

*Farmer-led Integrated Upland Watershed  
Management Trainers' Resource Book*

*Module 7*

Marginal Land Rehabilitation  
Processes/Experiences in the  
Hindu Kush-Himalayan Region  
of Asia

# MARGINAL LAND REHABILITATION PROCESSES/ EXPERIENCES IN THE HINDU KUSH-HIMALAYAN REGION OF ASIA

## Objectives of the Module

Before objectives of the module are defined, the Hindu Kush-Himalayan region, as it is today, is depicted.

## Background

### (1) What is the demography of the Hindu Kush-Himalayas (HKH) region?

- Parts of eight countries that fall in the region comprise the HKH.
- The region is inhabited by about 120 million people.

### (2) What effects will a degraded mountain watershed environment have on the people downstream?

- It will effect about 360 million human lives who:
  - live in the plains and
  - river basins.

### (3) Why is this region going through the vicious circle of poverty?

- It is due to:
  - conditions of underdevelopment,
  - owing to increasing population pressure,
  - agricultural production and productivity beyond the land's capability,
  - environmental degradation,
  - inappropriate technology, and
  - ineffective management practices.

### (4) What are the environmental problems in the HKH?

- It is experiencing increasing signs of land instability,
- decreasing soil fertility, and
- a high degree of soil erosion.

### (5) What is the overall resultant effect?

- The returns from land-based activities are showing a decreasing trend.
- This trend applies to the areas with
  - steep topography with fragile slopes, and
  - monsoon affected high rainfall areas.

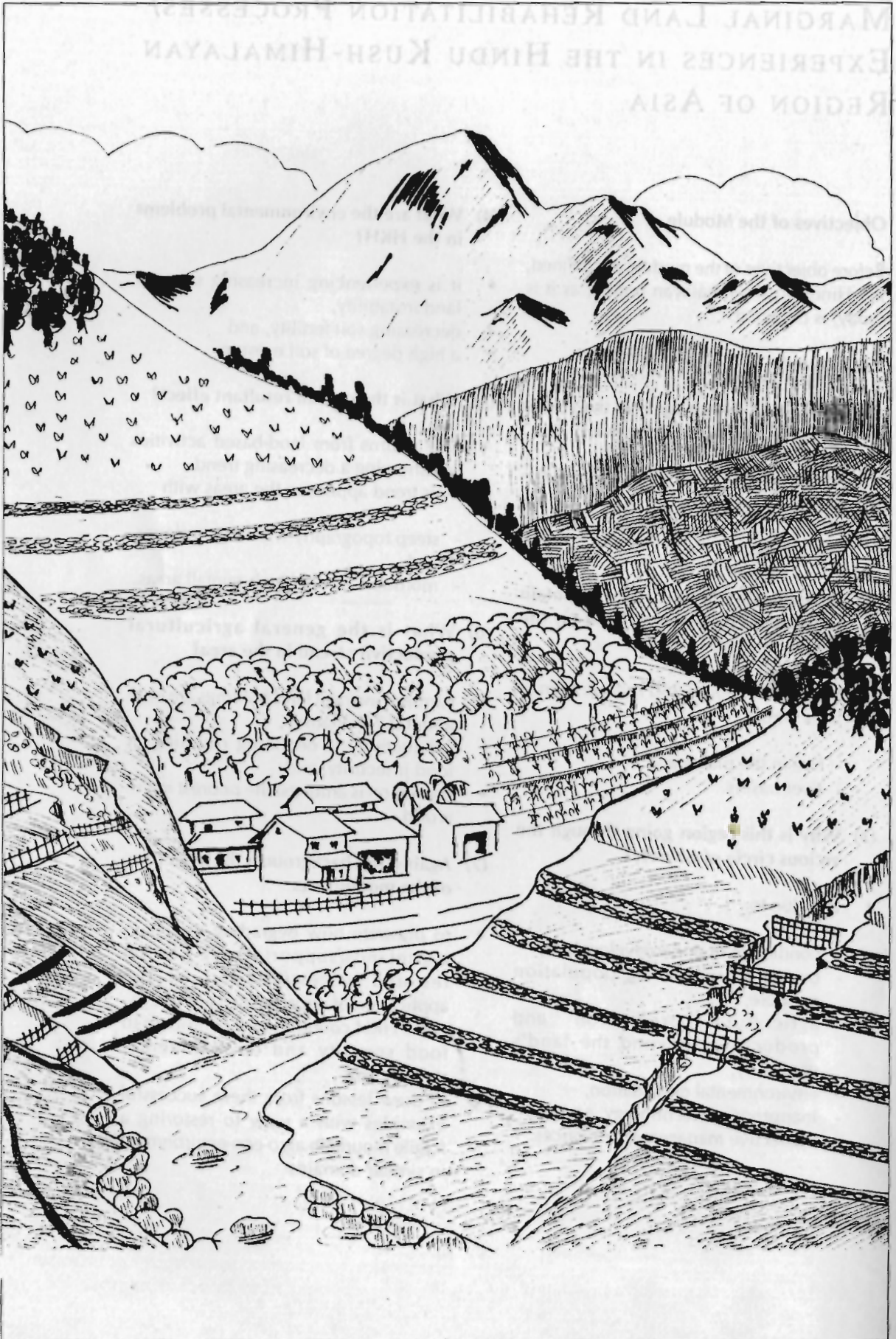
### (6) What is the general agricultural productivity trend in the area?

- Farmers' average land holdings are only about 0.25ha/family,
- productivity is declining resulting in food insecurity, and
- the region is amongst the poorest in the world.

### (7) Against this background, the objectives of the module are:

- to illustrate how degrading mountain wastelands/support lands can be restored successfully through the application of appropriate land use in some HKH countries and contribute to food security and environmental stability and
- to draw lessons from these successful examples with a view to restoring a fragile mountain agro-eco-environment in similar domains





Restoring Watershed through an Appropriate Land-use Management Plan

# MODULE 7.1

## *THE HINDU KUSH-HIMALAYAS (HKH) MOUNTAIN COMMUNITIES*

### **(8) Objectives of Module 7.1**

- To explain what is today's mountain watershed development priorities with respect to land resources' conservation, production, and productivity
- To disclose and emphasise the mountain people's efforts to cope with a rapidly deteriorating land-based resources' situation

### **(9) How is mountain agriculture characterised?**

- It is currently experiencing increasing unsustainability in:
  - agronomical crop production and productivity,
  - horticultural crops,
  - pasture,
  - livestock,
  - forestry, and
  - related support services.

### **(10) How are these effects reflected in the day-to-day lives of mountain people?**

- Increasing food deficit
- Energy shortages
- Declining agricultural productivity
- Extensive deforestation
- Physical and biological degradation of support land

### **(11) What is the general socioeconomic condition of mountain communities?**

- The living conditions in uplands are deteriorating and
- only a few alternatives remain available locally.

### **(12) How are mountain people coping with this depressing situation?**

- For seeking employment, many people are migrating to:
  - lowlands and
  - urban areas.

### **(13) How has mountain subsistence agriculture contributed to its fragility?**

- Steep and fragile slopes are being increasingly cultivated
  - for food crops and
  - are no longer kept under the protection of forest cover.
- Landslides are widespread.
- For decades, emphasis has been given only to food production.
- No care was given to preserve the soil.
- There is widespread soil erosion resulting in a major environmental problem.

### **(14) How can this environmental degradation be overcome?**

- One of the potential solutions can be
  - to bring all degraded areas under vegetative cover by appropriate land use.

### **(15) Will farmers participate in such programmes?**

- Farmers are not interested in those activities which do not address their food security concerns.

### **(16) What kind of development programme will attract farmers?**

- Those giving substantial, quick economic benefits.
- Also, those that conserve the environment with lasting effect.

### **(17) Are there such options available in the HKH region?**

- Some countries have been successful in putting innovative land use practices into practice for some time now.

They are:

- appropriate,
- sustainable, and
- environmentally friendly.

**(18) Are these practices socioeconomically and environmentally effective?**

- Efforts have paid off a rich dividend.
- Visible positive impacts of these practices can be observed on:
  - agro-economical,
  - environmental, and
  - social aspects.
- People in these areas are experiencing an improved lifestyle.

- They are living in harmony with the surrounding environment.

**(19) In this module, the undermentioned two appropriate land-use practices are included as successful examples of wastelands/ support lands' management in degraded upland watersheds.**

- Seabuckthorn (Shaji)- Ecological and Economic Forestry System, China
- Cardamom-based Agro-Forestry System, Sikkim, India.



## MODULE 7.2

### SEABUCKTHORN (SHAJI)-ECOLOGICAL AND ECONOMIC FORESTRY SYSTEM

#### (20) Objective of Module 7.2

- To discuss how Seabuckthorn plant species are being used successfully as land cover both for soil conservation and entrepreneurial purposes

- directly from seeds or
- from seedlings or
- through cuttings.

#### (25) Is propagation from seeds a better option?

- Growing it from seeds is:
  - simpler,
  - involves lower costs,
  - produces a greater number of seedlings,
  - SBT seedlings have a greater survival rate and grow faster compared to SBT grown from cuttings; and
  - one kg of air-dried seed material contains 130,000-140,000 seeds.

#### (21) What is Seabuckthorn (SBT)?

- It is an arboreal shrub-species (*Hippophae* Linn.).
- There are several species of SBT.
- The most important being *Hippophae rhamnoides* Linn.
- It is commonly known as Seabuckthorn (Shaji in Chinese)

#### (22) What is a Seabuckthorn Forestry System?

- It is one of the most successful watershed forestry land-use practices:
  - developed as a land cover,
  - used for quick economic gains, and
  - used for soil conservation and rehabilitation of degraded lands in upland watersheds.

#### (26) How are cuttings taken?

- Standard cuttings are taken from the base of a:
  - two to three years' old shoot,
  - 10-25 cm in length, and
  - 0.8-1.5cm in diameter.

#### (23) Does it have wide adaptability?

- It grows quite well in:
  - dry,
  - cold,
  - wet sandy areas,
  - hilly areas, and
  - even in semi-desert conditions.
- Its growing altitude ranges from a few metres to 5,200m above mean sea level.
- It can withstand temperatures from -43°C to 40°C.
- It can be grown under varying pH conditions.

#### (27) What is the age of seedlings for transplanting?

- Generally, 6-18 months old seedlings are transplanted.

#### (28) How soon do they start bearing fruit?

- Plants propagated from cuttings bear fruits:
  - one to two years earlier
  - than the ones grown from seedlings.

#### Planting Techniques

#### (24) How is SBT propagated?

- It can be grown easily either:

- It grows to a height ranging from 1.5 to 4.8m.
- It produces 750 to 1,500 kg of berries/ha.

## Ecological Benefits

### (29) How did the Seabuckthorn Forestry System provide ecological benefits?

- It achieved remarkable effects in:
  - retaining water and keeping soil
  - checking wind and stabilising sands, and
  - reduction of runoff and silt.

### (30) Does it improve the physical and chemical properties of the soil?

It:

- improves soil permeability,
- improves soil moisture content,
- increases the organic matter content, and
- facilitates ecological succession and healthy ecosystemic evolution.

### (31) What was its impact on forest resources?

- Regulated microclimatic conditions in forest regions
- Reduced wind speed
- Provided abundant feed to livestock
- Stabilised agro-ecosystems
- Increased mixed forests areas, new species, and biodiversity of plants and animals

## Products of Seabuckthorn

### (32) Are all the Seabuckthorn plant parts useful?

- Multifarious useful values are generally associated with:
  - branches,
  - trunks,

- barks,
- leaves, but mainly fruits and seeds are used in agro-enterprises.

### (33) What is its importance on the world scene?

- It is widely distributed throughout
  - the HKH region and temperate zones of Asia and
  - the European continent.
- For its remarkable value in:
  - improving environmental conditions and
  - in alleviating poverty.
- Its relative and specific advantages are being capitalised on in:
  - China and other areas of the world.
  - Russia has cultivated forms used as horticultural plants in several orchards.

### (34) What are its major uses?

- It can be used as a pioneer plant:
  - for soil and water conservation and
  - as a natural resource for over 200 products, covering:
    - \* food with no dangerous additives,
    - \* drinks,
    - \* wine, and
    - \* medicines.
- It is rich in nutrition.
- Because of these multipurpose uses of this plant, it is called a 'magic plant'.

## MODULE 7.3

### SEABUCKTHORN (SHAJI) SUCCESS STORY IN CHINA

#### (35) Objectives of Module 7.3

- To describe how Seabuckthorn is an excellent land-use option for improving degraded mountain watershed areas, in general, and areas with harsher climates, in particular, in China
- To reveal which other unique multifarious qualities the Seabuckthorn is famous for in China

#### (36) When was systemic and comprehensive development of SBT land use started in China?

- It was started in 1985.
- Local officers and farmers conducted trials.
- Demonstrations and extension activities were carried out.

#### (37) How large is the Seabuckthorn forest area coverage in China?

- By the end of 1990, China had already over 1 million ha of Seabuckthorn forest.
- It is distributed throughout 19 provinces.

#### (38) How is it performing in China?

- It has become a new industry in China.
- China has done very well in exploiting and using seabuckthorn fruit and seeds for agro-enterprise development in otherwise resource-poor mountain areas.
- Seabuckthorn is known for its extraordinary:
  - ecological functions and
  - economic value for poor farming communities.

#### (39) Where is it proving most useful and sustainable?

- In harsher areas characterised by:
  - cold,

- dry, and
- windy weather.

#### (40) Who are benefiting most from this plant species?

- It is understandable that harsher areas are:
  - inhabited and farmed by the poorest farmers, hence
  - they are the ones who get most benefit from it.

#### (41) How other interventions in the area failed?

- During the previous 20 years' period, government agencies and others
  - experimented with various interventions.
  - They met with limited success and no improvement in the areas.

#### (42) How did Seabuckthorn prove to be a technological breakthrough for the area?

- Due to the increase of area under Seabuckthorn forest:
  - there are improvements in soil and water conservation,
  - there is a substantial improvement in the environment,
  - the surface runoff has decreased by as much as 80 per cent,
  - the loss of topsoil has decreased by 75 per cent,
  - moisture in the soil has increased by 2.6 per cent,
  - the overall fertility of the soil has also increased, and
  - from Seabuckthorn fruits and seeds new raw materials were made available for agro-industries in abundance.



(43) What are the different uses of Seabuckthorn?

- The **fruit** is used in a variety of ways:
  - soft drinks,
  - wine,
  - medicine, and
  - cosmetics.
- The **leaves** make good fodder for livestock.
- The **residues** left after the fruit processing make high quality:
  - animal feed,
  - fish meal, and
  - additive.

(44) Has Seabuckthorn also become an industrial enterprise?

- To date, Seabuckthorn fruits and seeds have been used to support more than 150 factories.
- These factories are producing more than 200 Seabuckthorn products including:
  - oil,
  - medicine,
  - cosmetics, and
  - drinks.
- The total output value from Seabuckthorn enterprises is more than US\$ 20 million.

## MODULE 7.4

### OTHER BENEFITS OF SEABUCKTHORN (SHAJI)

#### (45) Objectives of Module 7.4

- To explain, apart from its major soil and water conservation role, what other benefits can be derived from Seabuckthorn land-use practice
- To describe the lessons learned from China's experience in the use of Seabuckthorn, both as a soil conservation method and as a cash income-generating enterprise

#### Economic Benefits

##### (46) What was the economic output?

- In 1993:
  - 2,400 tons of fruit and
  - 500 tons of seeds were harvested.
- The farmers received US\$ 90,330 by selling the seeds.
- The factories received US\$ 648,529 by selling processed products.
- The total income from Seabuckthorn products of the poor county of Jianping in north China reached US\$ 990,176.
- The export price of SBT oil is US\$ 500/kg.

#### Soil Fertility Improvement

##### (47) How has Seabuckthorn enriched plant nutrients in the soil?

- It has a strong and extensive root system.
- It has a high nitrogen-fixing capacity with 180 kg/ha.
- Organic matter content:
  - 20 to 30 per cent in SBT forest land, compared to
  - between two to three per cent in non-SBT area.
- There are increases in

- total nitrogen by 61 per cent and
- total phosphate by 14 per cent.

- The porosity of soil increased by 1.5 to 2.6 per cent.

##### (48) Has the Seabuckthorn plant improved the soil's physical and chemical properties?

- It has increased:
  - the soil fertility status and
  - soil conservation characteristics, e.g., texture, porosity, etc.

##### (49) How does the Seabuckthorn plant check wind erosion?

- It can decrease the wind velocity
- It is effective by as much as 81 to 90 per cent in protecting the area from drifting sand in windy areas
- Wind erosion resistance has improved by from four to 35 times.
- Wind erosion decreased by 85 per cent.

##### (50) How has Seabuckthorn improved soil infiltration rate?

- Due to SBT cover effects, the infiltration rate of soils has greatly increased on about two million ha compared to fallow slopes.
  - it has increased by around 500% due to the enormous root system

- this has led improvements in:
  - physical and
  - chemical characteristics of the soil.

##### (51) How has it been effective in checking water erosion?

- Runoff has decreased by 80 per cent
- Surface water erosion decreased by 75 per cent

**Agro/Forestry/Animal Husbandry Linkages****(52) Was there an increase in yield of cereal crops when grown in rotation with Seabuckthorn?**

- The agro-eco-environment has improved quite noticeably.
- The yield of wheat increased from a mere 300 to 1,125kg.
- Wheat was planted in the area previously occupied by Seabuckthorn for three to five years. (It is a general practice in the Northern Areas of Pakistan to cultivate Seabuckthorn for three to four years before opening up new agricultural land.)
- General crop yields have increased:
  - from 1,400kg/ha in 1980
  - to 2,625kg/ha in 1987.

**(53) How is Seabuckthorn proving beneficial to both farm and non-farm animal husbandry?**

- The development of animal husbandry has been promoted.
- The Seabuckthorn forest area also acts as an excellent grazing area for livestock.
- The number of wild animals has increased remarkably.

**(54) What is the availability of fodder grasses in the Seabuckthorn forest areas?**

- Forest grass resources become increasingly abundant.
- The problem of fuelwood has been fundamentally solved.

**Harvesting of Fodder/Fuelwood****(55) What are the suitable stages for Seabuckthorn fodder/fuelwood harvesting?**

- The definitions given below will facilitate our understanding of Seabuckthorn harvesting stages.

**(56) What is the Quantity Mature Age of Seabuckthorn?**

- The age when the maximum biomass/year/unit area is reached.

**(57) What is the Economic Mature Age of Seabuckthorn?**

- The age when the maximum energy reserve of branches per unit area and

the maximum nutrient content of leaves per unit area is reached.

- Branches have the maximum biomass when the tree is seven years old.
- Leaves have the maximum biomass when the tree is eight years old.
- Biomass increases rapidly until five years.
- Rapid growth of the Seabuckthorn plant:
  - \* for branches is at five to seven years age and
  - \* for leaves is at four to five years age.

- After the rapid growth period, quantitatively and economically Seabuckthorn exceeds maturity.
- Therefore, timely harvesting of the Seabuckthorn plant is necessary

- for fuelwood plantations:
  - \* rotation felling period should be seven years.
- For fodder, it should be at five years.

**(58) What are the problems associated with a mature Seabuckthorn forest?**

- The major problems are:
  - high canopy density and
  - low yield and difficulty in picking fruits.

**(59) Which are the major lessons to be learned?**

- Seabuckthorn is a multipurpose plant with its special features of usefulness which restore and conserve soil and water.
- The products and bi-products derived from SBT plants provide quick economic returns to farmers and entrepreneurs.
- Seabuckthorn, apart from its major role in soil conservation, has other multipurpose economic uses, e.g., fodder/feed, drinks and medicines.



## MODULE 7.5

### A CASE STUDY

#### (60) Objective of Module 7.5

- To reveal how an area in China having serious environmental problems, including soil infertility, severe wind erosion, frequent flooding etc has been remarkably improved through the use of Seabuckthorn land-use practice

This case study is from the Jianping county of China.

#### Revelations by the Case Study

##### (61) How was the area before the intervention?

- It was characterised by:
  - serious wind erosion,
  - lack of vegetation cover,
  - low soil organic matter,
  - drought in spring season,
  - frequent floods in summer,
  - deep ground runoff, and
  - mostly poor farmers.

##### (62) What was done to improve the area?

- SBT was used as a measure for soil conservation since the 1980s.

#### Programme Impact

##### (63) How were the wastelands recouped?

- It took three years to become a stable forest under poor soil conditions.
- In very poor soil conditions, it took five years to become a stable forest.

##### (64) What is the status of soil fertility in the area?

- The soil fertility level in Seabuckthorn forest is better than the non-Seabuckthorn area.
- Seabuckthorn forest has better organic matter content than non-Seabuckthorn areas.
- The fallen leaves helped to increase soil organic matter.
- A five-year old tree had 3.1kg of root mass providing remarkable development of the root system.

##### (65) What is the general condition of the area now?

- The soil moisture content has improved in Seabuckthorn forest.
- This area also showed a visible effect on soil conservation.
- By 1993, over 66.6 thousand ha were under Seabuckthorn plants.
- Widespread green cover was established in a cold and dry agro-ecological zone.

## MODULE 7.6

### THE CARDAMOM AGROFORESTRY SYSTEM OF SIKKIM

#### (66) Objective of Module 7.7

- To explore the background of the case study before objectives are described

#### Background

#### (67) Sikkim: Where is it located and what are its constraints?

- Sikkim is the 22nd state of India.
- It is situated in the eastern Himalayas.
- The altitude of Sikkim ranges from 300 to 8,500 masl.

#### (68) What are its major agro-ecological zones?

- Sub-tropical zone
- Mid-hill humid zone
- Mid-hill dry zone
- High hill temperate zone

#### (69) What are its present land-use patterns?

- The total land area is 710,000ha
- Only around 12 per cent of the land area is under arable crops
- About 33 per cent of the area is under forest cover

#### (70) How rich is Sikkim in its biodiversity?

- There are about 600 plant species and more than 4,000 species of flowering plants.

#### (71) Which are the dominant crops in Sikkim?

- Crops grown at lower elevations:
  - paddy and
  - mandarin oranges.
- Crops cultivated at higher elevations are:
  - potatoes and
  - maize.

#### (72) For which high-value cash crops is Sikkim agro-climatically more suited?

It is well suited to:

- cardamoms,
- ginger,
- potatoes, and
- various other horticultural crops.

#### (73) What is the present agricultural productivity of Sikkim?

- It records relatively moderate to low agricultural productivity.
- Agricultural practices are primarily based on organic farming. In Sikkim, there is very little use of chemical fertilizers.
- This all results in a poor quality of life for its people.

#### (74) What are its niches?

- This area has a unique agroclimatic feature resulting in
  - relative advantage and
  - biodiversity in low-lying plains' areas.
- The question is how to make use of this
  - incomparable resource-base advantage,
  - for the common good of mankind, and
  - also for preserving the mountain ecosystem.

#### (75) Hence, in light of this background, the objective of this module is established.

- To describe how the indigenous cardamom agroforestry farming system in Sikkim has been effective in development, conservation, utilisation, and sustainable use of its natural resources in an environmentally friendly way.

**Large cardamom (*Amomum subulatum*) is a native of the Sikkim Himalayas.**

**(76) What are the agroclimatic requirements for cardamoms?**

- Cardamom is a shade loving plant.
- It requires high moisture and high humidity.
- There should be perennial water around.
- The annual rainfall should be from 1,500 to 3,500mm.
- It grows well at altitudes between 600 m and 2,000 masl.

**(77) How many species of large cardamom are there in Sikkim?**

- Six species of large cardamom exist in wild form.
- *Amomum subulatum* is the cultivated species of large cardamom.

**(78) Where is it planted generally?**

- The large cardamom is planted usually on steep hill slopes.
- It is planted under tree cover:
  - either in natural forests
  - or in plantations.
- In Sikkim, it is generally found growing under:
  - the Indian Alder tree (*Alnus nepalensis*)
  - or mixed trees shades.

**(79) How was cardamom grown traditionally in the past?**

- In Sikkim, farmers have been cultivating large cardamoms for centuries.
- Before forest ownership was passed on to village communities, native people used to collect the large cardamom capsules from natural forests.

**(80) When was cardamom domesticated?**

- The crop was domesticated after the provision of forest ownership to village communities.

**(81) What was the system of cardamom cultivation prior to 1950?**

- It was under the total monopoly of big *Bhutia* landlords (*Kazi(s)*).

**(82) How are farmers taking care of marketing interests?**

- Farmers through their experience have understood
  - the intricacies of marketing mechanisms and
  - accordingly organised the market-oriented cardamom production system.
- Farmers have quite a reliable market, though price fluctuation can be a problem.

**(83) Is Sikkim the largest producer of large cardamoms in the world?**

- Sikkim alone produces around 80 per cent of the large cardamoms in the world.
- It is a highly entrepreneurial:
  - high value and
  - less volume cash crop of the area.

In spite of there being no modern communication facilities, cardamom cultivation is prospering and being sustained.

### Cardamom Propagation

**(84) How is cardamom propagated?**

- Seedlings are raised from seeds
- or by rhizomes separated from plant hills.

**(85) Which one of the two propagation methods is more common?**

- Propagation from rhizomes is more common as:
  - it is easier,
  - quicker, and
  - cheaper.

**(86) What is the duration of the crop?**

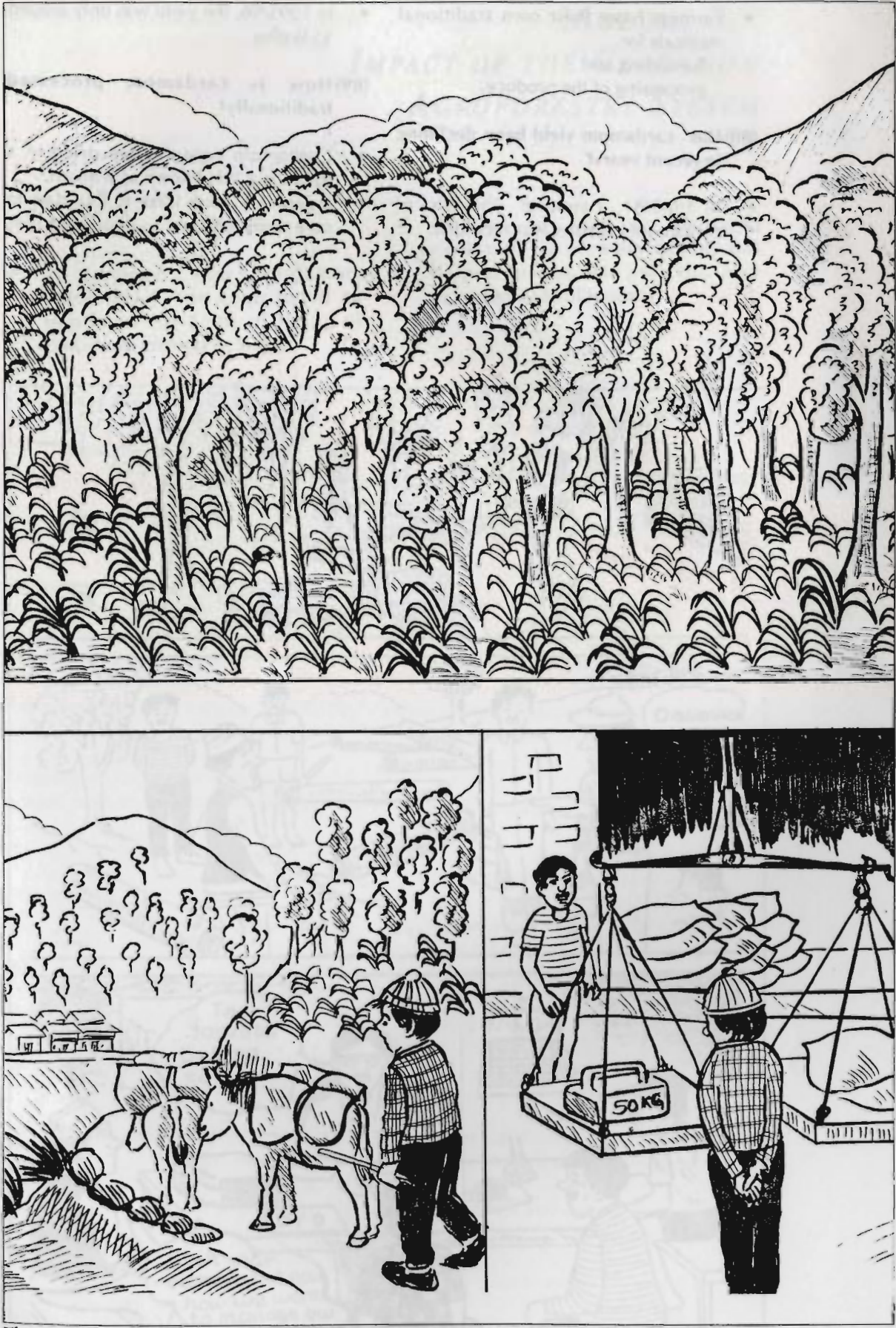
- Transplanting of the crop is carried out during the summer.
- The crop comes to maturity after a year.

### Cardamom Yield

**(87) When is cardamom harvested?**

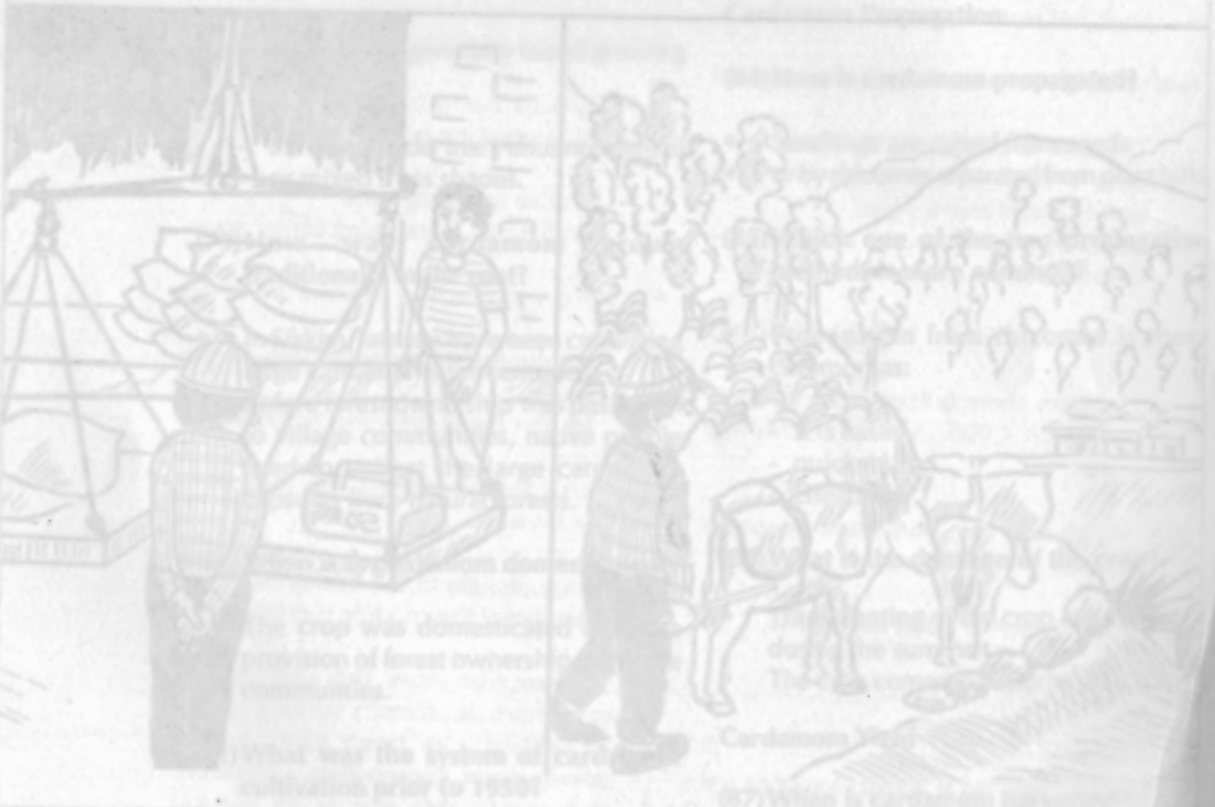
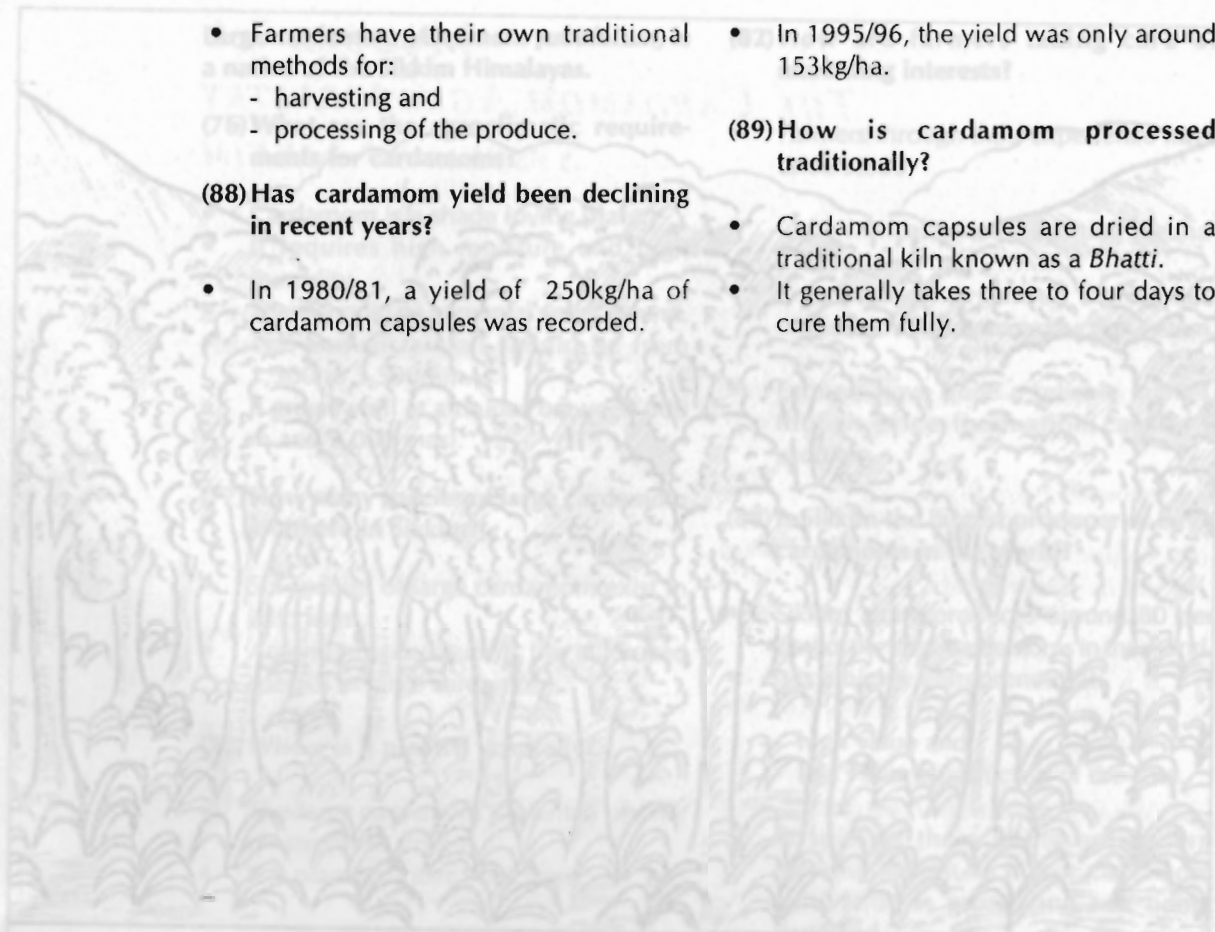
- It is harvested from August through to November.





The cardamom agroforestry system in Sikkim is proving an environmentally and economically viable proposition

- Farmers have their own traditional methods for:
    - harvesting and
    - processing of the produce.
  - In 1995/96, the yield was only around 153kg/ha.
- (88) Has cardamom yield been declining in recent years?
- In 1980/81, a yield of 250kg/ha of cardamom capsules was recorded.
  - Cardamom capsules are dried in a traditional kiln known as a *Bhatti*.
  - It generally takes three to four days to cure them fully.
- (89) How is cardamom processed traditionally?





## MODULE 7.7

### IMPACT OF THE CARDAMOM AGROFORESTRY SYSTEM

#### (90) Objectives of Module 7.8

- To explain how cardamom agroforestry has contributed to improved standards of living of cardamom growers in Sikkim
- To describe how an increased cardamom agroforestry canopy has helped to stabilise soil and also increased its fertility status



Negotiation is the best way to solve problems



**(91) How has cardamom agroforestry been contributing to environmental improvement?**

- Taking the agroclimatic relative advantage of the region:
  - by putting increasingly more land under high-value cash crops,
  - it has helped to improve the overall environmental conditions of the area mainly by bringing:
    - \* marginal and barren lands under a sustainable and agro-ecologically friendly production system
    - \* soil conservation promotion activities are leading to an improved mountain environment and soil fertility.
- This clearly indicates that the processes of:
  - development,
  - conservation, and
  - utilisation can be mutually supportive and reinforcing.

**(92) Has cardamom agroforestry contributed to an improved quality of life?**

- It has positive implications on the
  - quality of life and
  - sustainability of land productivity.

**(93) Are the plant nutrients higher in cardamom agroforestry areas?**

- Soil nutrient levels are higher especially:
  - organic carbon and
  - total nitrogen.

**(94) What is the effect of cardamom agroforestry on soil erosion?**

- The soil erosion rate measured in the rainy season is:
  - about 16 times less in cardamom agroforestry
  - compared to the maize-potato system.

**(95) Is cardamom agroforestry providing better protective cover?**

- There is less nutrient loss:
  - through soil erosion and
  - overland flow.
- The canopy interception of rainwater is much higher in the cardamom system than agricultural crops alone.
- The runoff as a percentage of the total precipitation
  - in the cardamom agroforestry system is only 2.17 per cent, compared to
  - 9.2 per cent in the maize potato system.

**(96) Is the cardamom agroforestry system less nutrient exhaustive?**

- Loss of plant nutrients in the maize-potato system
  - **Nitrogen** is 15 times higher than in the cardamom agroforestry system.
  - **Phosphorus** is 11 times higher than in the cardamom agroforestry system.

**(97) Which species of trees prove more beneficial?**

- The large cardamom is generally cultivated under the shade of both:
  - *Alnus nepalensis* and
  - mixed trees.

• The yield of cardamom is:

- 2.2-times higher under *Alnus nepalensis*
- than under mixed tree shade.

**(98) What is the cause of this yield difference?**

- It is mainly attributed to the atmospheric nitrogen-fixing ability of *Alnus nepalensis*.
- It is reported that it can fix 65.34kg of nitrogen/ha/year.

**(99) Does the cardamom agroforestry system promote biodiversity?**

- In Sikkim's context, it is supporting more than 23 tree species.

- These various trees play important roles in the:
  - socioeconomic life of the farming communities
  - by being valuable assets in the form of:
    - \* fodder,
    - \* fuel,
    - \* timber,
    - \* farm tool materials,
    - \* animal bedding, and
    - \* leaf litter compost.
- These trees also provide shelter to birds and animals who in turn help to maintain ecosystems.

# MODULE 7.8

## LESSONS LEARNED



### (100) Objective of Module 7.9

- To bring out the rational and salient features of indigenous cardamom agroforestry practices in Sikkim to help in replicating such systems in similar domains for niche-based farming
- The large cardamom is an excellent high-value cash crop.
- It is suitable for the mountain region's
  - agroclimatic conditions and
  - environment.
- The large cardamom as a production option is:
  - perfectly compatible with the mountain specificities and
  - fulfills both the necessary and sufficient conditions to be sustainable.
- The cardamom agroforestry system in Sikkim has clearly demonstrated that:
  - it is a viable land-use practice/farming system
  - for similar agro-ecological domains for both:
    - \* socioeconomic and
    - \* agro-environmental reasons.
- There are various issues which need to be addressed

These include:

- occurrence of viral diseases,
- over age of plants,
- lack of institutional build up,
- lack of necessary support and linkages between:
  - \* research,
  - \* development,

- \* extension,
- \* production, and
- \* marketing.

- Similar and more complex and diversified agroforestry systems have been highly prevalent and sustainable in farmers' 'Kandian Gardens' in Sri Lanka.
- The cases once again prove that for a successful farmer-led and owned watershed management programme, the following requirements should be met.
  - Ownership of the resource base
  - Investment
  - Capacity-building for farmers
  - Support facilities such as markets, infrastructure, extension facilitation, etc.

### (101) Conclusions

#### Seabuckthorn

- Seabuckthorn is a multipurpose plant with a special usefulness in restoring and conserving degraded, fragile marginal mountain ecosystems such as those prevalent in the HKH mountain regions.
- The products and bi-products derived from SBT plants provide quick economic returns to both needy farmers and entrepreneurs engaged in cultivation, harvesting, processing, and marketing activities.
- Seabuckthorn, apart from its major role in soil conservation, has multipurpose uses including:
  - economically viable enterprises,
  - nutritious fodder/feed,
  - excellent drinks, and
  - highly effective medicine.



Large Cardamom

- The large cardamom is an excellent high-value cash crop, suitable for the agroclimatic conditions and environment of the mountain region.
- The large cardamom as a production option is perfectly compatible with the mountain specificities and

fulfills both the necessary and sufficient conditions to be sustainable.

- The cardamom agroforestry system being followed in Sikkim has clearly demonstrated that it is a viable land-use option for similar agro-ecological domains both socioeconomically and agro-environmentally.

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