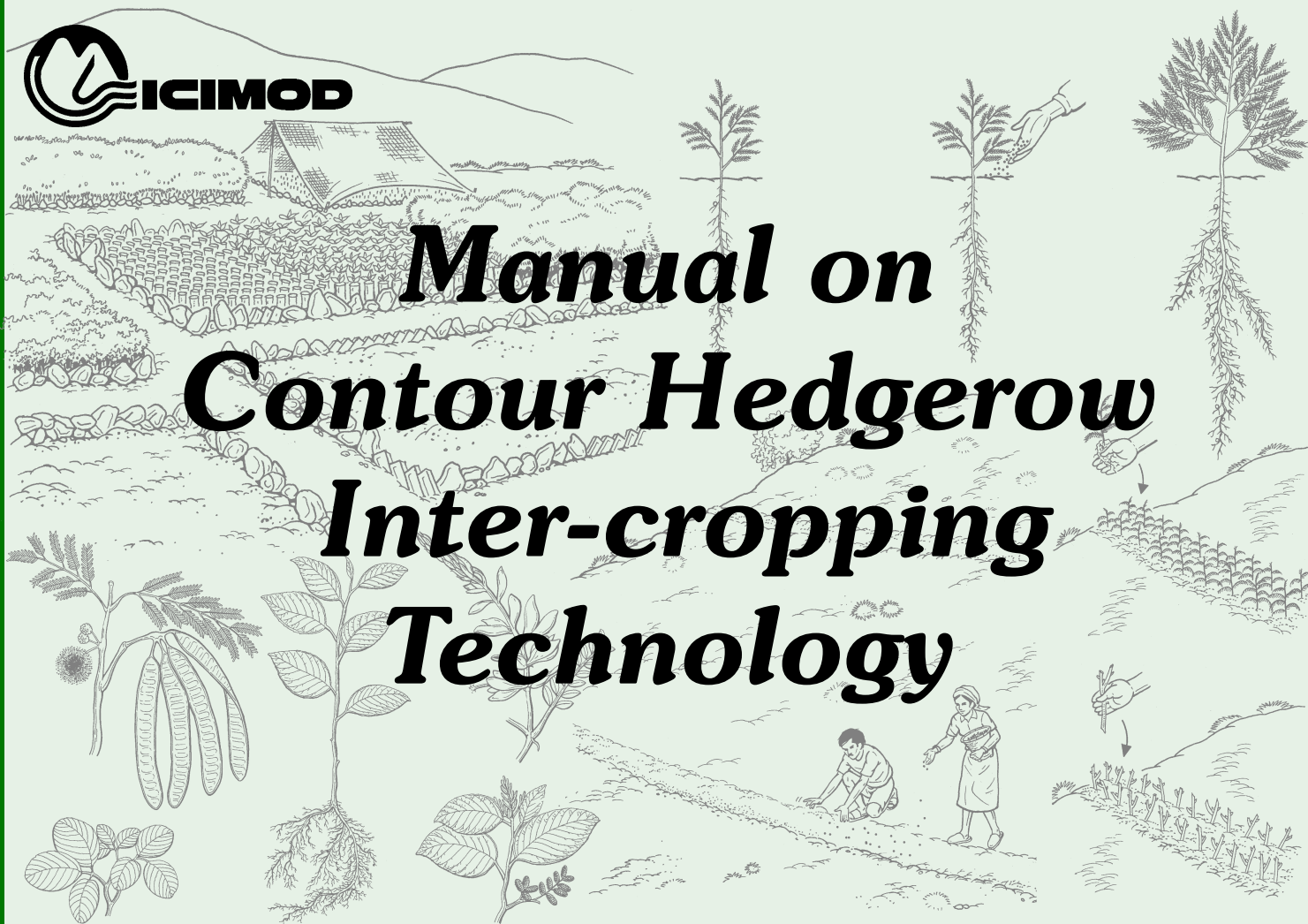




# **Manual on Contour Hedgerow Inter-cropping Technology**



*Manual on  
Contour Hedgerow  
Inter-cropping Technology*

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***Published by***

International Centre for Integrated Mountain Development  
G.P.O. Box 3226,  
Kathmandu, Nepal

***ISBN***

***Layout by***

Dharma R. Maharjan

***Typesetting at***

ICIMOD Publications' Unit

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## **Editor's Note**

Process of developing the manual

With a core team comprising of a person well versed in the technical aspects of the topic selected, an illustrator, and an editor/communication specialist, several planning and design meetings were held.

An outline of the manual was prepared from information collected from other manuals on similar topics together with experiences from the field. A page-wise break down was made and the first version of the text for each page was prepared along with a tentative design for the manual.

Thereafter, meetings on planning sketches were held. Feedback on the sketches was incorporated six to seven times. The text was constantly developed to match the changing illustrations. Feedback from all committee members was obtained both on illustrations and text.

Finally, sketches were inked and then scanned and saved in Photoshop Version 5. Further changes and finishing touches were added with the help of Corel Draw 8. The draft for field-testing was prepared by merging the text and the illustrations on each page.

## **Acknowledgements**

First of all, I would like to thank Mr. George Weber from Helvetas Nepal for his useful suggestions and his help in arranging the field testing in different parts of Nepal by four institutions. I would like to thank also those of my colleagues who have helped in the development of this manual.

I thank the Chittagong Hill Tracts' Development Board, Bangladesh, the Chengdu Institute of Biology, Chinese Academy of Sciences, ICIMOD Godawari Testing and Demonstration Farm, National Educational and Social Development Organization (NESDO), Nepal, District Agricultural Development Office, Parbat, Nepal, and Nepal Agroforestry Foundation (NAF) for field testing the draft manual and for their useful comments and suggestions.

**Tang Ya**

10 October 1999

This manual is part of the project on Appropriate Technologies for Soil Conserving Farming Systems supported by the Asian Development Bank (ADB). This project is implemented in Bangladesh, China, India, Nepal, and Pakistan in collaboration with partner institutions.

## **Guide to users**

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## Introduction

The challenge of a marginal farmer in the mountain areas is to maintain or increase crop yield with minimum external inputs to the ever-shrinking farmland while conserving soil. If properly managed, the same land that is used for food and cash crops can be used for fodder and fuelwood as well.

Contour hedgerow intercropping technology or Sloping Land Agricultural Technology (SALT) is primarily a soil-conserving technique. This technology involves planting double hedgerows of nitrogen-fixing plants along the contour lines on the slope at a distance of four to six metres. The space between the contour hedgerows, the alley, is used for agricultural and cash crops. The plants for the hedgerows are selected according to the need for fuel or fodder as also for their soil-conserving attributes. Additionally, farmers can also grow cash plants, such as mulberry, within the double hedgerows on each contour line. This technology, therefore, helps to increase farm income, facilitates multiple use of the land, and provides opportunities to marginal farmers to improve their living standards.

The present manual is being developed as a training tool, therefore the immediate users would be trainers and any institution with extension programmes. The interim users would be extension workers at the district/county level and the ultimate beneficiaries, of course, the farmers.

The goal of the manual is to establish links that bring about improved livelihoods by applying the contour hedgerow intercropping technology.



Compared to traditional up and down farming practice, contour hedgerow intercropping technology requires more labour in establishing and managing contour hedgerows. Before adopting the technology, the farmer should be convinced that the extra effort on contour hedgerows will bring forth benefits in terms of increased income and opportunities to expand the production base.

The manual is structured so that it will facilitate extension workers to open up discussion on the direct benefits of the contour hedgerow system before going into the process. This system allows for better management of the land; therefore increased productivity and increased income, apart from availability of fuel and fodder, are direct benefits. The indirect benefit to the farmer is soil conservation in terms of maintaining the nutrient balance, reducing runoff and soil erosion, and improving water infiltration.

ii ► The correct selection of hedgerow species is most important. Apart from the nitrogen-fixing attributes, the hedgerow plants should be selected according to the local needs and availability—fuelwood or fodder.

The hedgerow practice described in this manual will need adaptation according to local conditions. We suggest farmer-researcher discussion and farmer-led experimentation in order to find the best local model design.

The International Centre for Integrated Mountain Development (ICIMOD) has a unique mandate to foster an economically and environmentally sound mountain ecosystem and to improve the standards of living of the mountain people of the Hindu Kush-Himalayas. This is largely implemented through the four statutory functions, namely, information exchange, research, training, and advisory services.

People are central to sustainable management. Therefore, it is essential that many new technologies, strategies, and techniques that are being used to further this goal need to be disseminated. ICIMOD's throughput is

channelled mostly through networks of institutions within the region. It is, therefore, important to provide information in a format that is easily applicable in the field for the benefit of our 'ultimate' partners in development—the people. It is also important to provide the mountain communities with information that is sound and has been tested in their living conditions.

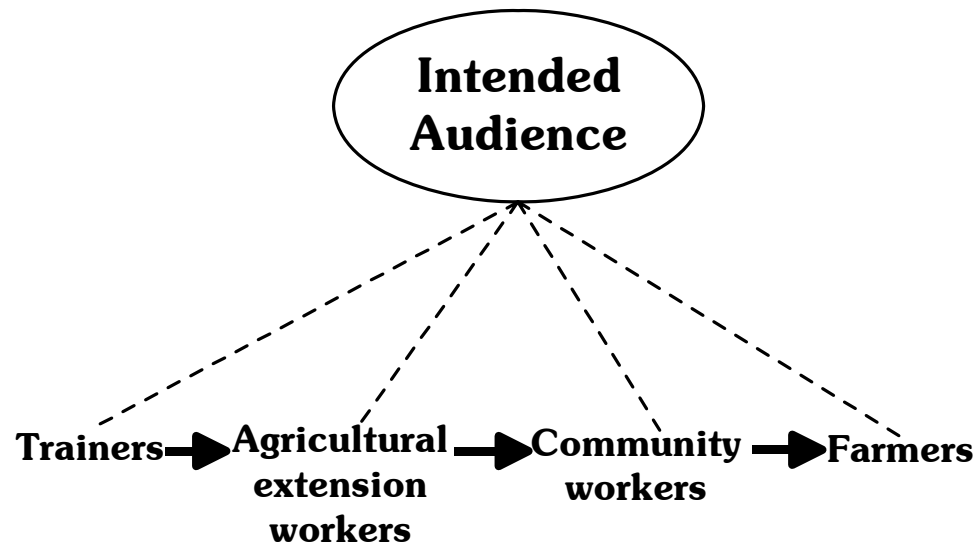
After a decade and half, ICIMOD has a wealth of information that needs to be analysed and presented in a form that will bring about change.

The drawings can be made available by ICIMOD on request from partner institutions and the text can be translated into any language.

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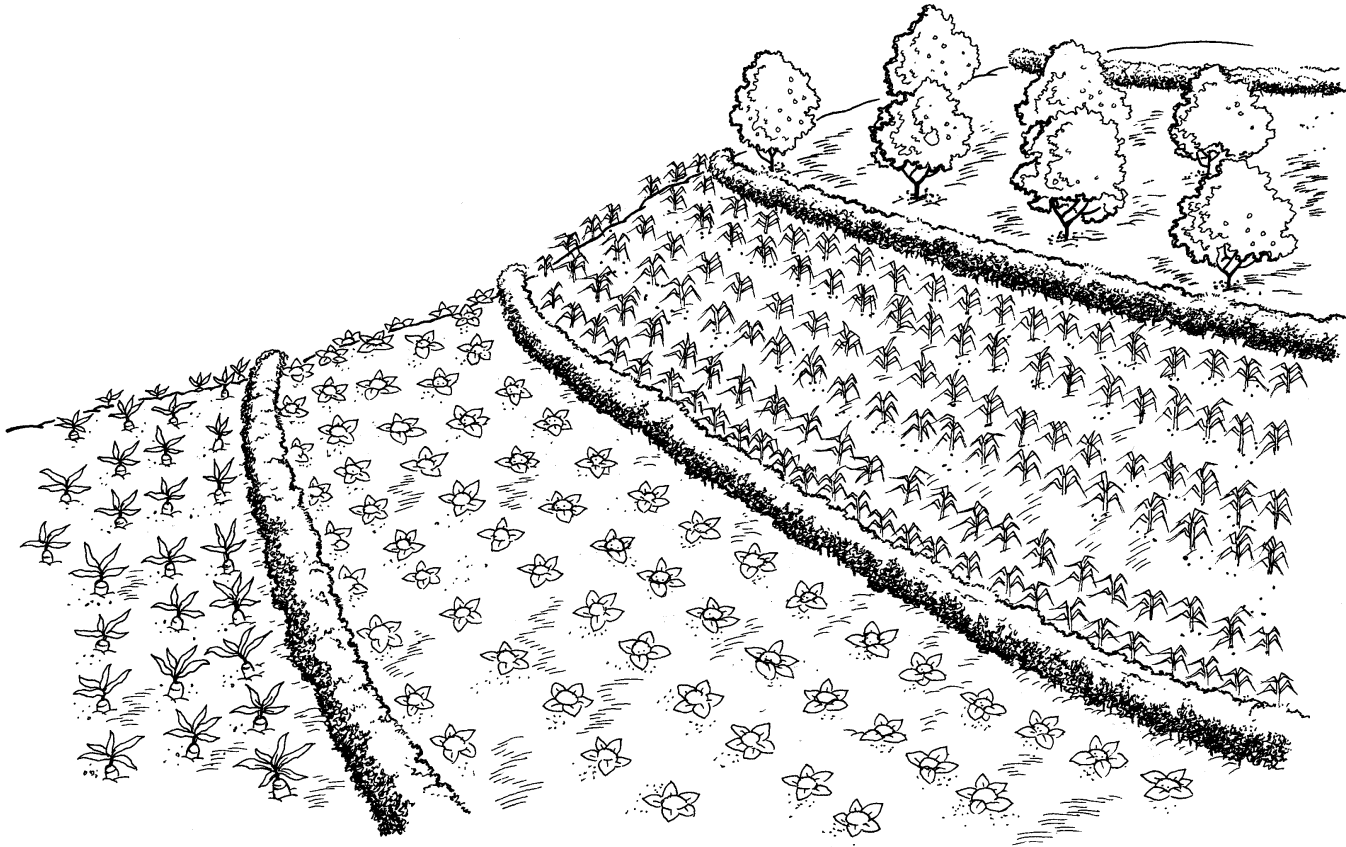
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## Intended Audience



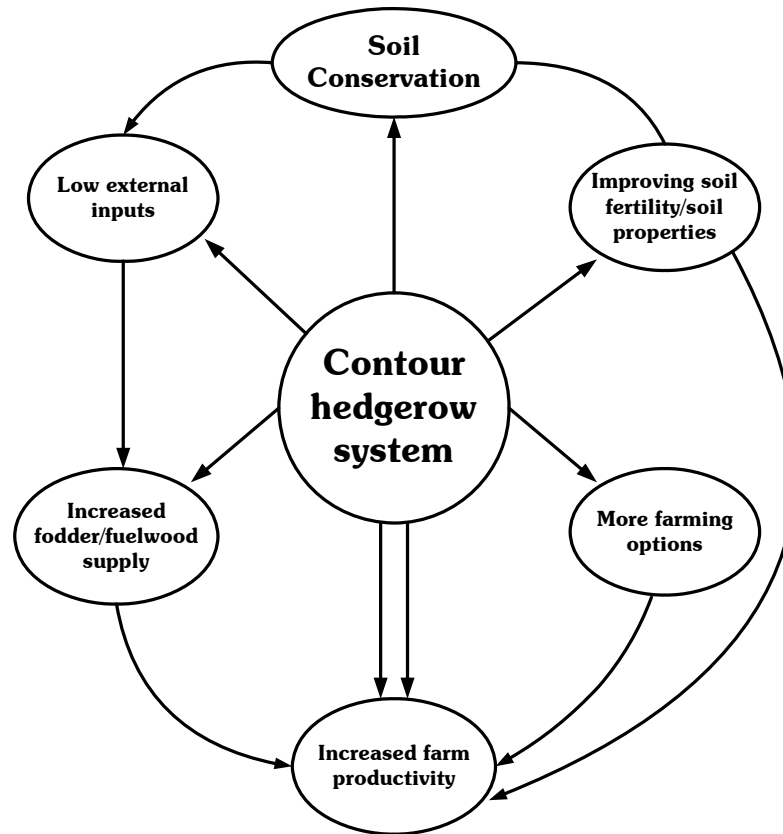
- ☆ The intended audience is at three levels. The immediate users are trainers and institutions with extension programmes. The interim users are agricultural extension workers and community workers. The ultimate users and beneficiaries are the farmers themselves.

## Contour hedgerow intercropping system



- 2 ►
- ☆ The contour hedgerow intercropping system involves planting double hedgerows of nitrogen-fixing plants along the contour lines on the slope at a distance of from (two) four to six metres. The space between the contour hedgerows, the alley, is used for agricultural and cash crops.

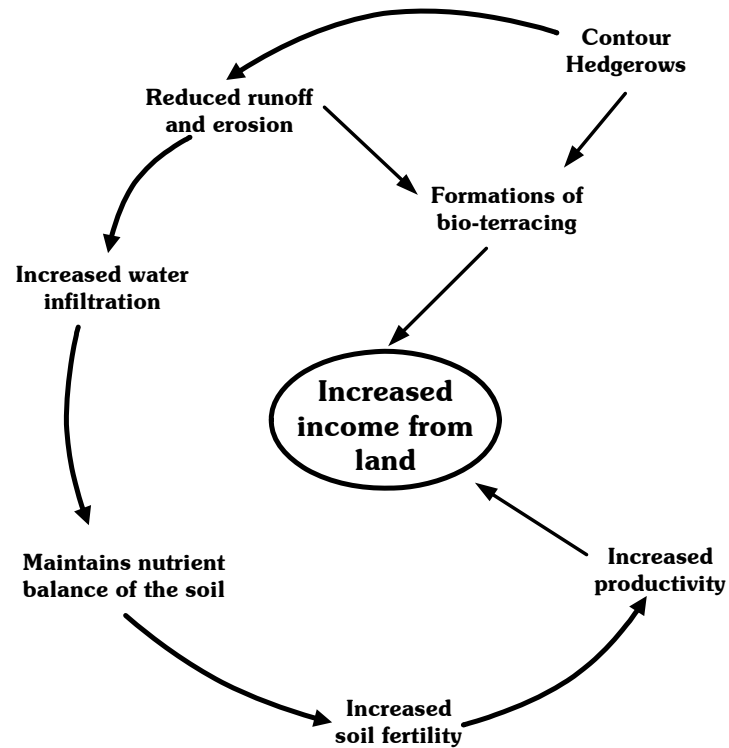
## Goals



### Function of a contour hedgerow intercropping system

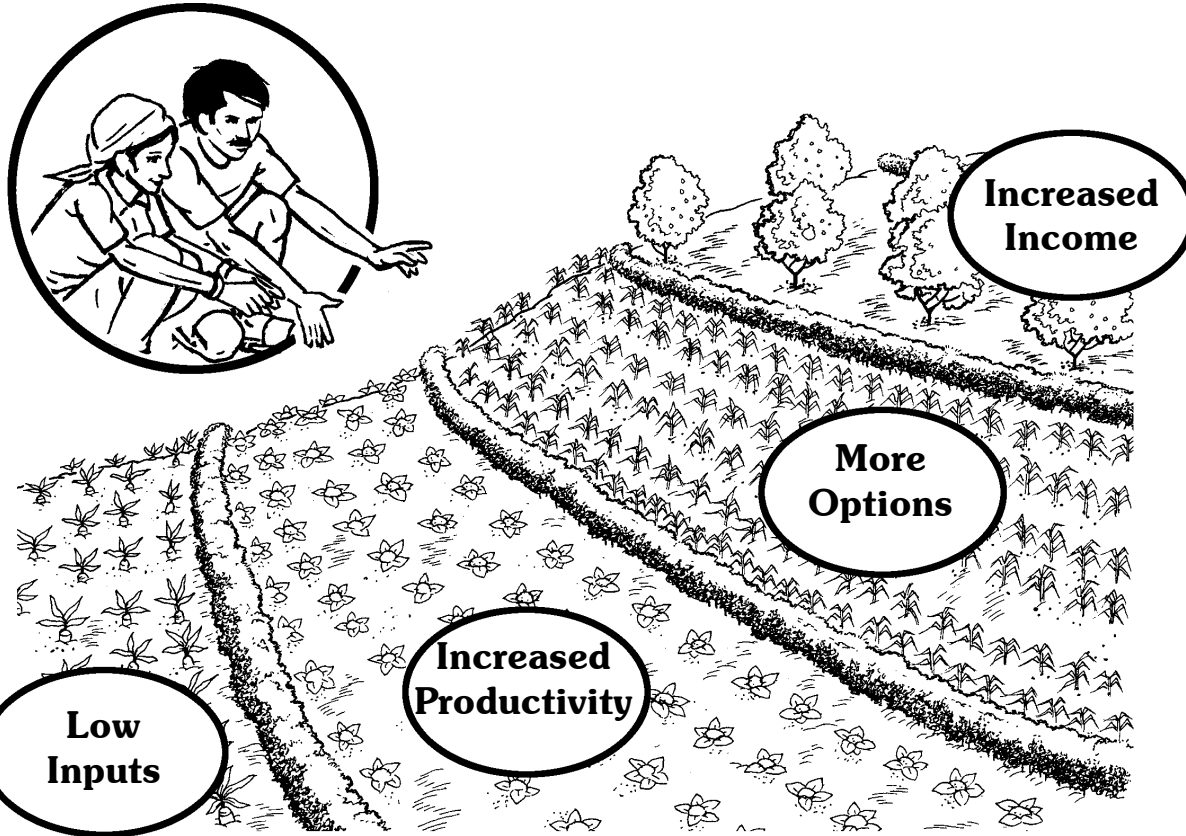
- ☆ The contour hedgerow system once adopted leads to various direct benefits for the individual farm family. There are indirect benefits too—soil conservation and rehabilitation of degraded slopes.

## Benefits to the land/slope



- ☆ Establishing and maintaining hedgerows require extra work.
- ☆ Once they are established, they result in increased crop yield, soil fertility, soil water moisture and conservation of soil.

## Benefits to farmers

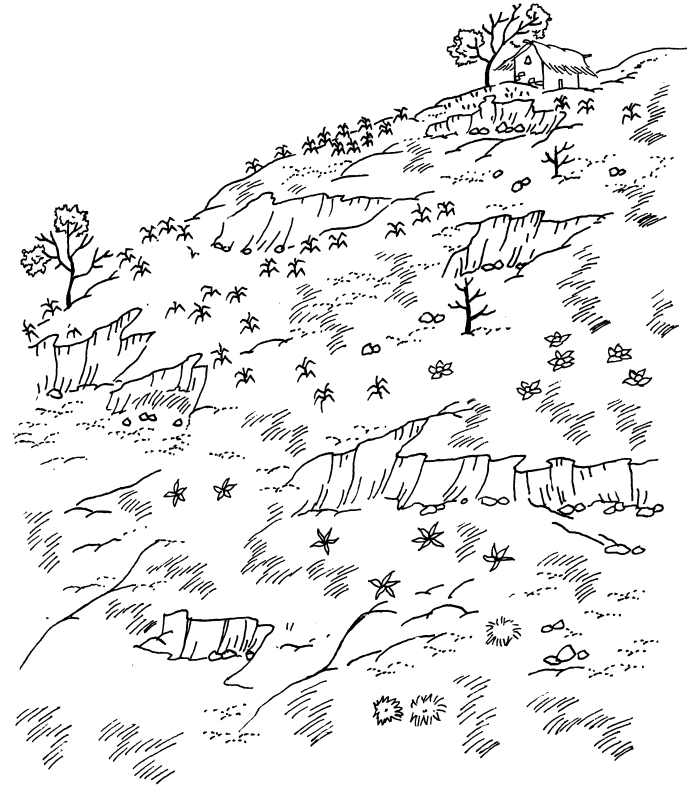
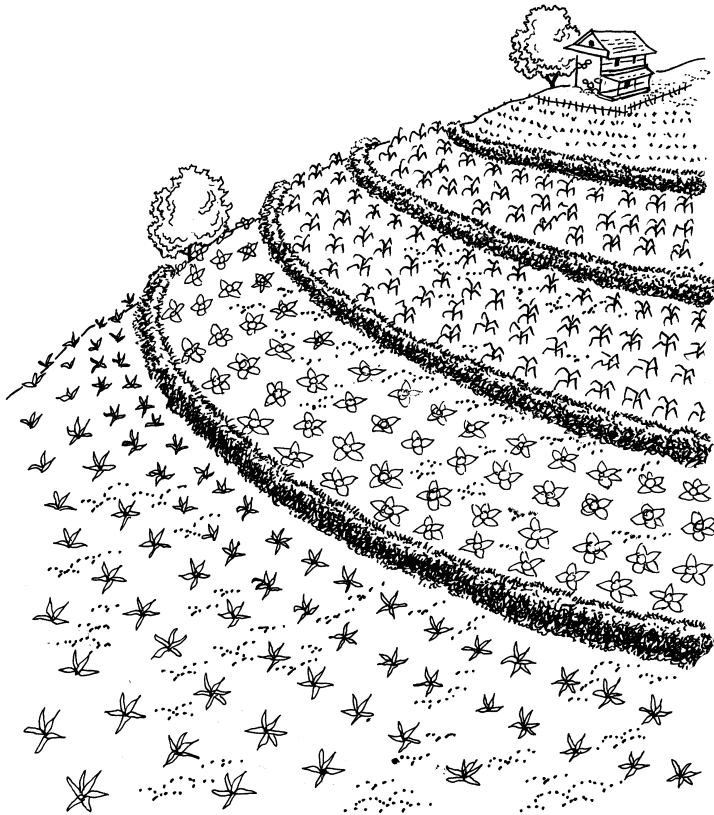


- ☆ Benefits to farmers are a natural outcome of adopting a contour hedgerow system. However, once the hedgerows are set up, agricultural alleys require less inputs in terms of chemical fertilizer. Crop yield increases and so do incomes and income-generating options.



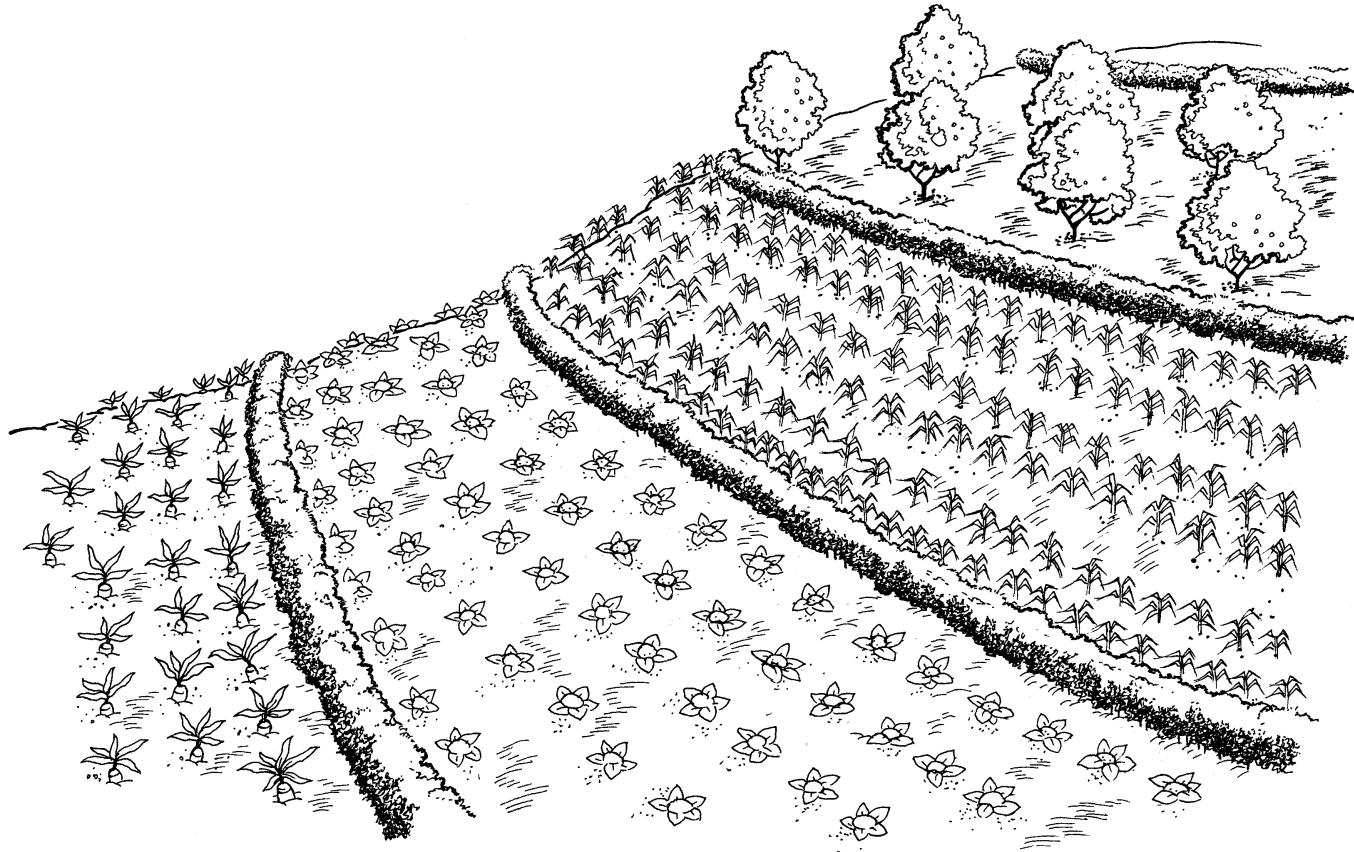
## Benefits of hedgerow systems

6 ►



- ☆ Hedgerow systems facilitate sustainable and continuous use of agricultural land.
- ☆ Under conventional farming, either the crop yield will decline or the land will be abandoned due to continuous soil loss and low fertility.

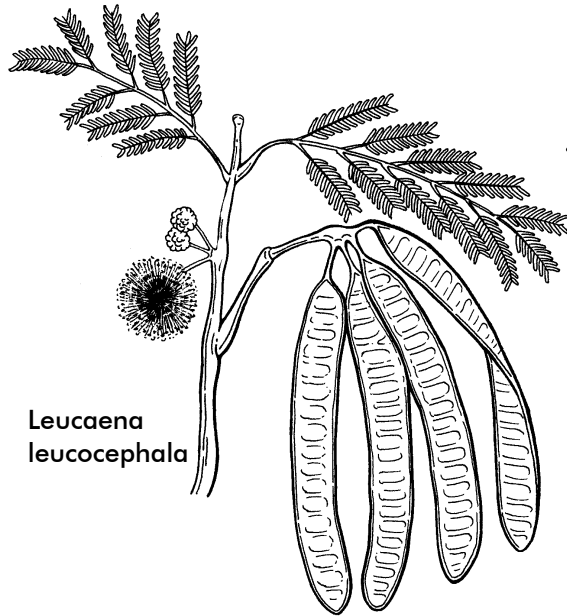
## More farming options in agricultural alleyways



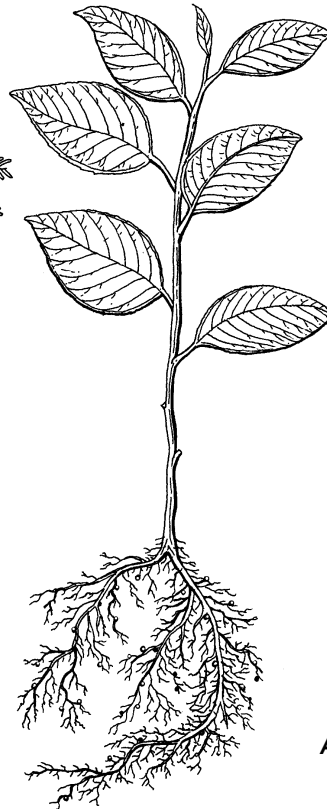
- ☆ Increased soil fertility permits plantation of different crops.
- ☆ Alleyways between hedgerows are used for food production, fruit trees or other cash plants.

## Nitrogen-fixing plants and their role

8 ►



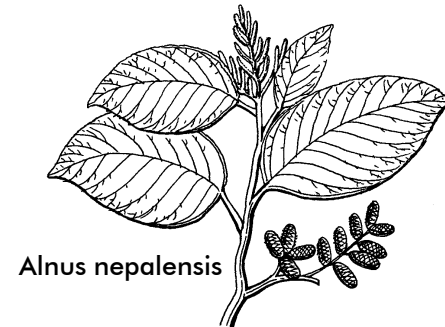
*Leucaena  
leucocephala*



*Indigofera dosua*



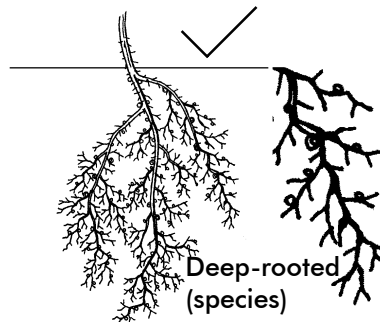
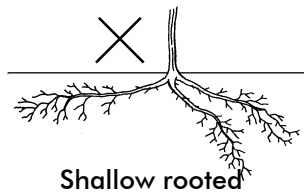
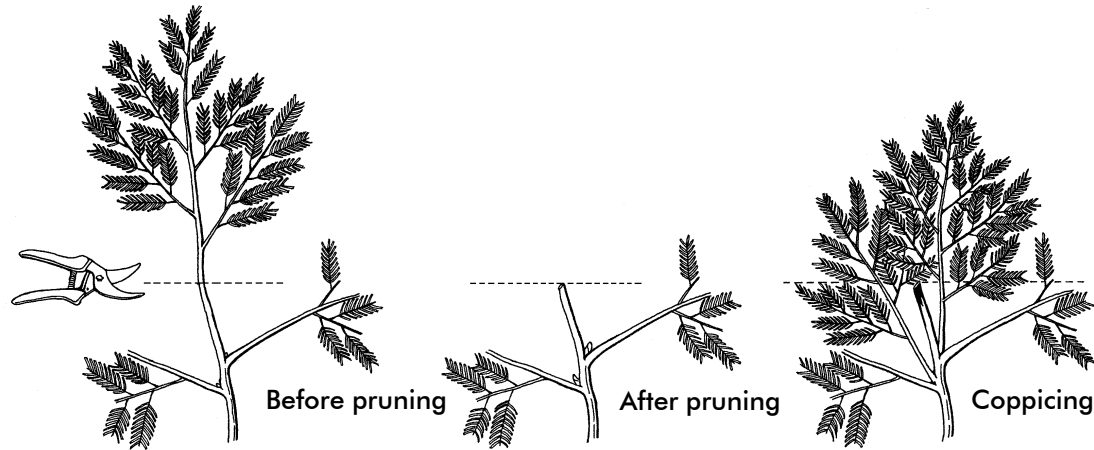
*Desmodium*



*Alnus nepalensis*

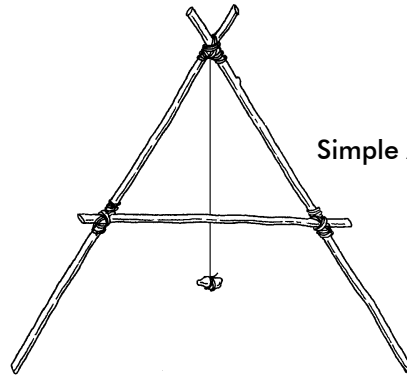
- ☆ Many legumes and some non-legumes can fix nitrogen from the atmosphere.
- ☆ These plants can be used to improve soil fertility of agricultural lands.

## Criteria for selection of hedgerow species

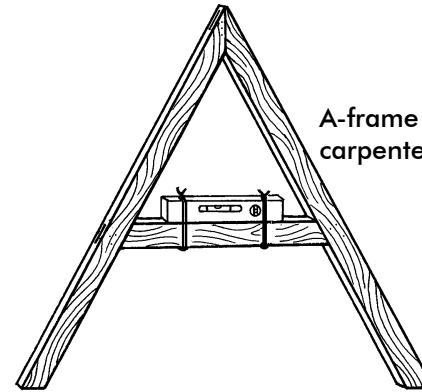


- ☆ Hedgerow species should be nitrogen-fixing, fast-growing, and deep-rooted.
- ☆ The selected species should coppice rapidly after pruning and should be resistant to repeated pruning. The mixture of species should cater to the local needs and be agroecologically adapted.
- ☆ They should be multi-purpose—fodder, fuelwood in addition to mulch or green manure.

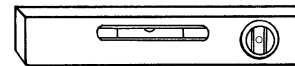
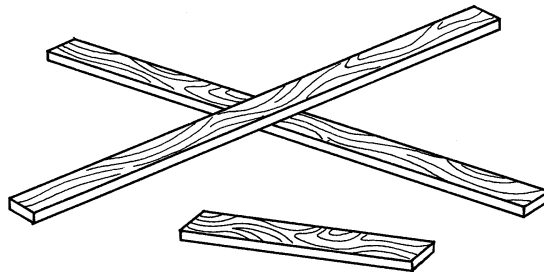
## Different types of A-frame



Simple A-frame



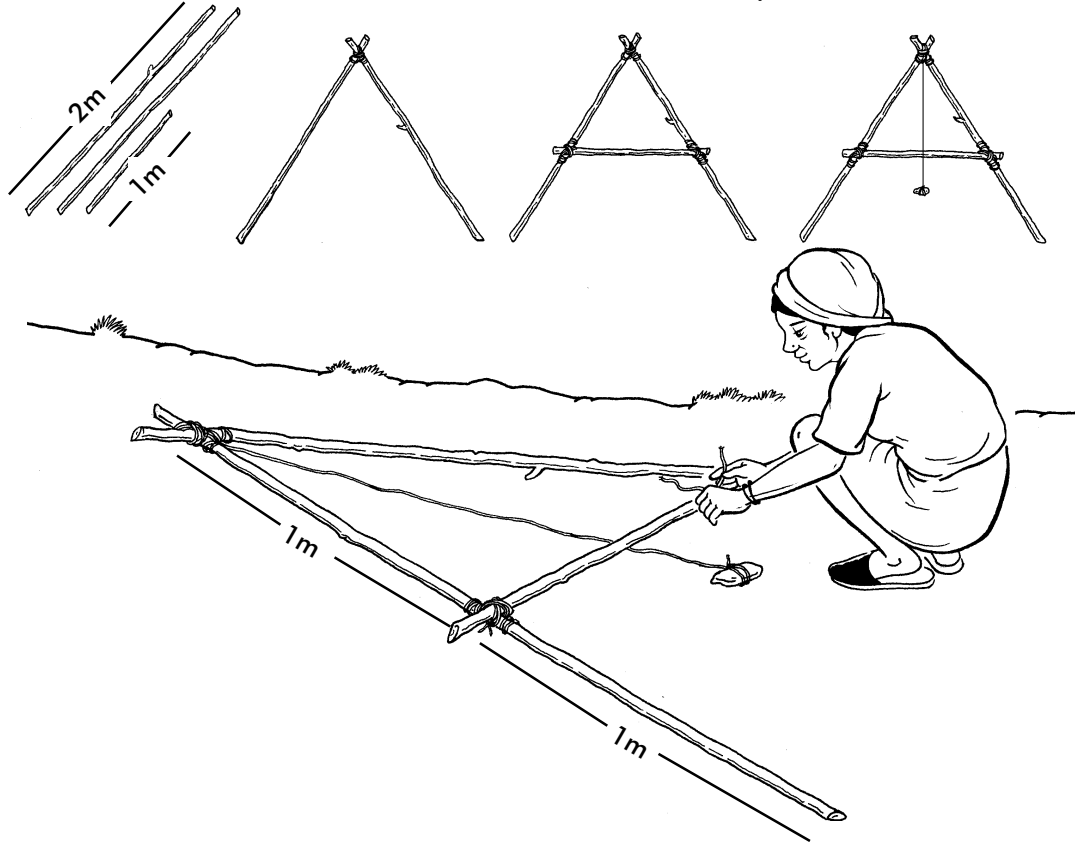
A-frame with  
carpenter's leveller



☆ An A-frame is used to locate contour lines. Other tools, such as the 'handy level', can also be used.

## To make an A-frame

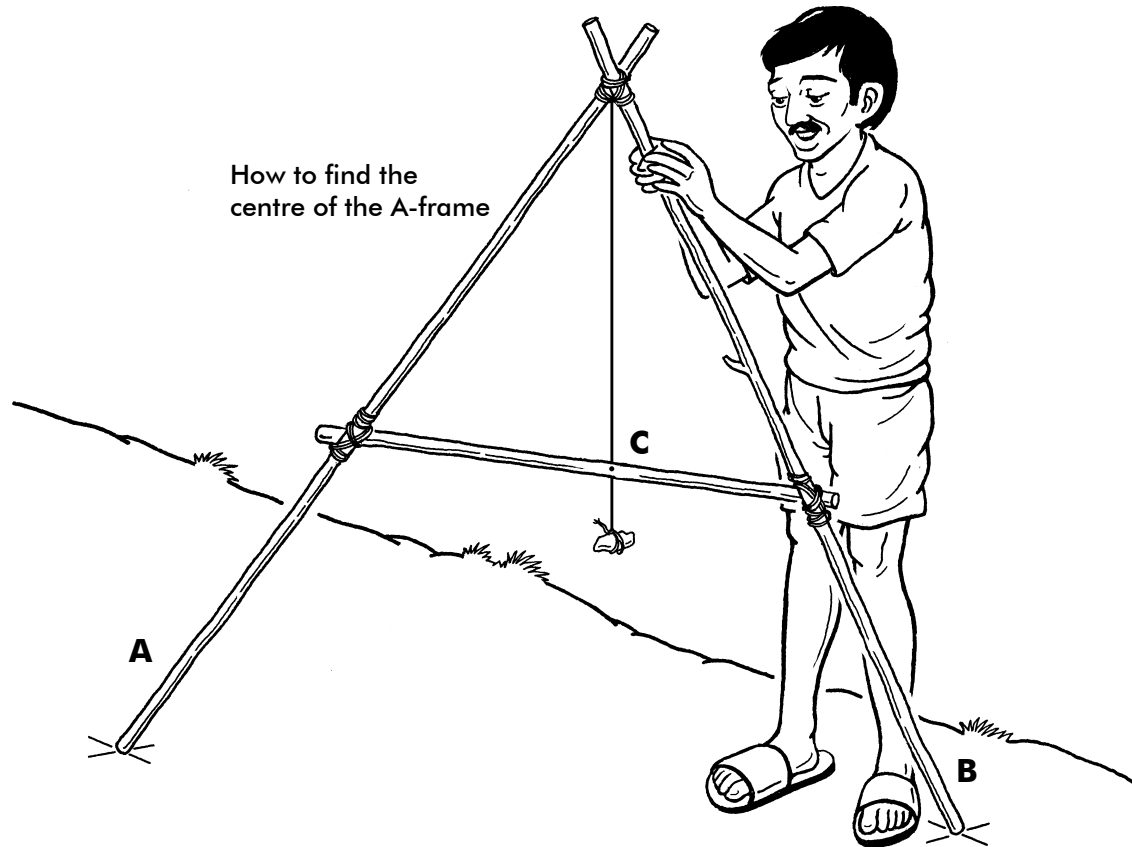
How to make a simple A frame



☆ The simplest A-frame can be made easily with three sticks and a string attached to a stone (plumb line) as shown in this figure.

## Calibrate or find the centre of the frame

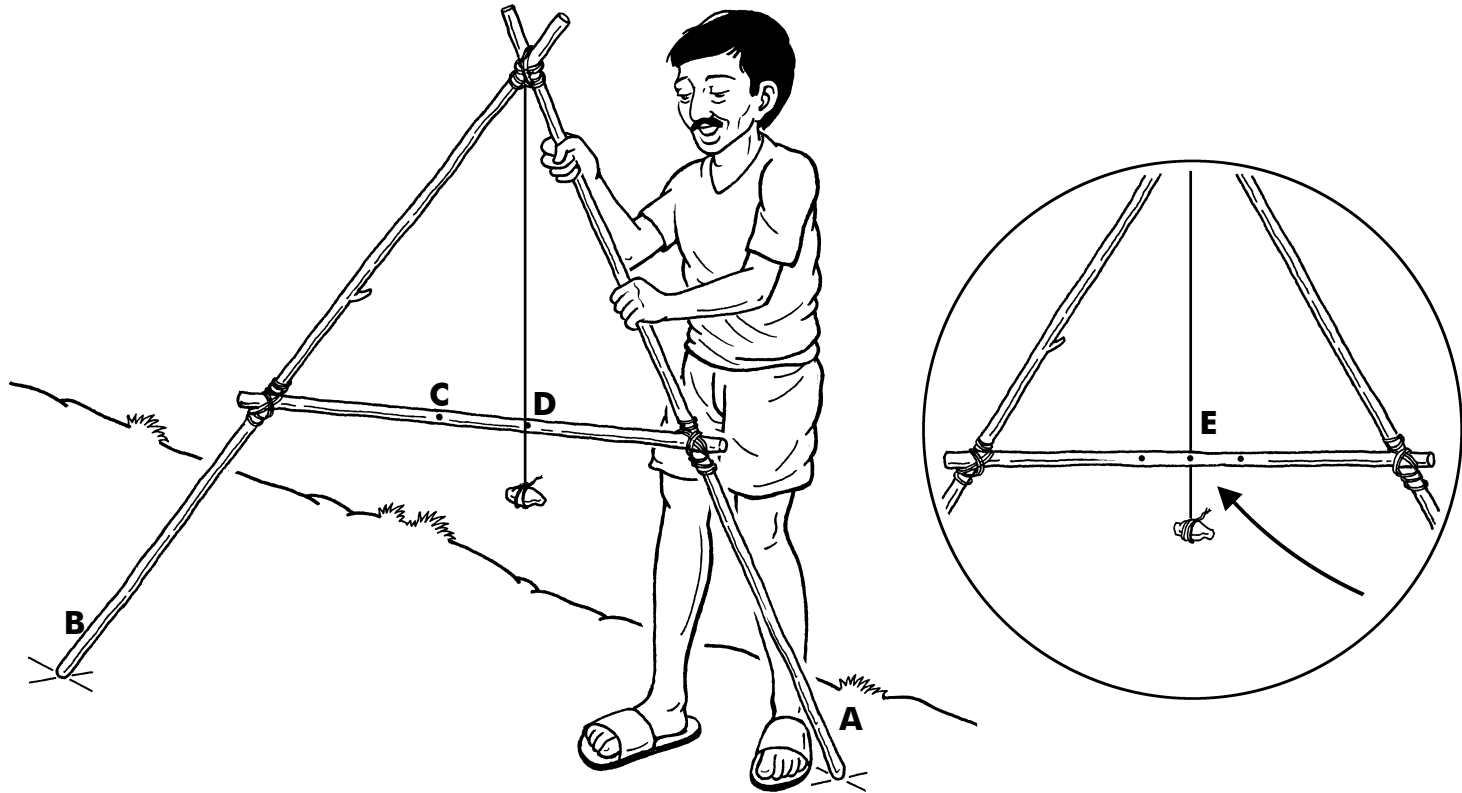
12►



- ☆ Before use, the A-frame should be calibrated to find its centre.
- ☆ Place the frame on the slope. Mark points where legs A and B are placed on the ground. Mark C on the horizontal stick.

## Calibration cont...

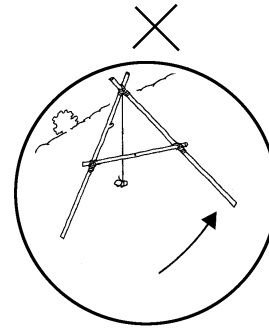
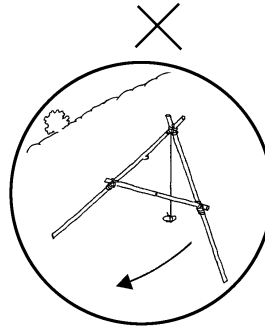
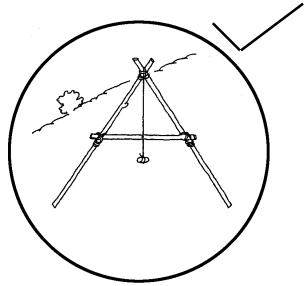
13►



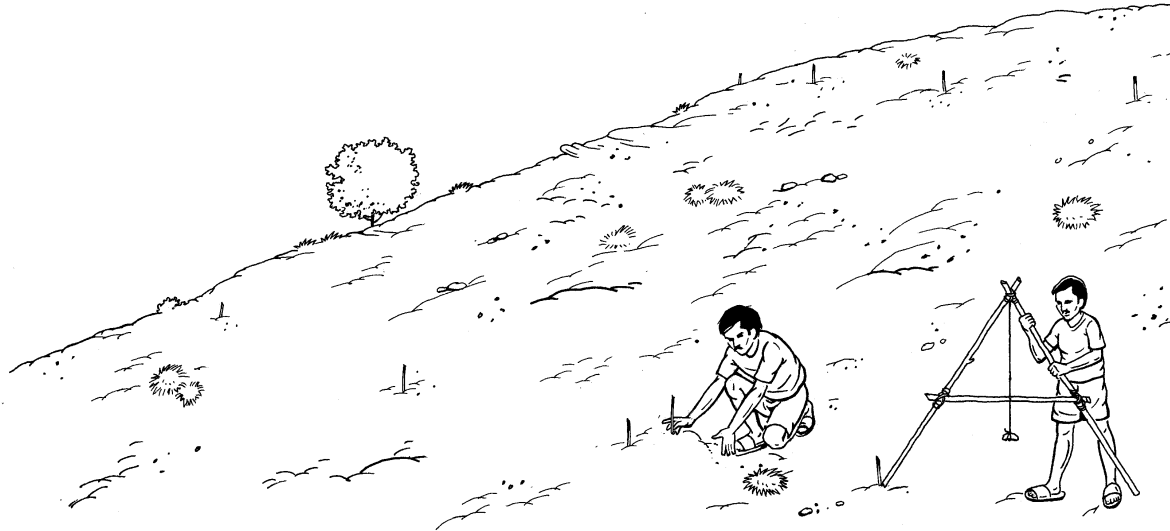
- ☆ Then exchange places of legs A & B and mark D on the horizontal stick.
- ☆ Measure length between C & D and mark the mid-point E.
- ☆ When the string crosses the horizontal stick at E, then the frame is placed evenly on the contour.



## Locate contour lines



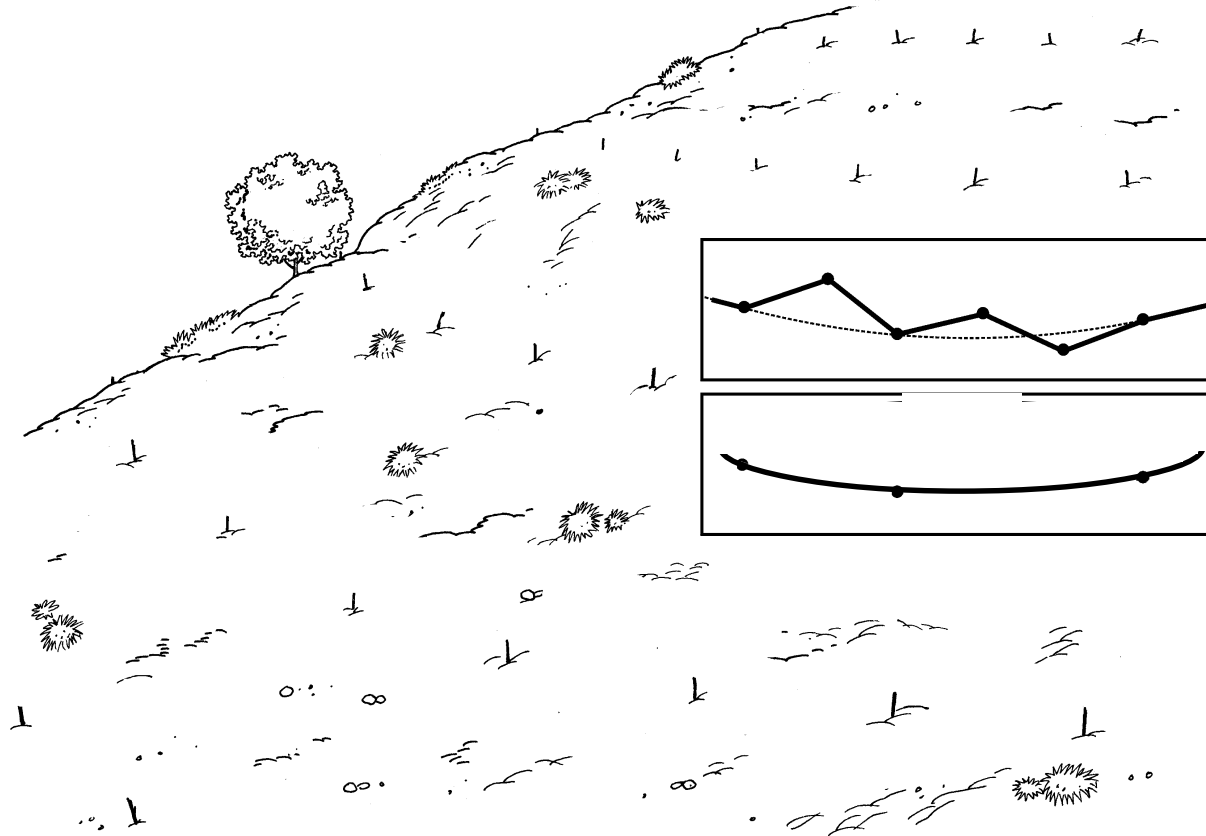
14►



- ☆ Adjust A-frame on the slope to bring the plumb line/string to the centre of the A-frame (Point E). Mark the spots on the slope. These spots will form a contour line.
- ☆ The distance between contour hedgerows should be approximately 4-6 metres.

## Adjust contour lines

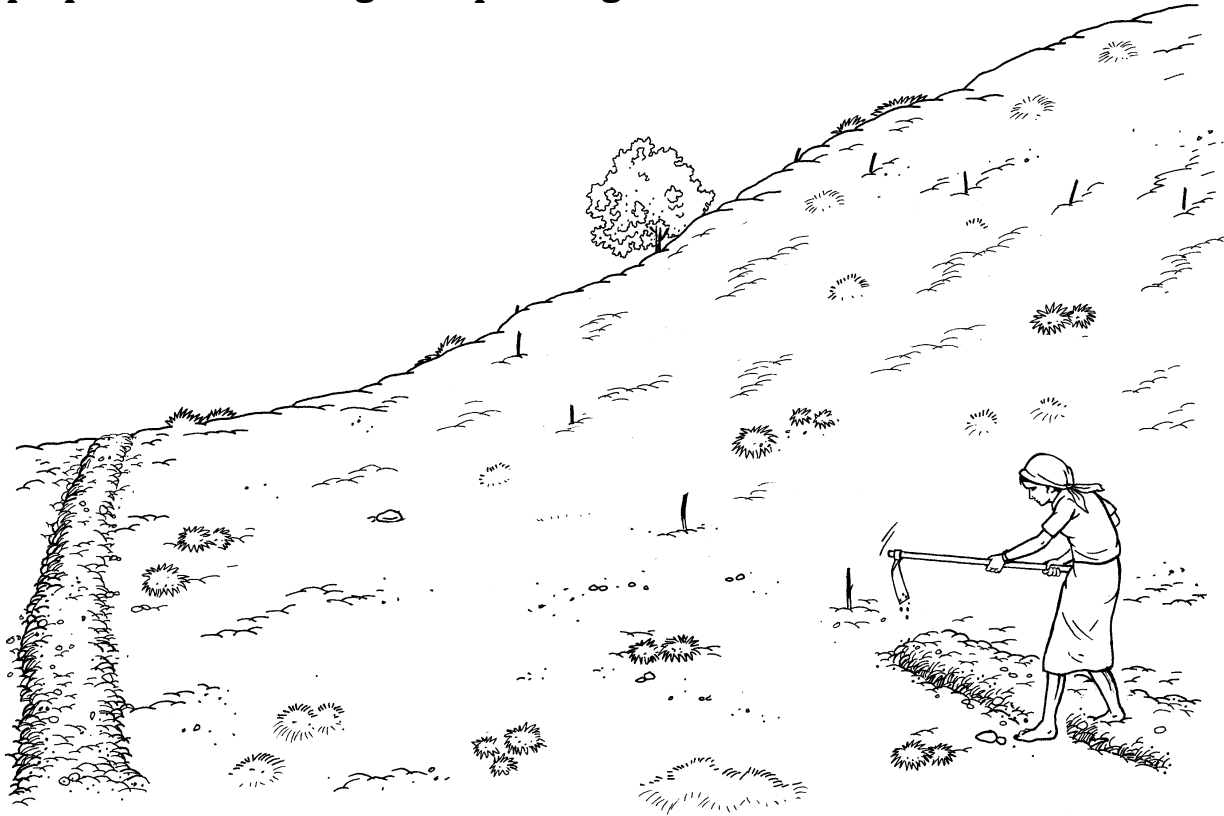
15►



- ☆ If the spots located by the A-frame zigzag too much, while planting consider only those points that form a smooth contour.

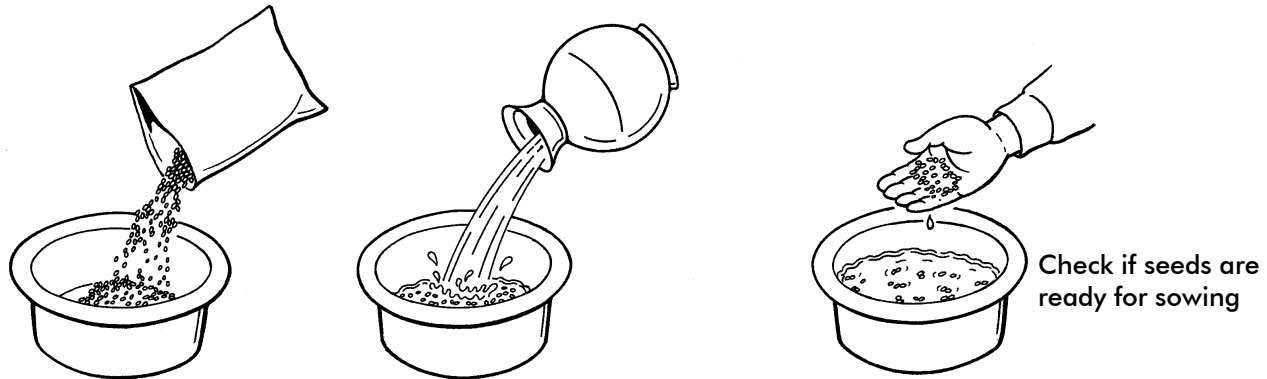
## Land preparation for hedgerow planting

16►



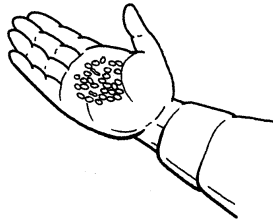
- ☆ Around a 60-80cm wide land area along the located contour spots should be finely prepared to facilitate germination of seeds or planting hedgerow plants.
- ☆ Careless and rough land preparation always results in low germination. Therefore, replanting has to be done and this increases the cost.

## Seed treatment

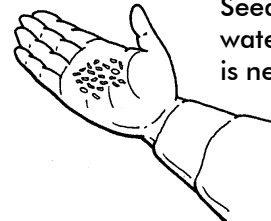


Seed treatment with water

Seeds absorbed sufficient water and are ready for sowing

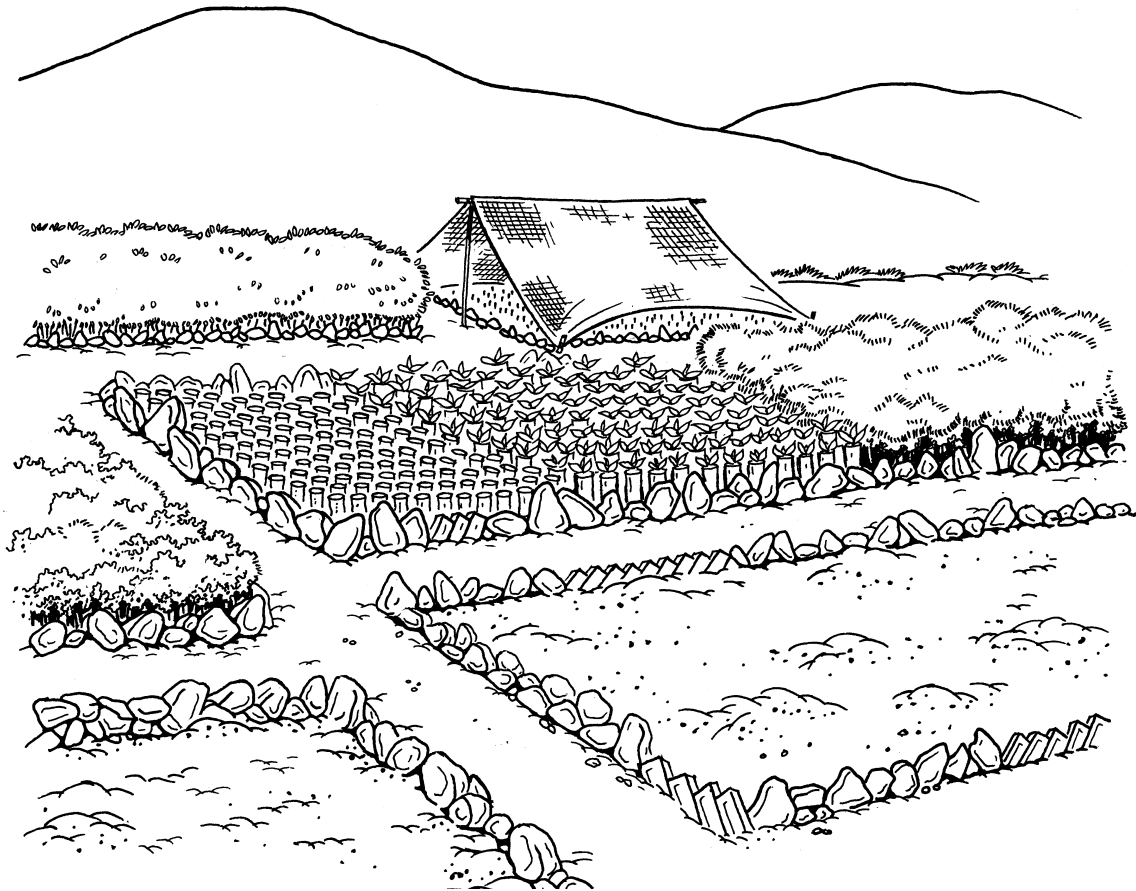


Seed did not absorb sufficient water. More time or hot water is needed for treatment



- ☆ Before sowing, seeds usually need pre-treatment to allow sufficient water absorption. The most economical, practical and effective method is by soaking seeds in water (hot water or normal water) for several hours. The time needed for soaking depends upon the species. Some species require only a few minutes to break dormancy and some require 24 hours, or even longer.
- ☆ Check for softness, if not swollen, soak again.

## Plant nursery

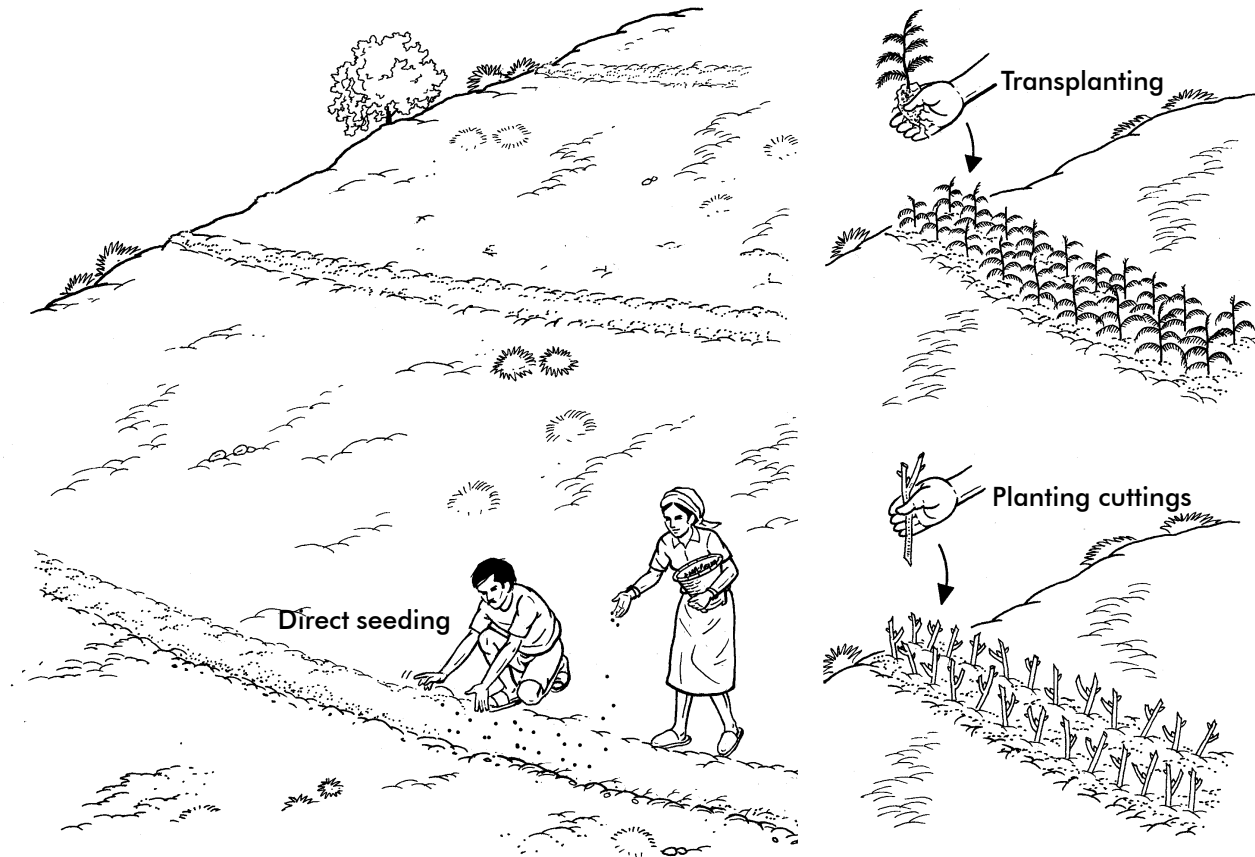


18►

- ☆ In the region where establishing double hedgerows by direct seeding is difficult because of the lack of water, grazing cattle, or frost, a plant nursery is necessary for raising seedlings.

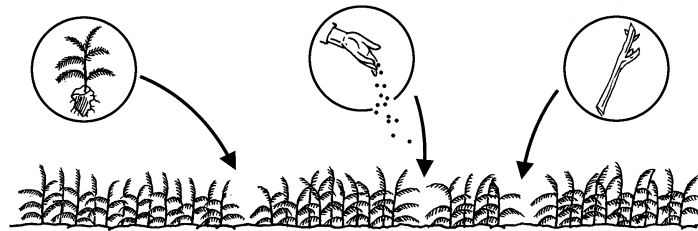
## Planting hedgerows

19►

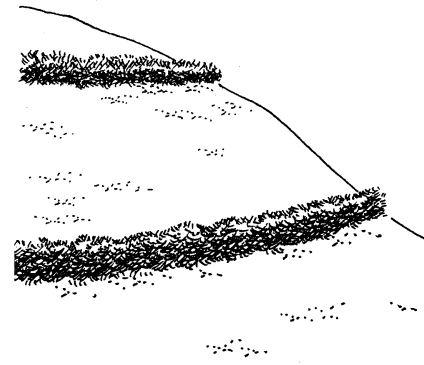


- ☆ Double hedgerows can be established by direct seeding, transplanting or using cuttings depending on the species used. The distance between two rows of double hedgerows varies from 30 - 60cm.

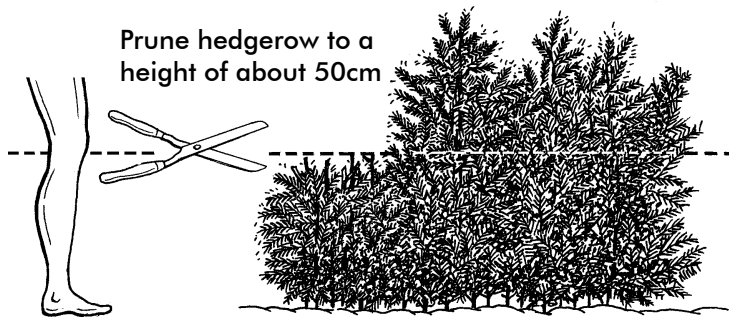
## Hedgerow management



Gap filling



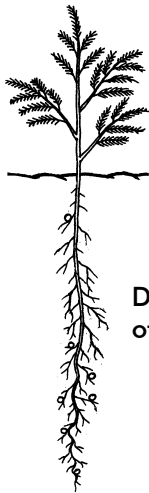
Side pruning



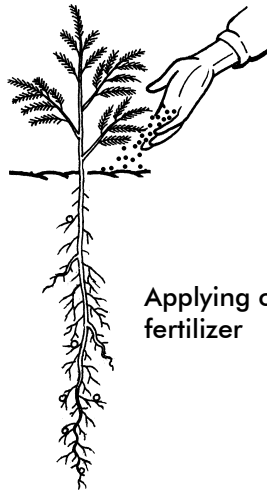
Prune hedgerow to a height of about 50cm

- ☆ Replanting and gap filling should be carried out to make double hedgerows dense.
- ☆ When double hedgerows grow to more than 1m tall, they are pruned to a height of about 50cm, or knee height. To avoid shade on crops in the alleys, side pruning is also important.

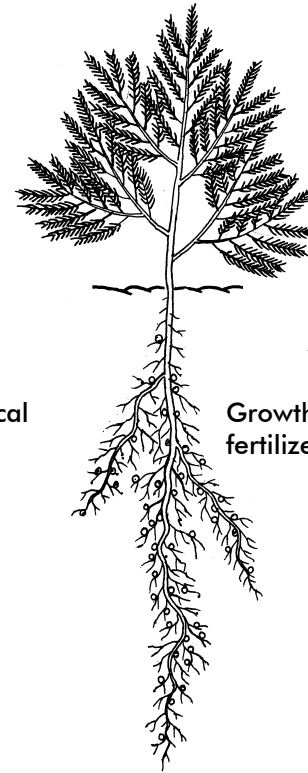
## Proper use of chemical fertilizer



Development  
of root



Applying chemical  
fertilizer



Growth after chemical  
fertilizer application

- ☆ Growth of double hedgerows in the early stages may be slow because root development is faster than growth of the part above ground. One or two weeding are essential.
- ☆ Application of a small amount of nitrogen fertilizer will greatly improve the growth of hedgerows in the early stages of growth.



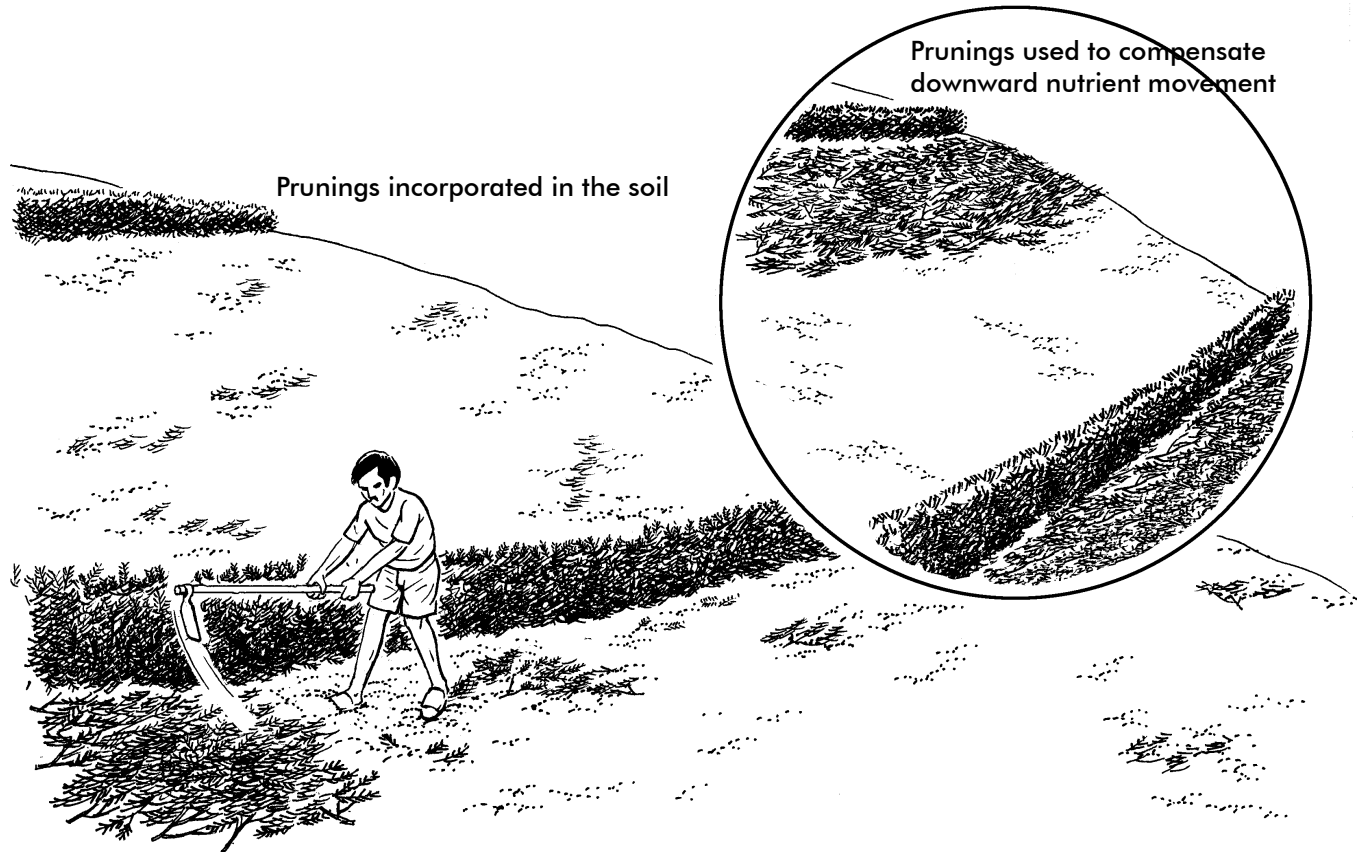
## Application of prunings



22▶

☆ Hedgerow prunings should be used as green manure, especially in the cropping season.

## Effective use of prunings

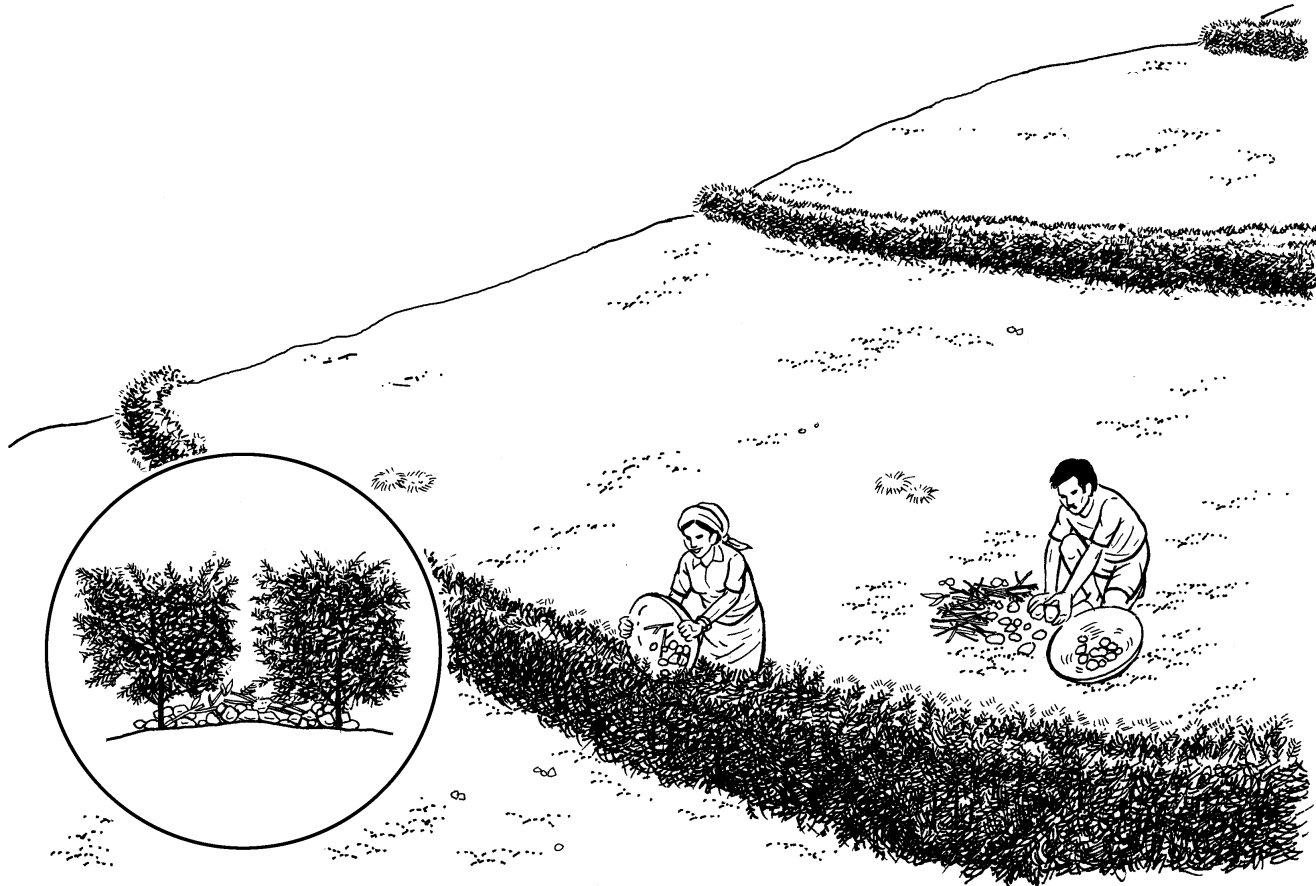


23►

- ☆ Prunings can be applied in the upper part of the alley. This compensates for the downward movement of soil nutrients .
- ☆ In order to improve soil fertility, prunings should be properly incorporated into the soil.

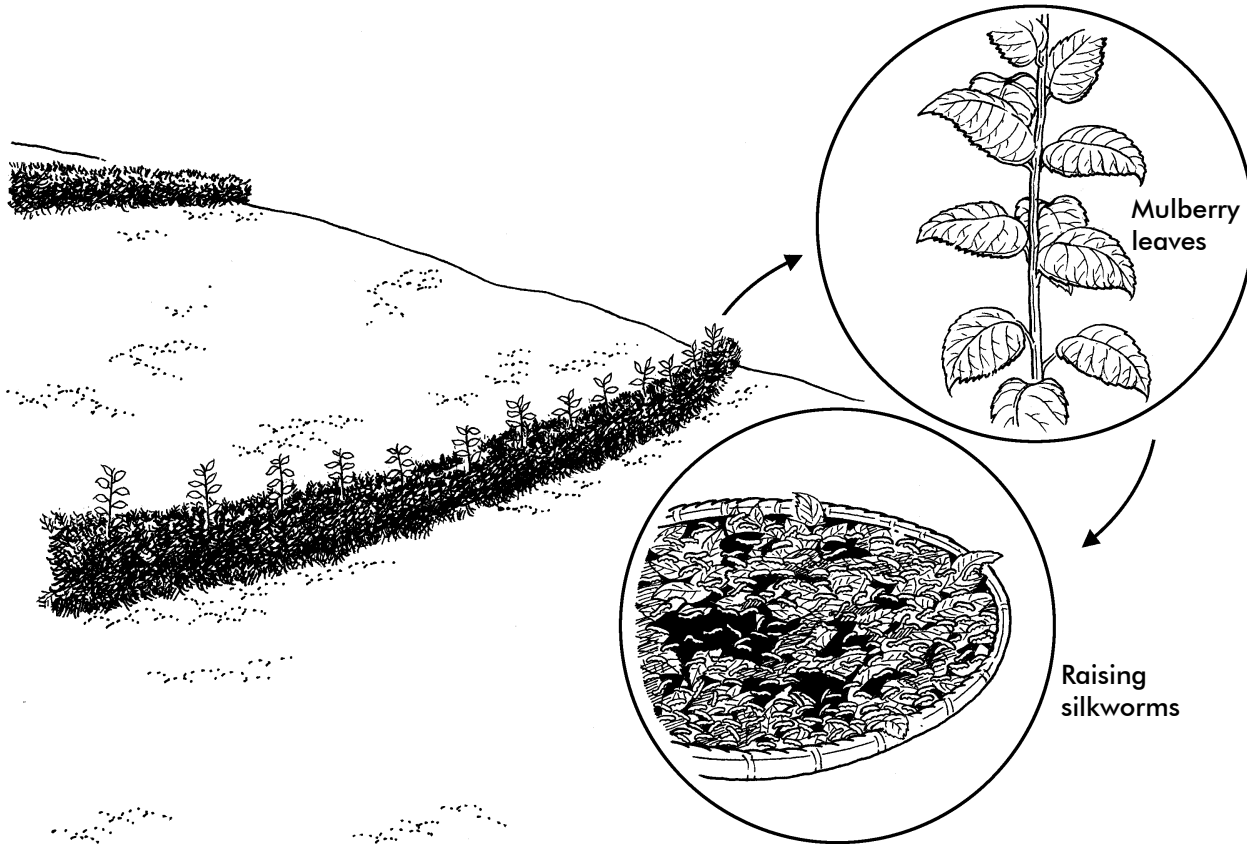
## Clearing alleys for crops

24►



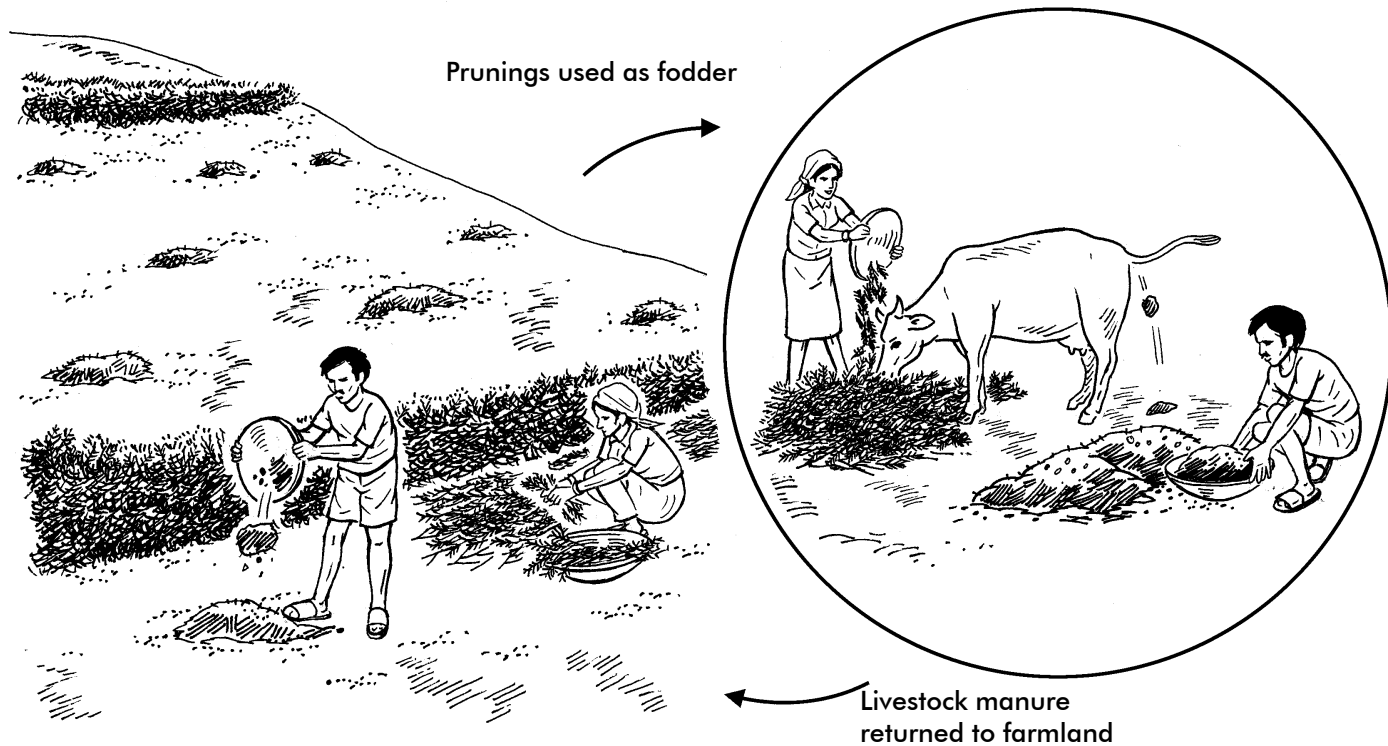
☆ Stones, big branches or non-decomposed crop residues are put in between double hedgerows. Clearing of stones from the alley facilitates easy farming activities.

## Cultivating within hedgerows



☆ In order to increase income, some cash plants, such as mulberry, can be cultivated within the double hedgerows.

## Nutrient cycle



26▶

☆ Some species provide good fodder. Returning livestock manure to the farmland increases production.

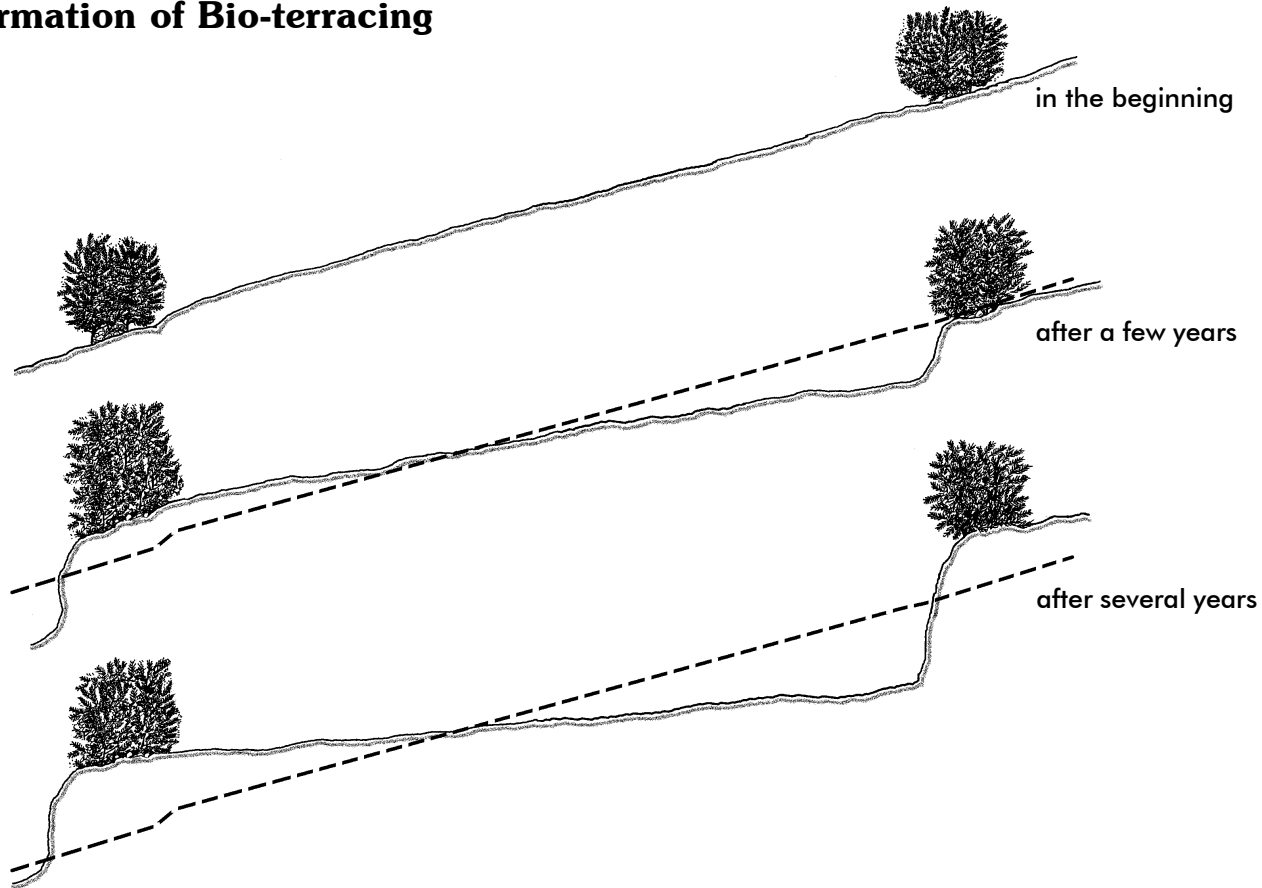
## Fuelwood production

27►



- ☆ When double hedgerows are managed to produce fuelwood or poles , trimming frequency should be reduced while side pruning should be carried out from time to time to avoid shade falling on crops.
- ☆ Stems/big branches are left in the alley and removed only after the leaves have fallen.
- ☆ This increases soil fertility as well as providing fuelwood.

## Formation of Bio-terracing



28►

- ☆ Double hedgerows can reduce runoff velocity and soil loss.
- ☆ Natural sedimentation process and normal farming will lead to formation of (sloping) terraces naturally after several years.

## Lessons learned from the HKH region



### A. Appropriate ways

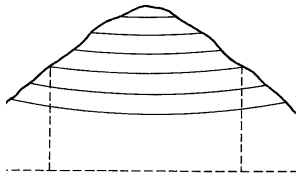


Fig. 1



Fig. 2

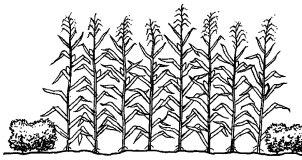


Fig. 3

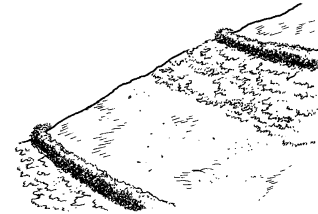


Fig. 4



### B. Inappropriate ways

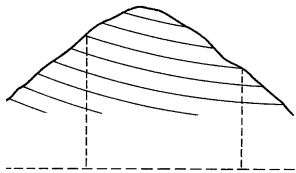


Fig. 1



Fig. 2



Fig. 3

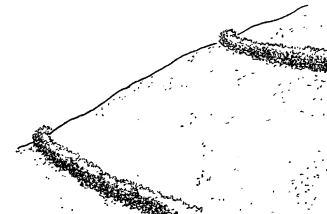


Fig. 4

- ☆ Fig. 1 Contour lines should be properly located.
- ☆ Fig. 2 Double hedgerows should be maintained densely.
- ☆ Fig. 3 Double hedgerows should be pruned properly and in a timely fashion to avoid shade falling on crops.
- ☆ Fig. 4 Hedgerow prunings should be applied in the alleys and not beside the hedgerows.



## Other areas of application

The main benefits of the contour hedgerow intercropping technology are soil and water conservation and supply of nutrient-rich biomass improving soil fertility and structure. Therefore, apart from application to sloping agricultural lands, the contour hedgerow intercropping technology can be applied also in other areas. Among them are the following.

- **Afforestation/reforestation:** In an afforestation/reforestation programme, contour hedgerows can be planted every 8-20 m on the slope, and they can function as soil erosion barriers to reduce soil loss before trees develop their canopy fully. When the afforested forest canopy is fully developed, hedgerows can be trimmed for fuelwood.
- **Orchard development/cash plant plantation:** Development of orchards or plantation of cash plants on sloping lands is an important income-generating option in the mountains. Application of contour hedgerow intercropping technology can greatly conserve soil and provide a considerable amount of green manure or mulch to the fruit trees or cash plants. This not only improves the quality of the product but also reduces inputs of fertilizers. Application of contour hedgerow technology will promote organic farming.
- **Integrated watershed management:** soil conservation is one main objective of integrated watershed management. Therefore, this technology will contribute a lot in this respect.
- **Rehabilitation of degraded lands:** Contour hedgerow intercropping technology can be applied in rehabilitation of degraded lands to conserve soil and improve soil properties; facilitating rehabilitation activities.
- **Development of livestock:** Livestock development has been an important sector in the HKH region but supply of sufficient fodder is always a problem in the region. Since many woody nitrogen fixing plants are good pioneer plants and are good fodder plants as well, contour hedgerow intercropping technology can be applied in fodder production. In this case, the difference is that fodder plants instead of food or cash plants are planted in the alleys. In this system, both contour hedgerows and fodder plants in the alley can provide fodder. Management of hedgerows is similar. This can be applied to wastelands.

**Annex 1: Plant Species Recommended for Different Climatic Zones — Primarily Based on the Results of ICIMOD's Work in the HKH Region**

<b>Tropical monsoon</b>	<b>Subtropical monsoon, frost free</b>	<b>Subtropical monsoon, short period frost</b>
<i>Leucaena leucocephala</i> <i>Leucaena diversifolia</i> <i>Calliandra calothyrsus</i> <i>Indigofera tysmanii</i> <i>Flemingia macrophylla</i> <i>Desmodium rensonii</i> <i>Gliricidia sepium</i> <i>Dalbergia sissoo</i> <i>Cassia siamea</i>	<i>Leucaena leucocephala</i> <i>Acacia mearnsii</i> <i>Acacia dealbata</i> <i>Albizia kalkora</i> <i>Albizia yunnanensis</i> <i>Albizia procera</i> <i>Albizia lebbeck</i> <i>Indigofera ducoa</i> <i>Bauhinia purpurea</i> <i>Alnus nepalensis</i>	<i>Acacia mearnsii</i> <i>Acacia dealbata</i> <i>Albizia julibrissine</i> <i>Albizia kalkora</i> <i>Albizia yunnanensis</i> <i>Indigofera ducoa</i> <i>Bauhinia purpurea</i> <i>Leucaena leucocephala</i>

Computerised copies of illustrations and text can be supplied to institutions that need to translate this manual into local languages.

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