a different way (Chart II).



(Chart II: A bamboo agroforestry approach)

### Management Technique: Bamboo Agroforestry

- Preference will be given to legume nature trees and a sparse crown of trees.
- Spacing should be given in an east-west orientation to reduce the competition for light and the shading effect on other vegetation.
- Pruning of trees will be done to enhance light penetration, including mulching.
- Root pruning will reduce the moisture, nutrients and choice of agricultural crops, which in turn reduces negative effects on allelopathic symptom.
- Bamboo agroforestry facilitates permanent intercropping with nitrogen-fixing trees, alley cropping and trees for soil conservation.
- In hilly regions, bamboo agroforestry will be combined with the silvi-horticultural system; agri-silvicultural; agri-horticultural and silvi-pastoral systems.
- In arid lands, bamboo agroforestry will focus on windbreaks; shelter-belts; block planting of fuelwood; the agri-silvi pastoral system and the agri-silvicultural system.

### Bamboo Agroforestry: Benefits

- Bamboo agroforestry reduces the pressure on forests and enhances better protection of ecological systems. Farming households can outsource bamboo for household energy, animal fodder and feed.
- It reduces soil run-off and improves soil fertility through the addition of litter-fall and composting on the soil.
- It augments biological diversity, creating enabling environments for birds, mammals, etc.
- It improves the microclimate by lowering soil temperatures, reducing evaporation and maintaining soil moisture.
- Bamboo agroforestry reduces total crop failure and increases farm income, mitigate the risk as a smart-agriculture practice.





Homestead Bamboo agroforestry in Tanzania, INBAR South-south Phase-II Project, May2018

## 3. Bamboo Homesteads: Cultivation Practices

Homestead bamboo farming cultivation should be established at sites suitable for bamboo growth and survival. Bamboo has two different types of rhizomes – the leptomorph type, with a single stem (monopodial), which is found mainly in temperate regions, and the pachymorph type (sympodial), found mainly in warm regions. However, most bamboo types suitable for rural homestead plantations in Africa and Asia are of the clumping type.

The running bamboos (monopodial) have long rhizomes that are quick to spread horizontally, while clumping bamboos (sympodial) have shorter rhizomes that stay closer to their point of origin and do not spread so rapidly. However, bamboo performs well in porous, deep and fertile soil with good drainage and relatively high moisture content. The dense and concentrated root systems of bamboo demand particularly high levels of soil moisture and nutrients. These species are best established on sites such as valleys, gentle slopes, streams, rivers, ponds, and backyards. Any grasses and shrubs that cover the plantation site should be cleaned and if necessary be burnt. The burned materials will be kept on the planting site and mixed with the soil to stabilise the soil and improve or maintain the soil's fertility. Site preparation for homestead bamboo farming could be done as a part of overall preparation, strip preparation or pit preparation.

The northwest area of the homestead is the most suitable location or area for homestead farming. The growing and established clumps play a role as a windbreak. The plantation site needs well-drained, healthy soil conditions and good moisture. Avoid planting bamboo in deep shade, waterlogged or salty locations. In hilly locations, the lower slopes of the hills offer good conditions for bamboo to grow well. The upper slopes have to be avoided due to issues with physical reach. The gentle slope is a conducive environment for homestead bamboo farming system development. Pits should be planted with a 30-cm cubical shape (hilly areas) with 5 m x 5 m spacing, 400 propagules (seedlings, offsets and cuttings) and African highland bamboo (4 m x 2m) using 1250 propagules per hectare. The offset pits need to be 40–45 cm larger than other planting materials. The pits need to be prepared at least 15 days prior to plantation. Using vermicompost or simple cow dung is a suitable option for fertilization. It will help to grow the bamboo in a healthy manner.



Homestead bamboo farming in Ethiopia, INBAR South-south Phase-II Project, July 2018

### 3.1 The Planting Season

The planting of homestead bamboo is best during the rainy season. Sympodial bamboo (clump forming bamboo) is usually planted before the rainy season, and it helps to generate new plantlets during or after the rain due to the congenial moisture content in the soil. The replacement of plants is needed in the instance of juvenile death of the plants.

**Planting density:** The planting density depends upon the specific site conditions and the size of the involved species. Higher densities are suitable for the establishment of small-sized bamboo. Plantings with a low density may suffer from canopy exposure, low soil moisture and strong competition from weeds and shrubs. In addition, high productivity may also be hampered by economic costs. In contrast, overstocking plants in a small area may reduce the productivity of bamboo due to intense competition in terms of light, space, soil moisture and nutrients.

### 3.2 Planting Materials

Quality planting materials (QPM) for homestead farming could be collected prior to establishing a bamboo nursery. It could be done through seeds, wildings, offsets or cuttings, which can be found in forests. Tissue-cultured plantlets can also provide planting materials. Bamboo generates seeds when it flowers; however, many tropical bamboo plants do not flower until between 40–80 years of age. In the case of gregarious flowering, an entire species will flower and die, while in sporadic flowering, clumps usually survive. Even if large amounts of seed are produced, they may be only used for a short period of time. Therefore, seeds may not be a suitable method for large-scale propagation on homestead plantations; alternative methods of raising planting materials should be investigated as follows:

- Wild bamboo (plants from seeds) from indigenous forest areas may be collected and used as bamboo planting material.
- Branch or culm cuttings from healthy mother clumps (2–3 years old) from prospective bamboo framers from the locality or adjoining village/Kebele may be employed.
- Offsets or rhizomes may be obtained from bamboo clumps at the start of the rainy season and before new buds emerge from the healthy mother clumps.
- Bamboo QPMs could also be raised to establish a micro-nursery through vegetative propagation and macro-proliferation methods. This method provides the freedom to access and multiply the planting materials according to specific needs; reduces the costs and difficulties associated with transportation; conserves planting material; and generates income from the sale of planting materials.

### 3.3 Management and Harvesting

The growth and supply of bamboo is required both for industrial and commercial markets as well as products like fuel and services like energy and restoring ecosystems. Bamboo resource management practices are needed to guarantee resources for production systems. Current yields tend to be 2–6 tonnes per acre, which is about 20 percent of a well-managed bamboo plantation. Homestead bamboo plantations can be effectively managed and support provided to achieve the maximum yield.

Weeds should be effectively controlled to prevent them from competing with bamboo for soil moisture and nutrients. Soil-loosening in bamboo plantations is important; it maintains a good soil structure due to the clumps' benefits and grows new shoots and expands the roots along with water conservation. It should be done twice in a year, both before and after the rains.

Efficiently managed bamboo homestead plantations can ensure a consistent supply of raw materials to the bamboo enterprises. In China, a suitable household management system was developed and co-opted families into managing bamboo plantations.

This resulted in a multifold increase in bamboo productivity. India has recently emphasised bamboo farming in rural, non-forest areas

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but is yet to allow forest bamboo to be managed by tribal and other farming households.

Harvesting practices should maximise the yield and at the same time fulfil the objectives of local harvesting while ensuring the sustainability of the bamboo plantation. These steps should be followed for the harvesting of homestead bamboo farming systems:

## Harvesting steps:

- Harvest mature culms 4 years of age and older, which can be identified by their colour (less green, culm sheath), sound (like iron or steel) and presence of existing lichen.
- The dry season is the best time for harvesting.
- The culms should be harvested from the centre and not at the periphery of the clump.
- A few older culms should be left in the clump after cutting as long as congestion is under control.
- Use very sharp tools. Cut each culm between 15–30 cm from the ground or just above the first node from the ground level. This is necessary so that water does not accumulate in the protruding internodes.
- The large culms should be stacked horizontally on parapets where there is good air circulation. Smaller culms may be piled horizontally at a 60° angle to form a 'tepee shape' allowing air to circulate around them to aid in the drying process.

Harvesting of the bamboo should be done selectively according to the age and maturity of the culms. Systematic and selective harvesting of mature culms assures the continuous production of young shoots and a quality supply of raw material to the bamboo enterprises. A homestead bamboo plantation will be managed on a sustainable basis. It should not be over-harvested. One-year-old or two-year-old culm should not be harvested. Only mature culm four-years-old or older should be harvested annually.

## 3.4 Pests and Diseases

Sometimes, homestead bamboo is affected by diseases; blights are common and occur in the first year of bamboo in the clump. Generally, June to December is a critical period for blight to attack emerging shoots and damage the culm sheaths along with the internodes before spreading gradually. Farmers should handle bamboo blight diseases systematically. Moreover, the harvested bamboo should also receive proper post-harvest management, including soaking, spraying or pressure treatment, using copper chromium boron (CCB) or related materials.

Step1: Visit and identify the affected culms in the plantation area.

Step2: Remove the affected growing culms from the clumps and destroy them to dig into the soil.

Step3: Sanitise the affected culms/clumps with available blight control pesticides (i.e. Carbendazim50WP; Novos +, Tricyclazole, 2ml per litre water).

Step4: A scientific plantation schedule needs to follow(Table3). It helps to build a quality plantation and encourage the return of bamboo.



## 4. Bamboo in Homestead Farming: Income and Livelihoods

The adaptation of homestead bamboo farming systems is a driving force of and a livelihood safety net for rural economies. Homestead bamboo farming has many uses for farming households in addition to income, such as its socio-cultural and ecological contributions.

Bamboo plants need 3–5 years of gestation. The intercropping of cash crops and vegetables may be done between the rows of newly planted bamboo plants; vegetable crops provide greater stability to the soil and help control erosion.

The crops suitable for inter-cropping are bananas, beans, ginger, tapioca, pigeon pea, soybean, turmeric, ginger, chilies, etc. These plants generate additional income and nutrition for the farming household.



Homestead bamboo intercropping in Tanzania, INBAR South-south Phase-II Project, July 2018

One homestead bamboo clump produces a number of new culms every year, which is its annual yield. Culms mature after three to four years; maximizing shoot production requires some shoots to not be harvested and instead be allowed to develop into leafy young culms. Under good growing conditions, a bamboo clump produces about 10 culms in a year and can produce 300 culms over a 30-year life cycle. The annual yield in tonnes/ha varies according to the species and the area in which it is cultivated. Profitable harvesting normally begins in the fifth year for commercial production.

The average income generated from per ha homestead bamboo farming is around USD2000–2500 per annum after six years of plantation. Moreover, this amount excludes the selling of bamboo culms, bamboo shoots, compost, charcoal, biochar, and nutrient value from soil conservation, including incremental soil carbon.

The scientific harvesting of bamboo culms every year will induce the emergence of new shoots and ensures regular and healthy culm production. It also aids in increasing the yield of bamboo every year by 10–20 per cent and stabilises after 5 years. The production quantity depends upon the species, plant quality, planting density, quality of the soil, fertilization, and management practices.

## 5. Conclusions and Recommendations

Establishing and promoting homestead bamboo farming systems is a critical challenge for policymakers, bamboo sector development specialists and researchers. A coordinated effort and strong networking and partnership building attempts with different stakeholders are needed to maintain progress in this area in the future.

Issues on the availability of quality bamboo planting materials, plantation methods, investments and overall supply chain management still need to be addressed. China has effectively developed a supply chain using innovation and technology. The global bamboo market had a combined annual value of approximately USD 7 billion in 2006. There is likely to be exponential growth in future global bamboo markets when bamboo products are driven by environmental concerns and linked to global GDP growth.

Empowering local institution through enabling policy could be a suitable approach to mobilise the community to adopt bamboo as one of the crops including benefits at homestead farming.

The growing and supply of bamboo are required both for industrial and commercial markets as well as products like biofuels and services like energy.

Bamboo resource management practices are needed to guarantee resources for production systems; current yields tend to be 2–6 tons per acre. Aggregating the homestead farming community will boost a large plantation and compound the direct benefits to the individual farmer by providing diverse opportunities for increased household income and indirect benefits to the environment, which will benefit the community in the long term. Start-up funding for homestead bamboo farming communities could have been done through convergences with government's flagship programmes or grants for poverty alleviation, forestation and land restoration programmes.



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## BAMBOO IN HOMESTEAD FARMING SYSTEM DEVELOPMENT

**Table 1. Calendar on homestead bamboo farming**

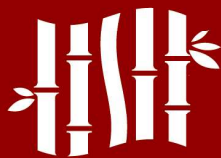
Sl.No.	Activities	Months	Gender	Manpower
1.	Plantation site preparation	February to April	Male & Female	Semi-skilled
2.	Pit Digging	May end to June	Male & Female	Semi-skilled
3.	Plantation	June to July	Male & Female	Semi-skilled
4.	Replanting	October	Male & Female	Skilled
5.	Weeding, soil-loosening and fertilization	December and January	Male & Female	Skilled
6.	Harvesting and felling	October to January	Male	Skilled

**Table 2. Investment, yield and return/per hectare farming**

S.No.	Particulars	Unit	Rate in USD	Investment in USD		Total in USD
				Labour	Materials	
1	Land preparation	18	3	54		54
2	Organic manure and nutrients(2kg per pit)	8 Quintals	15		200	200
3	Preparation of planting pits and other earthwork	50	3	150		150
4	Planting material costs and transportation(LS)	400	1		400	400
5	Fertilisers, planting and staking	5	3		15	15
6	Weeding and maintenance	5	3	15		15
7	Farm management	10	3	30		30
	Total costs			249	615	864

**Table 3. Cost, investment and return**

Sl.No.	Particulars	Unit	I year	II year	III year	IV year	V year	VI year	VII year
2	No. culm harvests (per ha)	No.	-	-	400	800	1000	1500	1500
4	Weight of the per culm	Kg	-	-	25	30	35	35	40
5	Yield per ha	Tons	-	-	10	24	35	52.50	60
6	Total expenditure	USD	864	464	510	560	610	670	730
5	Income from bamboo @ USD40/per tonne (10% increment every year)	USD	-	-	400	1080	1750	2888	3600
7	Income from intercropping with other crops agroforestry	USD	300	250	200	100	100	100	100
8	Income (Total Income - Total Expenditure)	USD	-564	-214	90	620	1240	2318	2970
Note 1: This does not include income from selling on a per pole basis to buyers for use in construction, fencing, packaging, baskets, etc. The amount could be 2-4 times higher depending on the sale price individually negotiated with buyers.									



The International Organisation for Bamboo and Rattan (INBAR) is an intergovernmental organization established in 1997. INBAR is dedicated to improving the social, economic and environmental benefits of bamboo and rattan. INBAR plays a unique role in finding and demonstrating innovative ways of bamboo and rattan to protect environments and biodiversity, alleviate poverty and facilitate fairer pro-poor trade. INBAR connects a global network of partners from the government, private, and not-for-profit sectors in over 50 countries to define and implement a global agenda for sustainable development through bamboo and rattan.

