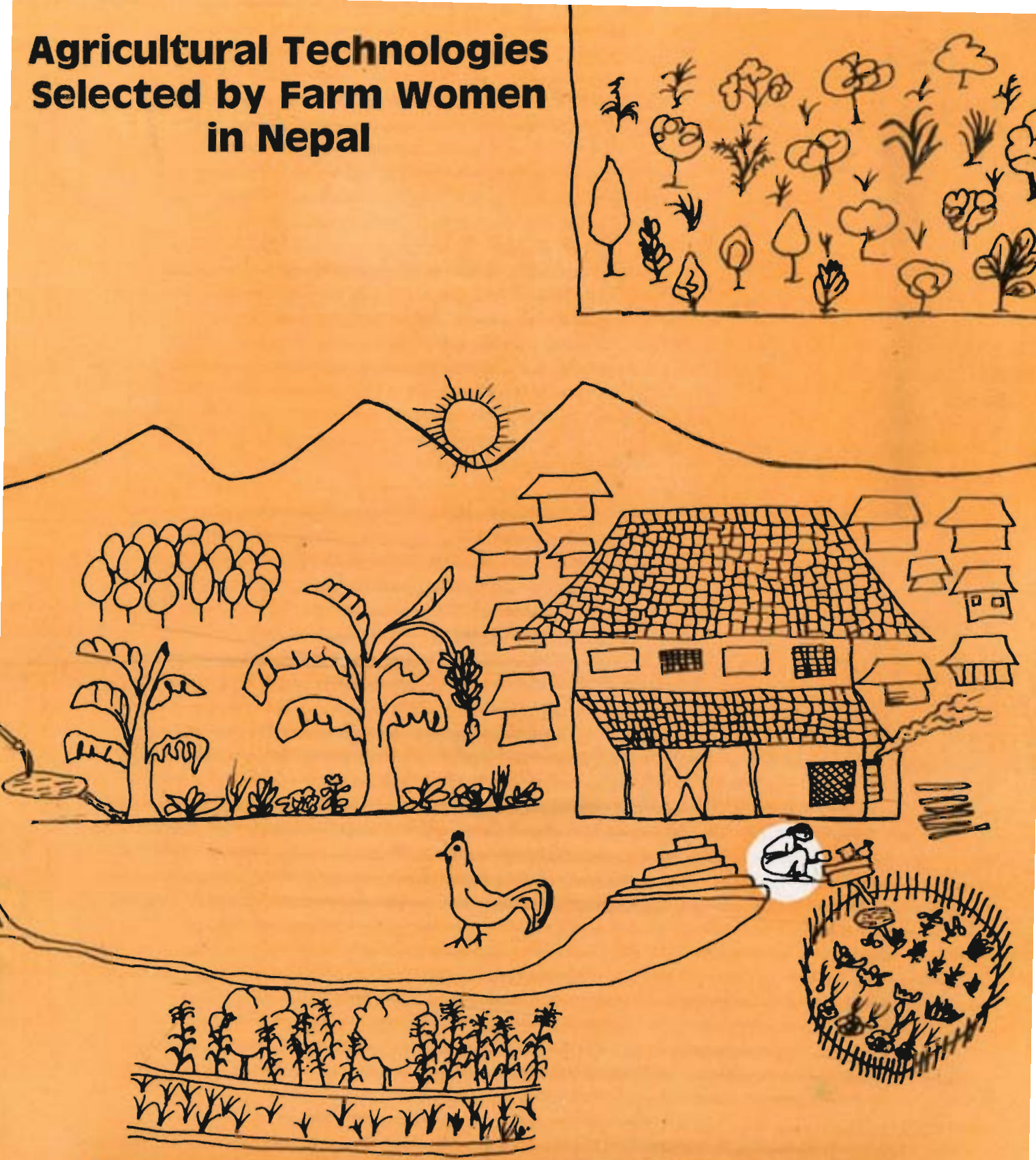
Agricultural Technologies Selected by Farm Women in Nepal



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Agricultural Technologies Selected by Farm Women in Nepal

Benigaon & Ranagaon
Gorkha District

International Centre for Integrated Mountain Development
Kathmandu, Nepal

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Jeannette D. Gurung

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INTRODUCTION

In 1992, an 'Information Kit on Regenerative Agricultural Technologies for Nepali Hill Farmers' was produced by the Nepal Rural Reconstruction Association (NERRA) in collaboration with the International Institute for Rural Reconstruction of the Philippines and a few other international organisations, including ICIMOD. This Kit was widely disseminated to government agencies, NGOs, and individuals working in the extension of agricultural technologies in Nepal. To date, the effectiveness of the Kit has not been evaluated on a large scale.

However, in light of the fact that over 50 per cent of the agricultural work done in the hill regions of Nepal is carried out by women, it was deemed useful to evaluate the technologies of the Kit through women's eyes to learn of its practicality to them. Also, although it was realised that numerous factors constrain women's access to knowledge and the adoption of new agricultural practices, few efforts have been made to specify those constraints and find ways to overcome them. Many traditional ways of performing agricultural tasks are full of drudgery, consuming women's time and energy needlessly while alternative methods exist of which they are unaware or are unable to access. An interest in searching for technologies that could ease the drudgery of women led to the development of an action research project to assess the technologies of the Kit and other practices, while developing methods of extending new knowledge to women who are mostly illiterate and have little spare time for training.

In June 1994, ICIMOD initiated the project on Agricultural Technologies for Farm Women in Nepal in two villages of Gorkha District, in the mid-hills of central Nepal. Through training workshops and intensive personal follow-up instructions, 24 women learned of new technologies.

A total of 30 topics from the Kit and elsewhere were pre-selected for introduction to the women farmer participants, based on the project team's familiarity with their needs and priorities. In addition to 18 topics from the Kit, other new topics were included. These were introduced in Workshops I & II, held in the village, and through discussions with other women farmers while on tour. After being introduced to the topics - techniques and rationale - the participants were given the option to choose which topics they would be interested to try, with follow-up training and resources provided by the project agriculturalist. After a period of less than six months allocated for trials, the women selected 18 topics that they felt were acceptable to them, based on feasibility and usefulness. Some of the technologies selected by women were again explained and observed during a farmers' tour to other areas of west Nepal, namely Champaphant in Tanahu District and Lwang in Kaski District.

The lists of topics introduced, tested, and accepted are given below with reasons for the women's likes or dislikes of the technologies. A minikit of technologies selected for testing by the women participants has been assembled, hoping that it may be of use to government and NGO development workers in Nepal in their efforts to bring new practical knowledge to farm women and government and NGO projects.

Pre-selected Topics from the Kit Introduced to Women Farmer Participants

1. Kitchen garden for better living (Circle garden)
2. Vegetables for human nutrition
3. Off-season vegetable production
4. Vegetable seed production
5. Optimum use of marginal land with agroforestry system
6. Multipurpose tree species and their uses
7. Feed shortages and seasonality issues of livestock in the hills
8. Propagation of fodder grasses
9. NB-21 grass on terrace risers and bunds
10. Preparation of organic manure
11. Effective methods of compost application in hill farms
12. Efficient method of organic matter application for maize
13. Indigenous species for green manuring
14. Sesbania cannabia and S. rostata as green manure
15. The pesticide problem
16. An introduction to integrated pest management
17. Ayurvedic pest management in Nepal
18. Chinaberry tree (*Bakaino*) for pest control

Other Topics Introduced

1. Smokeless *chulo*
2. Liquid manure
3. Improved shed
4. Off-season onion cultivation
5. Citrus nursery (orange)
6. Manakamana-I-maize variety
7. Annapurna 1,2,3, & 4- wheat variety
8. Introduction of buckwheat
9. Improved *dhikki* (rice husker)
10. Solar cooker
11. Improved *jaanto* (rotary quern)
12. Pressure cooker (observed during tour)

Introduced but Not Tested

1. Feed shortages and the seasonality issue of livestock in the hills
2. NB-21 grass on terrace risers and bunds
3. Effective method of compost application in hill farms
4. Efficient method of organic matter application in maize
5. Sesbania cannabia and S. rostata as green manure
6. Chinaberry tree (*Bakaino*) for pest control
7. Annapurna 1,2,3 and 4 wheat varieties
8. Buckwheat

9. Improved *dhikki*
10. Improved *jaanto*
11. Pressure cooker

Tested but Rejected

1. Solar cooker

Not adequately demonstrated (Rejected)

1. Improved *dhikki*
2. Improved *jaanto*

Evaluation of Agricultural Technologies for Farm Women

Total topics introduced =	30	Accepted for trials =	18
Topics from Kit =	18	(12 Kit + 6 New)	
New topics =	12	Not tested =	11
		Rejected =	3

Percentage of technologies accepted for trial (18/30) = 60%

Of the introduced technologies, 11 were not tested due to:

1. Inadequate time -

a. 6 months was not adequate for some technologies as they required longer duration for trials

b. Some technologies needed specific seasons

(i) compost application on hill farms is most effective in Feb/March

(ii) efficient method of organic matter application in maize should be carried out in Feb/March

2. Unavailability of required resource material

a. NB-21 grass on terrace risers and bunds
b. Chinaberry tree (*Bakaino*) for pest control

From the 12 new topics introduced, three technologies were not tested and three were demonstrated during trainings but not accepted for trials.

Not tested

1. Improved maize variety - Manakamana-I can only be planted in Feb/March

2. Trials of buckwheat varieties and wheat varieties failed due to lack of rain since mid-September, as the area is rainfed

3. Pressure cooker was observed in field tour, and was found to appeal to Gorkha women; they have plans to try them now

Rejected

1. Improved *dhikki* (rice husker)

2. Improved *jaanto* (rotary quern)

3. Solar cooker

The reasons for rejection of technologies are given below.

1. Improved *dhikki*

(a) Too complicated - rope and pulley system

(b) Increases manpower requirements - normally one person lifts the *dhikki* and uses one hand to push the grain (using a long stick with a cloth tied at the tip). This new improvised tool would require two people.

(c) However, it must be noted that this topic was presented only with a rough drawing; perhaps the results would have been different if the women were to see an actual improved *dhikki* working.

2. Improved *jaanto*

(a) They would not risk their existing jaanto to reshape its teeth as it is an important tool essential for every day use.

(b) Same point as (c) in the above description of *dhikki*.

3. Solar Cooker

(a) The construction is too complicated and it needs a person to keep turning it during the day to face the sun.

(b) Need to buy various materials - plastic, aluminium foil, etc., from outside for construction.

(c) It is not a dependable tool (it depends on availability of sunlight).

Preference Ranking of Accepted Technologies

The women participants of Benigaon and Ranagaon were asked to rank technologies introduced and tested according to their preferences. The result is the following list:

1. Optimum use of marginal land with agroforestry
2. Multipurpose tree species and their uses
3. Kitchen garden for better living
4. Vegetables for human nutrition
5. Liquid manure
6. Preparation of organic manure
7. Indigenous species for green manuring
8. Propagation of fodder grasses
9. Citrus nursery (orange)
10. Off-season onion cultivatior
11. Off-season vegetable
12. Vegetable seed production
13. Smokeless chulo
14. Improved shed
15. Ayurvedic pest management in Nepal
16. An introduction to integrated pest management
17. The pesticide problem
18. Pressure cooker

The Farm Women's Reasons for Selecting the Technologies

1

Optimum Use of Marginal Land with Agroforestry System

- Highly liked by participant women farmers
- Reasons

1. Fodder, fuelwood, fruits, timber, etc. can be grown on small parcels of marginal land which are lying fallow at present.

2. It reduces the time and labour being spent collecting fodder and fuelwood, from distant forests, especially during the fodder scarcity period (October-May). On an average, about six hours a day is spent to collect a bundle of fodder and fuelwood.

3. Agroforestry on marginal land helps to protect the forest for regeneration since pressure on forests will lessen.

4. In livestock management a gradual transition from winter-free grazing practice to stall-feeding provides continual fodder supply with minimum extra work.

5. Income generation is enhanced, especially through orange and winter crop production, once the winter-free grazing practice is controlled and saplings and crops are protected.

2

Multipurpose Tree Species and Their Uses

- Highly liked
- Reasons

1. Supplies their most important needs -- fodder and fuelwood

2. Saves time and labour in collecting fodder and fuelwood from forests

3. Multiple products - fodder, fuelwood, timber, leaf litters, fruits, etc. are availalbe and nitrogen fixation takes place, all of which are useful to them.

3

Kitchen Garden for Better Living

- Accepted
- Reasons

1. Provides different types of fresh vegetables round the year

2. They do not need to buy vegetables

3. Everybody can learn how to grow vegetables in a permanent way for home consumption

4. Even wastes such as dirty water and household waste can be reused to grow vegetables

5. Double dig bed gives long-term production

a. **Circle Garden**

- Accepted
- Reasons

1. Fresh vegetables can be harvested during dry season

2. Wastewater and household manure can be used to grow vegetables

3. Diverse vegetables can be grown in a small area

4. Simple and easy to make

4
Vegetables for Human Nutrition

- Accepted
- Reasons

1. Vegetables are important for the good health of the family

2. Different types of vegetables are useful in preventing nutrient deficiencies and diseases

3. Vegetables add taste and acts as an appetiser in daily diet (with rice). (Sometimes, during scarcity periods, grain, starch, and mustard cakes are used instead of vegetables.)

4. Ample amount of vegetables saves foodgrain

5
Liquid Manure

- Accepted
- Reasons

1. Easy to prepare using local materials

2. Effective in controlling common pests (aphids, caterpillar, ants)

3. Promotes quick and healthly growth of plants

6
Preparation of Organic Manure

- Accepted
- Reasons

1. It maintains soil fertility

2. Need not buy and carry chemical fertiliser (urea)

3. Simple to prepare using local plant materials

4. A big help in improving the soil fertility as the livestock manure alone is insufficient

5. It can be prepared in the field (on-site) which saves labour and time (need not carry manure)

7
Indigenous Species for Green Manuring

- Accepted
- Reasons

1. Most of the plants with green manuring properties are locally found (*asuro, titepati, khirro*, ricebean, etc.)

2. It is easy to use

3. Acts as mulch, pest repellent, and manure - multiple benefits
4. Need not buy chemical fertiliser from the market

8
Propagation of Fodder Grasses

- Accepted
- Reasons

1. Fodder grasses are of special importance to livestock production

2. Various techniques of propagation are helpful in the propagation of local and introduced fodder species, example: *amliso*, napier, etc.

9
Citrus Nursery (Orange)

- Accepted
- Reasons

1. Oranges are one of the important cash crops of the locality

2. They need not buy expensive saplings and transport them over a long distance

3. Orange saplings are in great demand but no reliable nursery to supply them are available

10
Off-season Onion Cultivation

- Accepted
- Reasons

1. The trial carried out by the women themselves proved successful

2. Does not need much watering/irrigation unlike onions planted in winter (dry season, normal planting season)

3. The bulb can be harvested during scarcity periods, hence fetches a good price

11
Off-season Vegetable Production

a. Not accepted - Techniques for winter season

Reasons - It is complicated - need to buy plastic sheet and construct structure which is suitable for commercial growers

b. Accepted - Techniques for dry season (using wastewater)

Reasons - As the area has a water shortage problem, waste water can be reused to grow vegetables. Hence, vegetables do not require extra water.

c. Rejected - seedling (sub-topic) production in plastic house and protection of seedlings from cold

Reasons - They are tedious and expensive processes - difficult and time consuming

12
Vegetable Seed Production

- Accepted
- Reasons

1. Good seeds are important for good crops and good seed is not found easily these days.

2. Seed are a constraint during planting time as they are not available locally (have to depend on Gorkha market)

3. How to select the best plant for good seed production is a simple yet effective method. It yields pure seed, saves money, and provides seed at the time required.

13
Smokeless *Chulo*

- Accepted
- Reasons

1. Smoke-free cooking area

2. Saves firewood by almost 50 per cent

3. Small pieces of wood from livestock fodder can be used for cooking

4. Two items can be cooked at the same time (saves time)

5. Easy to construct using local materials

14
Improved Shed

- Accepted
- Reasons

1. Comfortable, smooth, and dry floor space for the animal

2. Urine can be used to fertilise crops (vegetables)

3. Need not scoop the urine from the floor (especially during rainy season)

15
Ayurvedic Pest Management in Nepal

- Accepted
- Reasons

1. Plants with different odour when planted together on vegetable plots reduce pest damage

2. When plants with varying heights, leaf size, and shape (broad and narrow) are planted together, more vegetables can be grown on a limited space

3. With diverse planting, different vegetables can be harvested

16
An Introduction to Integrated Pest Management (IPM)

- Accepted
- Reasons

1. The elements of an IPM strategy are simple, most of them are being practiced (they only have to be improved)

2. Some of the alternatives tried in the field proved successful

3. Need not depend on chemicals to control pest

Example

1. *Titepati* extract - controlled aphids

2. Cow wine - 1:4 (urine: water) - effective in controlling aphids in green leafy vegetables

3. Woodash effective against ants

New ones tried by the women

1. *Simali* + *asuro* mulch - controlled red ant in vegetable nursery

2. *Simali* + *asuro* + *titepati* mulch - protected potatoes from red ants (on-going)

17
The Pesticide Problem

- Accepted
- Reasons

* Metacid and BHC are in use (DDT is rarely used)
* It is only an awareness (caution)

1. It is harmful to human health, if not used carefully

2. It can cause damage to animals, birds, fish, bees, and other beneficial organisms

3. Chemicals (such as BHC) can pass on to children through breast milk

4. Alternatives to chemical pesticides are safe and easy to apply

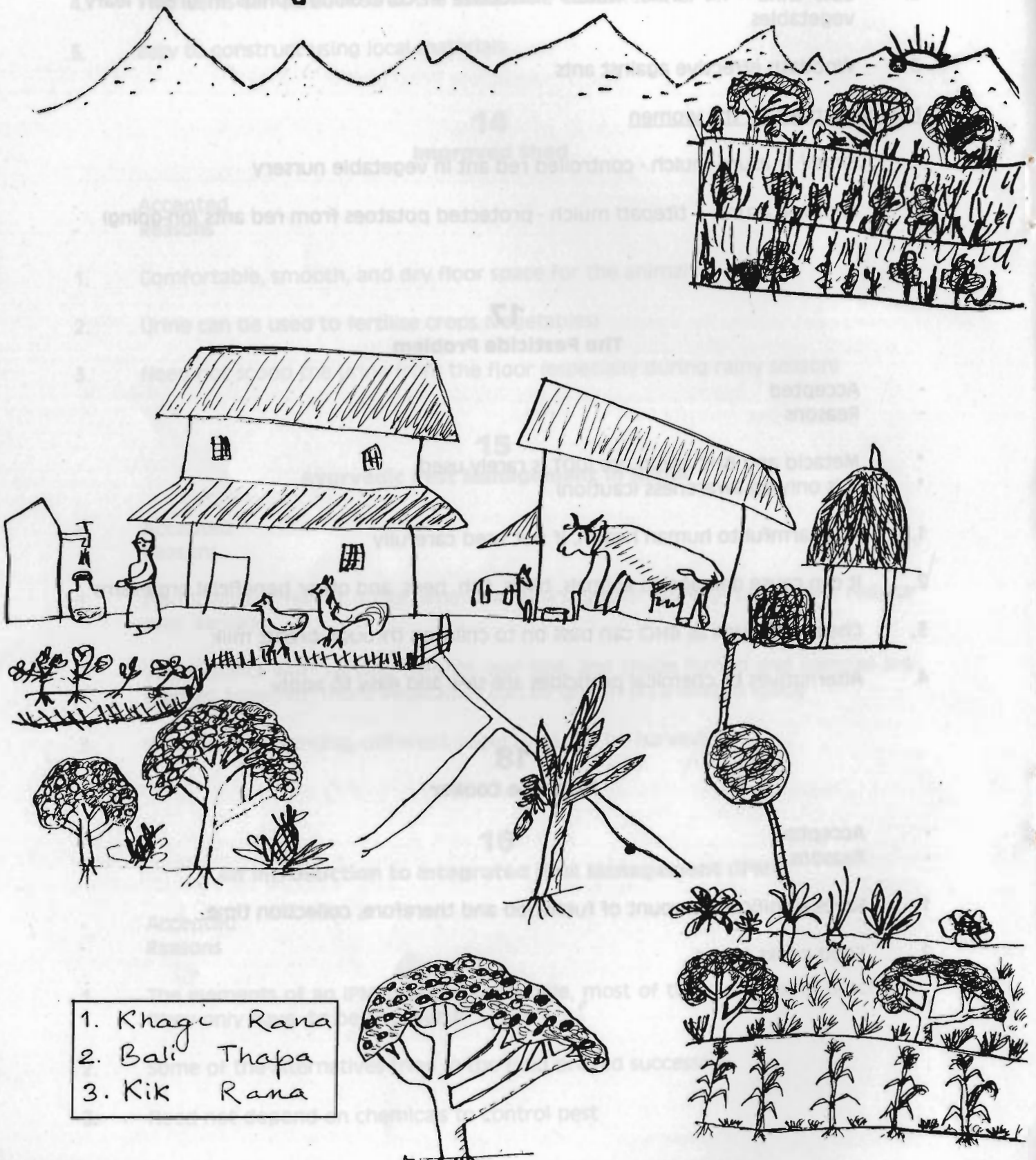
18
Pressure Cooker

- Accepted
- Reasons

1. Saves significant amount of fuelwood and therefore, collection time.

2. Food cooks faster

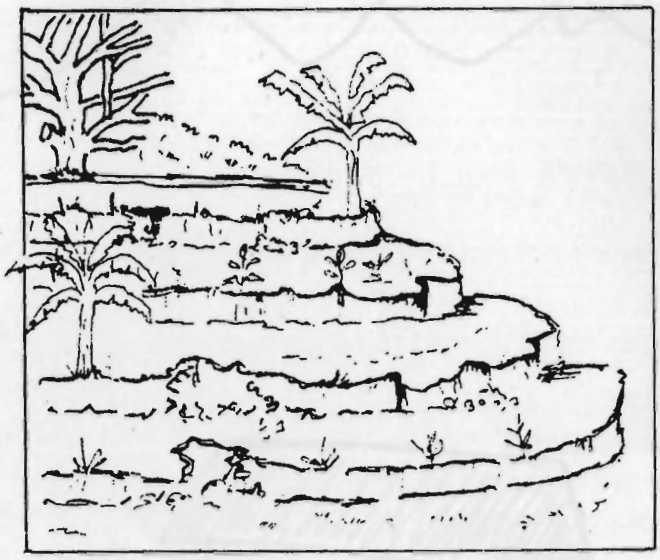
Integrated Farming System

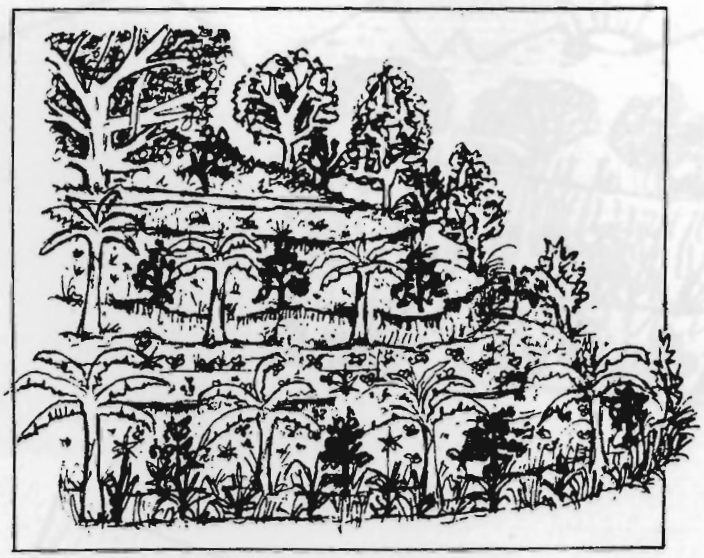


1. Khagi Rana
2. Bali Thapa
3. Kik Rana

TECHNOLOGIES SELECTED BY FARM WOMEN

OPTIMUM USE OF MARGINAL LAND WITH AGROFORESTRY SYSTEM





Private marginal lands, such as abandoned terraces, degraded and/or eroded land and often single-cropped areas, can be converted into more productive land.

While establishing the system, the emphasis must first be given to improving the soil fertility of the land. This can be done through the use of legumes (green manuring), in situ mulching and/or composting and the incorporation of any other locally available organic matters, such as agricultural by-products and other bio-degradable materials.

BENEFITS ACCRUING FROM THIS SYSTEM

1. Productive use of marginal land.
2. Reduction of soil erosion.
3. Early returns as fruit, fodder grass, vegetables and fuelwood can be harvested the second year.
4. Income-generating sources created.
5. Lower maintenance because perennials require less attention than annual crops.

FACTORS TO BE CONSIDERED BEFORE ESTABLISHING THE AGROFORESTRY SYSTEM

1. Identify the marginal land to be converted.

2. List the locally available and suitable plant species. These will include legumes, shrubs, fruit and other multipurposes trees selected by the farmer.

3. Protect the area, if necessary, through live fencing, using plants, such as ***Asuro, Khirro, Taleto, Padke, Simal, Ketuki, Sajiwan, Sihundi, Nilkanda,*** etc. Stone-fencing can be built if sufficient stones are available.

4. Prepare a simple scheme of the major species that the farmer wants to establish over the long term. Focus should be given to fruits and fodder.

5. *In-situ* composting, green manuring and green leaf manuring should be done wherever possible for improvement of soil fertility and for water conservation.

STEPS TO BE TAKEN WHILE ESTABLISHING THE AGROFORESTRY SYSTEM

1. Seasonal legumes with vigorous growth, for example: cowpea, velvet bean and rice bean (*masyang*) should be planted in the beginning in order to have enough soil cover, thereby improving the soil condition. Planting should be dense and thick. The best time to plant these species is April-May.

2. In the first year, with the onset of the monsoon, pioneer species, such as banana (at lower elevations), pineapple and some tree species can be planted following the contour or at regular intervals. At the same time, pits can be dug for other tree species.

3. The dug soil from the pit should be mixed with a little compost and returned to the pit in order to prevent soil loss.

4. Tree seedlings can be planted in the prepared pits during July-August.

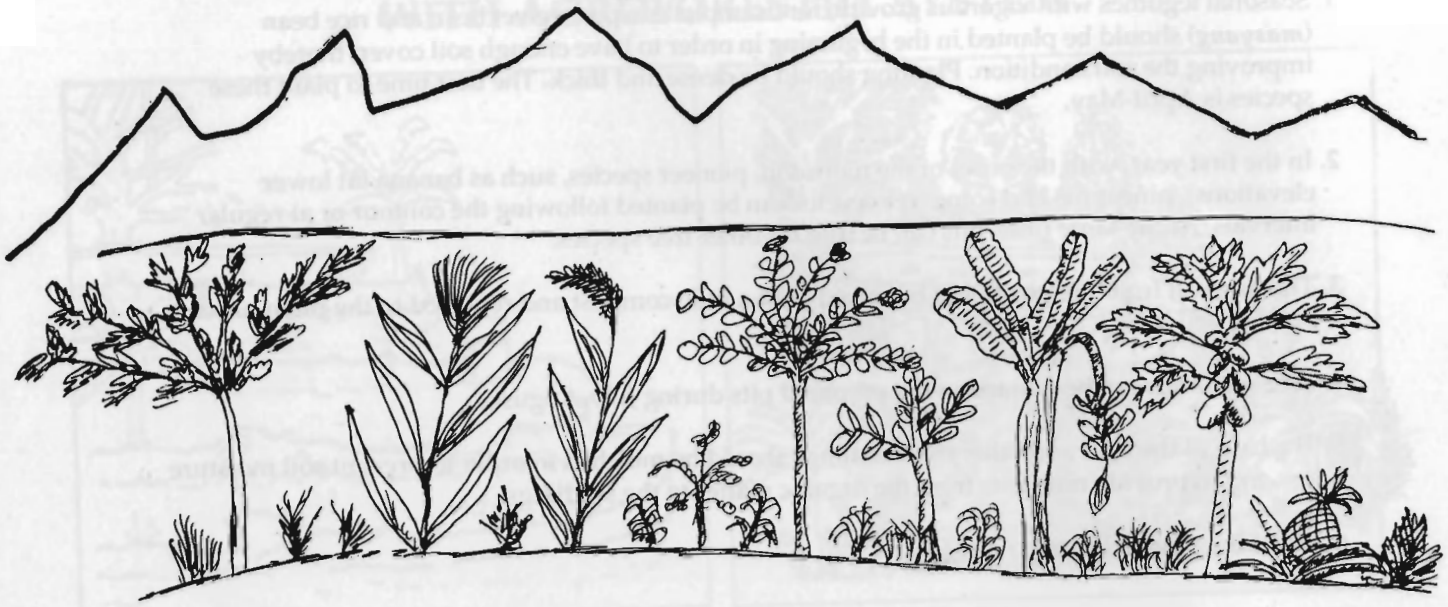
5. The base of the fruit and other tree seedlings should be mulched in order to prevent soil moisture loss and to provide nutrients from the organic matter to the seedlings.

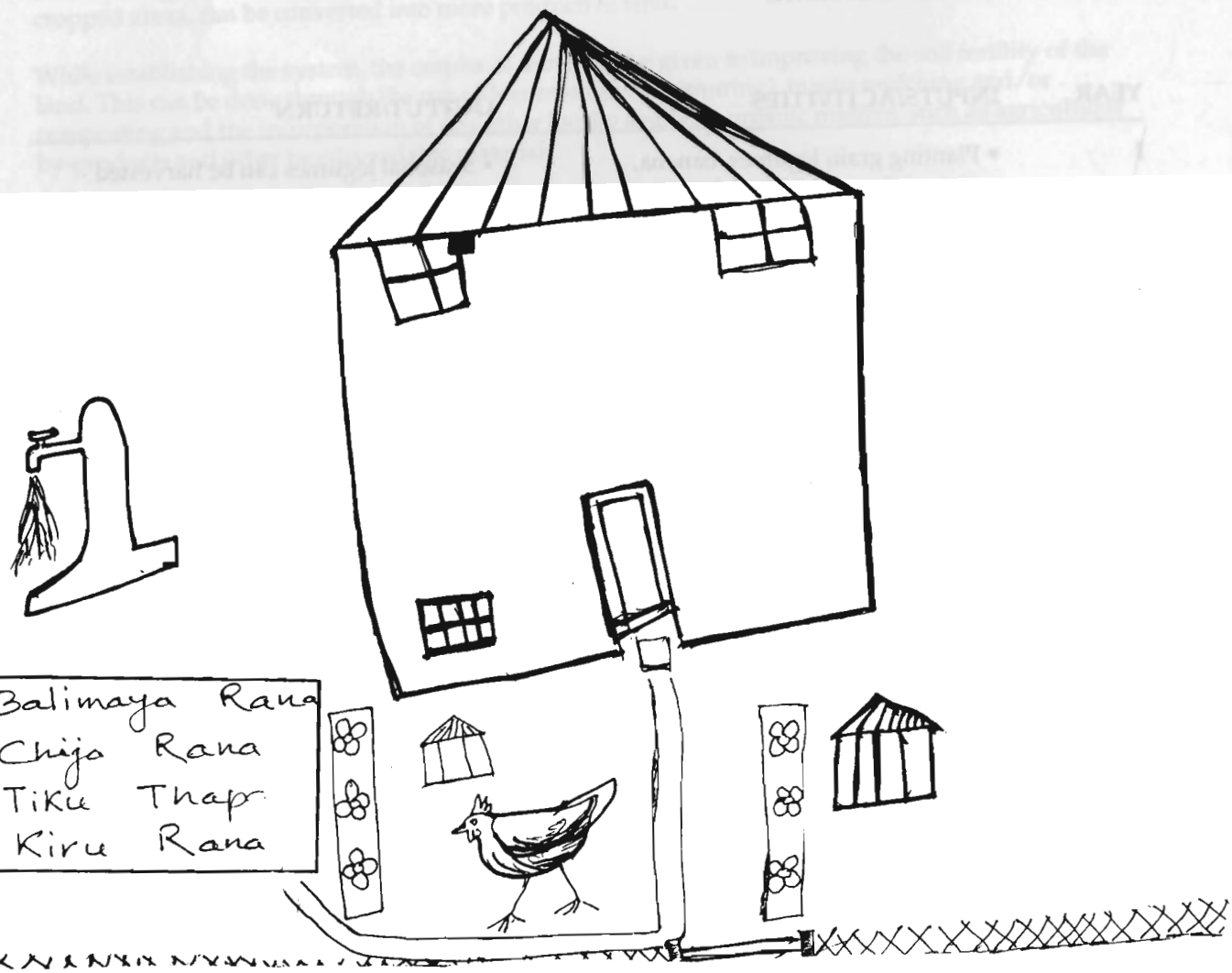
6. Weed the base of the tree regularly.

INTERVENTION SCHEME

YEAR	INPUTS/ACTIVITIES	OUTPUT/RETURN
I	• Planting grain legumes, banana, pineapple, up to100 m alt. and some tree species • *In-situ* compost-making • Addition of all available organic matters • Mulching and weeding	• Seasonal legumes can be harvested • Fodder grass for cattle can be harvested
II	• Continuation of legumes and *in-situ* composting • Planting fruit saplings • Replacement planting, if necessary • Planting of vegetables (i.e., brinjal, tomato, pumpkin, gourd, etc.) • Continue mulching and weeding • Addition of more tree	• Seasonal legumes and early -maturing pineapples can be harvested • Grass, fodder can be harvested
III	• Continue activities, such as legume planting, mulching and weeding at the base of fruit trees	

Agroforestry





1. Balimaya Rana
2. Chija Rana
3. Tiku Thapa
4. Kiru Rana

AN EXAMPLE OF USING MARGINAL LAND FOR INTEGRATED FRUIT FARMING

- Establish a diversified fruit orchard integrating mandarin orange, sweet orange, lemon, coffee, cardamom, guava, pineapple, banana, plums, pear.

- Plant ipil-ipil and *Albezzia falcataria* on the bund of terrace by direct sowing. Distance between plants should be 50 cm.

- Plant ***sisso, bakaino***, neem, bamboo, ***koiralo*** and other fodder species on the boundary line of the orchard with the following distance between plants:

    - ***Sisso***— 2.5 m.
    - ***Bakaino***— 10 m.
    - ***Neem***— 15 m.
    - Bamboo— 30 m.
    - Fodder trees in between of other plants.

- Plant coffee, banana, orange and pineapple. Alternate orange and coffe in rows. Plant banana and pineapple throughout the fields between the orange and coffee.

- Intercrop various species of legumes, garlic and onion.

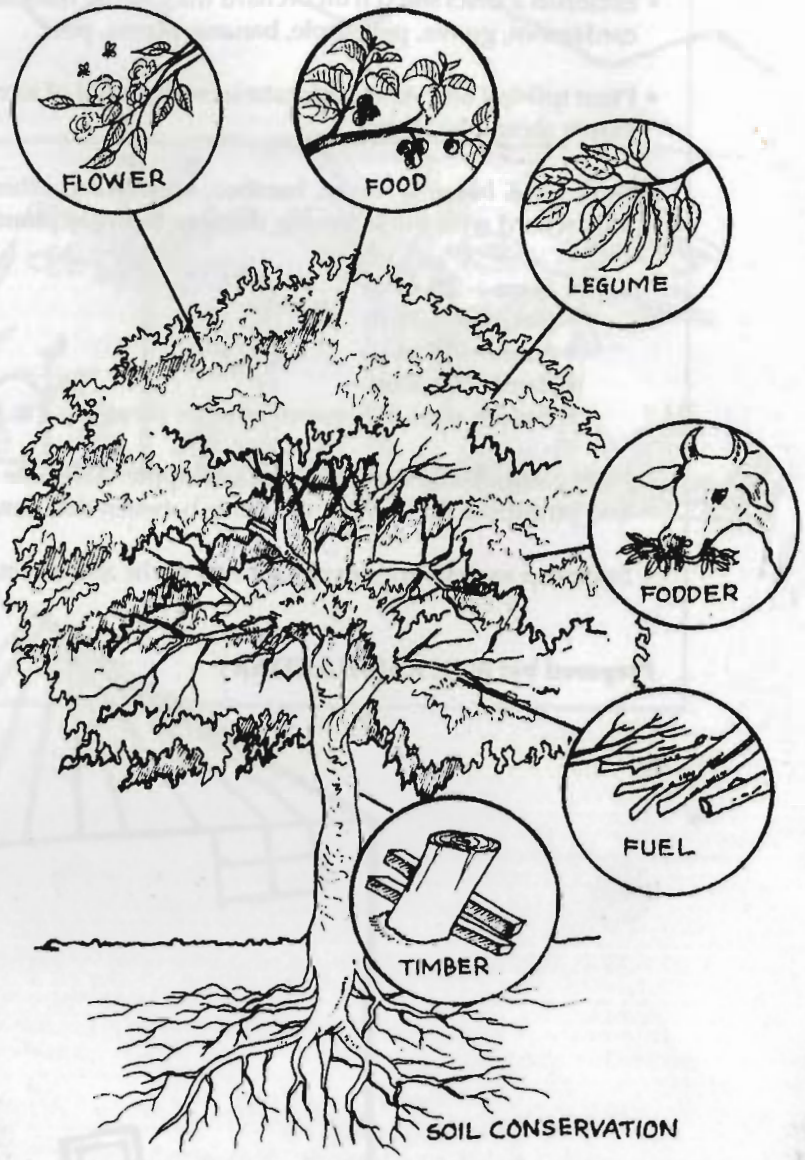
Prepared by: B. D. RAJBHANDARY

MULTIPURPOSE TREE SPECIES AND THEIR USES

Decreasing forest resources, shrinking land holdings and labor shortages have forced farmers to look for viable farm alternatives. Fodder for cattle, fuelwood for cooking and fertilizer for the field remain priorities for farmers.

The importance of trees for firewood, timber, food and fodder is well-recognized by communities in the rural hills of Nepal. However, planting trees is not commonly practiced due to the common thought that trees belong in a forest. People are reluctant to plant trees on their croplands as they suspect that trees can have a negative impact on field crop production.

Survey findings show that households spend an average of 3-8 hours a day gathering fodder and fuelwood. Therefore, by planting tree species which have multiple uses on the farm, less family labour is devoted to these tasks and can be used for other activities.



CHOOSING TREES

Before making any decision regarding the establishment of trees, it is important for both the extension worker and the farmer to know the specific details of a tree species. For effective planning the following must be considered:

- water and nutrient requirements
- tolerance to adverse climates
- root system development
- foliage density
- coppicing ability
- multiple uses
- palatability of leaves to animals.

The use of fast-growing, leguminous tree species should be emphasized. In addition to fuel and fodder, legumes will add nitrogen and organic matter to the soil. Small-sized trees with an open crown and good coppicing ability should be given priority.

TREE-GROWING *NICHES* ON SMALL FARMS

When proper on-farm *niches* for growing trees can be identified, trees can meet the social needs of firewood, food, fodder and timber production. Also, soil fertility can be maintained and enhanced and landslides can be controlled. Growing trees on croplands near the home can save time in collecting fuelwood, fodder and timber and helps to maintain the natural vegetation, thus reducing human pressure on existing forest resources. However, tree species must be planted in appropriate tree growing *niches* within the farm.

TREE MANAGEMENT

Tree management must be based on individual farmer decisions because a farmer categorizes his management priorities on the basis of the expected harvest. It is important to understand that farmers require multiple products from their trees. This can be most effectively ensured by selecting tree species that have a valuable primary harvest, as well as secondary products.

Some of the tree species identified on the basis of their multipurpose uses are presented in the table. (Exotic species such as Ipil ipil, *Caliandra*, etc., are not included as sufficient information exists on these species.)

KITCHEN GARDENING FOR BETTER LIVING

Even in a small space and with little water, it is possible to grow many kinds of plants for the production of food, fodder, fuel, etc., primarily for home consumption. This guide is designed to help a kitchen/home gardener in the sub-tropical/temperate areas of Nepal.

WHY A KITCHEN GARDEN ?

- to get fresh and nutritious vegetables, fruits, herbs, etc.
- to have safe food, free of pesticides and other chemicals
- to make productive use of waste water and other wastes from the home garden, cattle shed, etc.
- to save money on the purchase of vegetables and fruits.
- to have fun and to be in touch with the earth.

GARDEN DESIGN

To design a garden, try to observe and follow nature. In nature, things grow together, competing but also cooperating, changing over time, needing little effort to maintain and remain productive.

Increase diversity: Growing different crops and trees together has many benefits. Different plants need different nutrients; some love sun, some like shade, some give fruit in the dry season and others during the wet. Thus, by growing several plants together, we better utilise the natural resources and have a more stable and well-distributed yield. Combinations of sun-loving/shade-loving, short season/long season, shallow-rooted/deep-rooted and nutrient-demanding/nutrient-supplying plants usually work well. Some examples include corn and beans, peas and radish, millets and black or green gram, etc. This is called *companion planting.*

Reduce external inputs: Try to produce as much of the materials needed for your garden in the garden itself. If you need to keep buying seeds, plants, compost, straw, etc., gardening will become expensive and unstable, with little chance of quality control or improvement. The mixture of crops, trees, animals, birds, etc., must be well-planned and all wastes must be recycled by composting, mulching, or decomposing in a biogas plant.

Observe weeds: Weeds are plants that grow naturally and vigorously in a place. They are good indicators of soil condition and their extract in water ratio of 1:20 (left to set for 5-7 days) can supply nutrients and control many insects. Before you remove or cut them, carefully observe which weeds grow in the garden and what seems to be their function. Weeds which have deep roots can be used as green manure or cover crop, especially in poor eroded soil.

Weeds should be kept under control and not eliminated as they also play an important role in developing healthy soil. Unwanted weeds and troublesome grasses are usually best controlled by shading them or suppressing them with mulch or cover crop. *Canavalia gladiata* and *C. ensiformis, Dolichos lablab, Centrosema pubesence,* (Jack bean, velvet bean, sword bean, etc.) are some vigorous trailing and climbing plants which can suppress weeds. Low tillage or no tillage, mulch farming and close spacing in raised bed are also effective techniques in weed control.

Use of Perennial/Tree Crops: Some tree species can improve the environment in the kitchen garden and also provide a yield. The advantage of using trees is that after establishment, inputs are very low while outputs increase with age. Trees supplying food crops include drumstick (leaves, flowers and

pods), *Sesbania grandiflora* (leaves, flower and pods) etc. Other benefits include light shade, bee forage, biomass for mulching, pest predator habitat, wind break, pleasant scent and aesthetic flowers. Trees are, therefore, an important part of a kitchen garden. Other species include Custard apple, *Leucaena*, *Cargana*, dwarf fruit trees, papaya, *Gliricidia*, pigeon pea.

CROP LOCATION IN THE HOME GARDEN

Different vegetables are suitable for different areas of the garden and homelot. Some examples are provided:

Plants for wet areas (near water pump)

Colocasia
Swamp cabbage
Sugar Cane
Banana

Plants for dry areas

Legumes	Jackfruit
Cassava	Grapes
Pineapple	Papaya
Guava	Guava
Citrus	Lime

Plants that make good live fences

Leucaena
Gliricidia
Drumstick plant
Casuarina
Bamboo (poles)
Hibiscus
Cactus
Pineapple
Cassava

Plants for trellis

a) Climbing legumes
String bean
Lima bean
Yardlong bean
Winged bean
Yarn bean

b) Climbing fruit
Squash
Gourd
Cucumber
Bitter melon
Climbing spinach

Plants for under the trellis

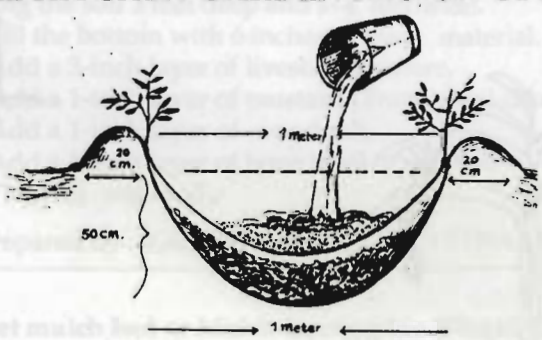
Colocasia
Swamp cabbage
Sweet potato (leaves)
Ginger
Cardamom
Turmeric
Spinach

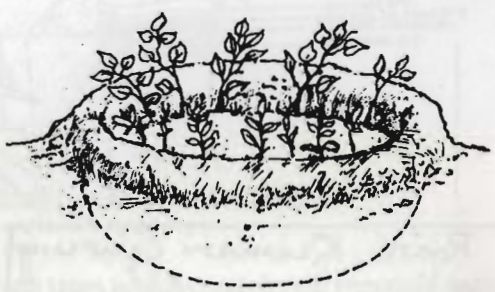
Plants that suppress weed growth

Sweet potato
Swamp cabbage
Squash
Bitter melon

Note: For seasonal cropping patterns, see the diagram on the last page.

SOME KITCHEN GARDEN DESIGN OPTIONS



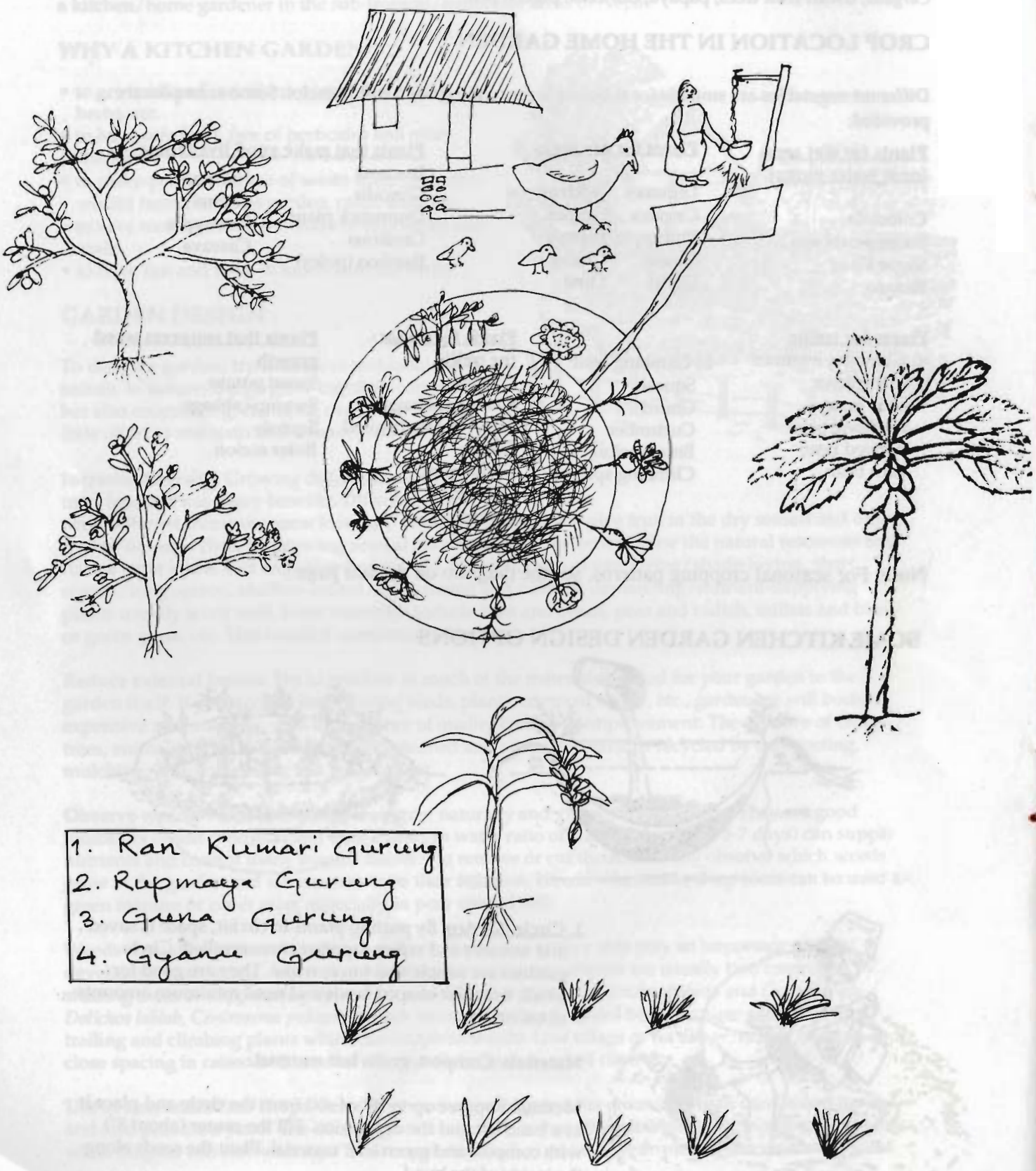


1. Circle Garden: By putting plants in circles, space is saved and nutrient and water supplies are controlled. Circle gardens are simple and fun to make. They are good for small, irregular-shaped lands and need minimum amounts of materials.

Materials: Compost, green leaf material.

Method: Remove up to 18" of soil from the circle and place it as a bund around the depression. Fill the center (about 8") with compost and green leaf material. Plant the seeds along the inside of the bund.

Circle Garden



1. Ran Kumari Gurung
2. Rupmaya Gurung
3. Grena Gurung
4. Gyanu Gurung

Advantages: Easy to make, uses only local green leaf material, all plants get nutrients and water in equal amounts (nutrients are applied in the center of the circle), no wastage.

2. Raised beds (bio-intensive gardening): Raised beds and channels (which are also used for pathways) allow for denser planting and avoid soil compaction in the growing area. This provides better soil cover, easier weed control and higher biological activity resulting in improved soil and more production. These are highly productive and intensive garden beds and production in the first year can be as high as 2-3 kg of produce per day from a 20'x4' bed.

Double digging is of special relevance to urban gardeners interested in maximizing their outputs from limited land areas.

Materials: compost (6"), bonemeal (1"), mustard seed cake and ash (3")(optional) .

Method: Soil in the bed is dug deeply (2') and removed from the bed. The soil is then mixed thoroughly with the compost and placed in layers in the bed. The bed is ready for planting and should be lightly mulched to conserve moisture.

Advantages: The addition of large amounts of compost ensures that the beds are very fertile and nutrient-rich. High productivity starts immediately.

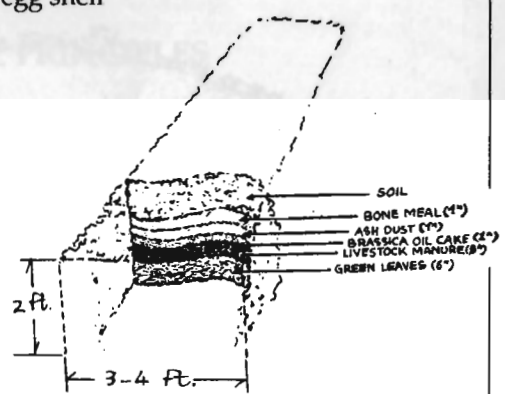
Disadvantages: The labour input required to double dig the beds and establish the systemhigh and the high amount of compost is sometimes an obstacle.

MODIFIED DOUBLE-DIGGING TECHNIQUE

- Plant material — leaves of leguminous trees, weeds, herbs (e.g. *Eupatorium,*)
- Animal products —livestock manure, bone meal, egg shell
- *Brassica* (Mustard) oil cake
- WoodAsh

Method

1. Dig the soil 2 feet deep and 3-4 feet wide.
2. Fill the bottom with 6 inches of plant material.
3. Add a 3-inch layer of livestock manure.
4. Add a 1-inch layer of mustard (*Brassica*) oil cake.
5. Add a 1-inch layer of wood ash.
6. Add a 1-inch layer of bone meal or egg shell.
7. Then fill with soil .

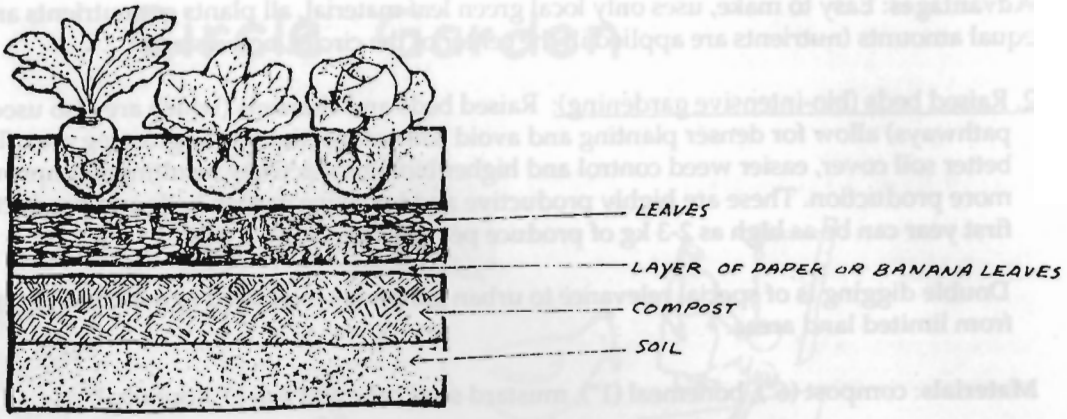


Prepared by : KAMINI VAIDYA, SUCHITRA PRADHAN, MADAN SHRESTHA

3. **Sheet mulch bed or Mulch farming (no tillage)**: Growing trees which can tolerate repeated cutting and putting all leaf/branch materials on the bed as mulch, many crops (especially large seeded crops like corn, beans, etc.) can be grown with little effort. In the dry seasonthe trees are allowed to grow; in the wet season, the biomass is used as a mulch. This is method of growing vegetables that is quick and easy to start and gives a seed bed for the future.

Materials: a layer of paper, banana leaf or old rice straw mats, compost, leaf matter

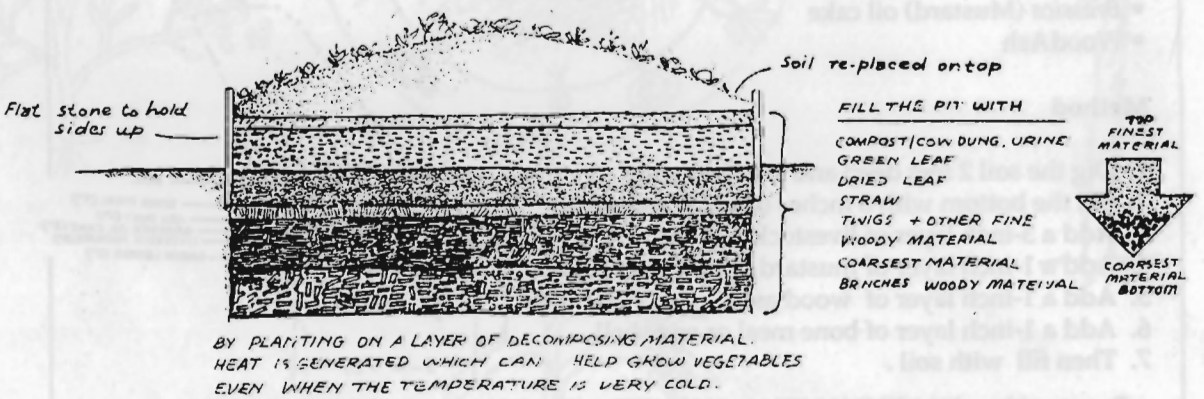
Method: If the soil can be loosened, this may help for an improved early production. Place some compost and then a thick layer of paper, banana leaf, rice straw mat on the ground. This layer is designed to prevent seeds emerging, so the layer should be thick (3-4 overlapping paper sheets). Next, layer on organic matter free of weed seeds (ideally, about 12" of straw, leaf litter, green leaves). Beds should be 3-4 ft. wide and as long as desired. Planting of large seeds or transplanting seedlings is required. Each seedling/seed should be placed in the mulch with a handful of compost/soil.



Advantages: Quick and easy to make. Least soil disturbance. Weed-free and easy maintenance. Heavy use of mulch, so good water conservation and future soil fertility are high.

Disadvantages: Plants with small seeds may not easily establish initially in the mulch. So, seedlings plants with large seeds (beans, cucurbits, etc.) are required. As the mulch decomposes, smaller seeds can be used. Ideally, the garden is designed so that future mulch is produced in the garden for the plants. Small, fast-growing trees (e.g. *Gliricidia*, *Erytrina*) growing near the beds can produce mulch for the future.

4. **Hot bed**: By placing a range of fresh organic matter underneath the soil, decomposition occurs which generates heat. This allows cultivatio of vegetables in colder areas over a longer period.



Materials: Any organic matter can be used including twigs, branches, green leaves and compost.

Method: Dig one foot of soil from the bed and place to one side. Place the organic matter in the bed, putting the woodiest and largest material at the bottom. The finer, freshest organic matter (green leaves, etc.) and compost are placed at the top of the pile. Cover with soil. Plant seedlings/large seeds into the soil.

Advantages: All biomass can be used, including small branches and twigs. Because decomposition of the material takes place, heat is generated which helps vegetables to grow during cold months in the high hills. Productivity increases over time.

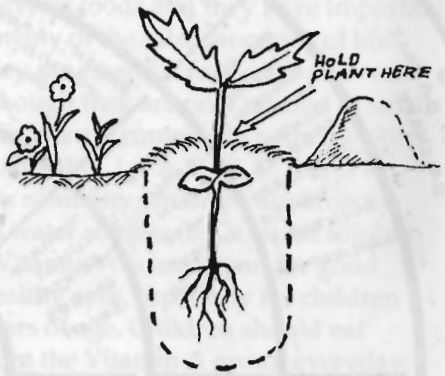
Disadvantages: In the initial stages, it is hard to grow some plants with small seeds and root crops like carrot. Because decomposition is not complete, productivity in the initial stages may not be very high. This can be improved by using more compost or urine.

PLANTING AND TRANSPLANTING: A FEW TIPS

Vegetable seedlings are usually raised in high beds of compost mixed with loose soil in order to have a well-developed root system. The bed is well-soaked, 24 hrs before transplanting. Transplanting should be done in the late afternoon/evening or on a overcast/cloudy day. Plants should be 6-8 weeks old when transplanted.

While transplanting seedlings, do not touch the roots and do not expose them to the sun. Hold the plant above the primary leaf and plant it in a way that it is level with the soil surface. Make the hole large enough so that the roots hang free and are not bent.

The larger the seed, the deeper it has to be planted (roughly 3 times the width of the seed). In the notillage method, large-seeded crops need at least 10 cm of leaf or grass cover.



Tomato, chili, *capsicum*, *brinjal*, beet root, cauliflower, cabbage, etc., are usually transplanted. Pumpkin and other gourds may be transplanted also, but this is usually done only in cold areas.

Root crops and beans are sown directly; so are most spinach and herbs.

SEED SELECTION AND STORAGE: BASIC PRINCIPLES

For most vegetables, we can easily grow our own seeds, provided the seeds are not hybrids. Local varieties may sometimes have a lower yield (which can be improved through careful selection); but they are always stronger against insects, diseases, etc. So, their total yield may be more because you lose less! Local seed is also more nutritionthan commercial improved varieties. Local seed produces over a longer period, as it is not designed to produce its seed all at one time. If you have a choice, start with local crops and seeds.

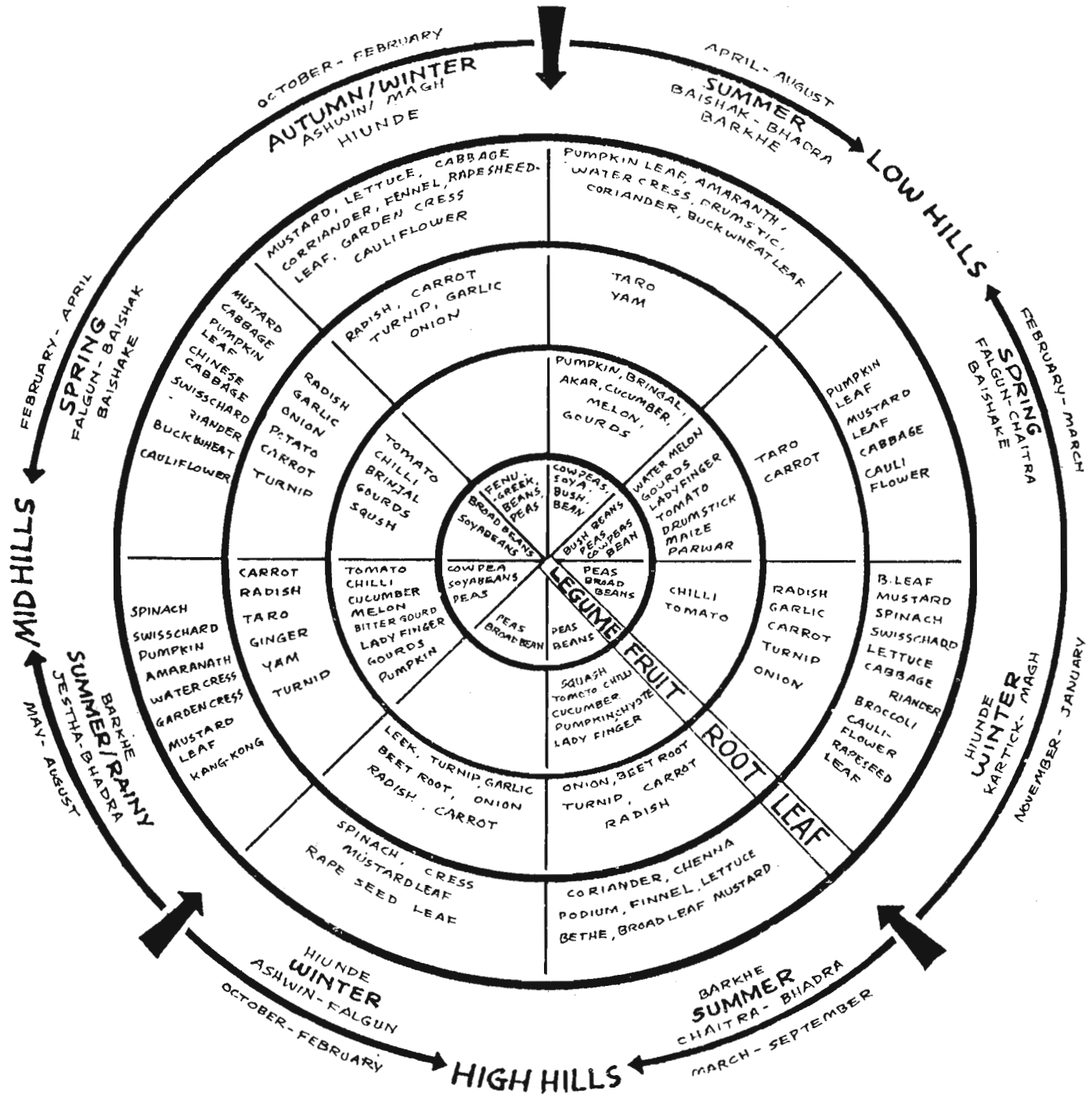
When selecting seeds, look at the whole plant and do not select seeds from just one big fruit. Is the plant strong and disease free? Did it give fruit over a long period? Mark the plants from which you plan to collect seeds.

Do not keep seeds from just one plant, even if it is a very good plant. Keeping a genetic variation of seeds is also important. The practice of exchanging seeds with farmers from your community and neighboring villages helps maintain seed quality and genetic diversity.

Store only those seeds which are well-formed, medium-sized and without shrinkage marks. Do not keep inferior seeds. **Use known seed; use own seed.**

NATURAL INSECT CONTROL

Most insects do little harm to crops and bring several benefits. If even after choosing good seeds, planting them it in the right spot and in a healthy soil, specific insects still cause a problem, traps, insect repellents, antifeedants and other methods can be used to protect the plants in a natural manner.



SEASONAL CROPPING PATTERNS FOR VEGETABLES

Prepared by: CHRIS EVANS and
MIKE FEINGOLD;
Also thanks to: Ardhandu
Chatterju, Auroville,
Pondicherry India

April 1992

REGENERATIVE AGRICULTURE TECHNO'
FOR THE HILL FARMERS OF NEPAL
NERRA/IIRR

VEGETABLES FOR HUMAN NUTRITION

Vegetables can be excellent sources of protein, iron, minerals and vitamins. Dark/leafy vegetables can contribute significant amounts of vitamins and minerals, and are especially excellent sources of protein, carotene (Vitamin A), iron and ascorbic acid (Vitamin C).

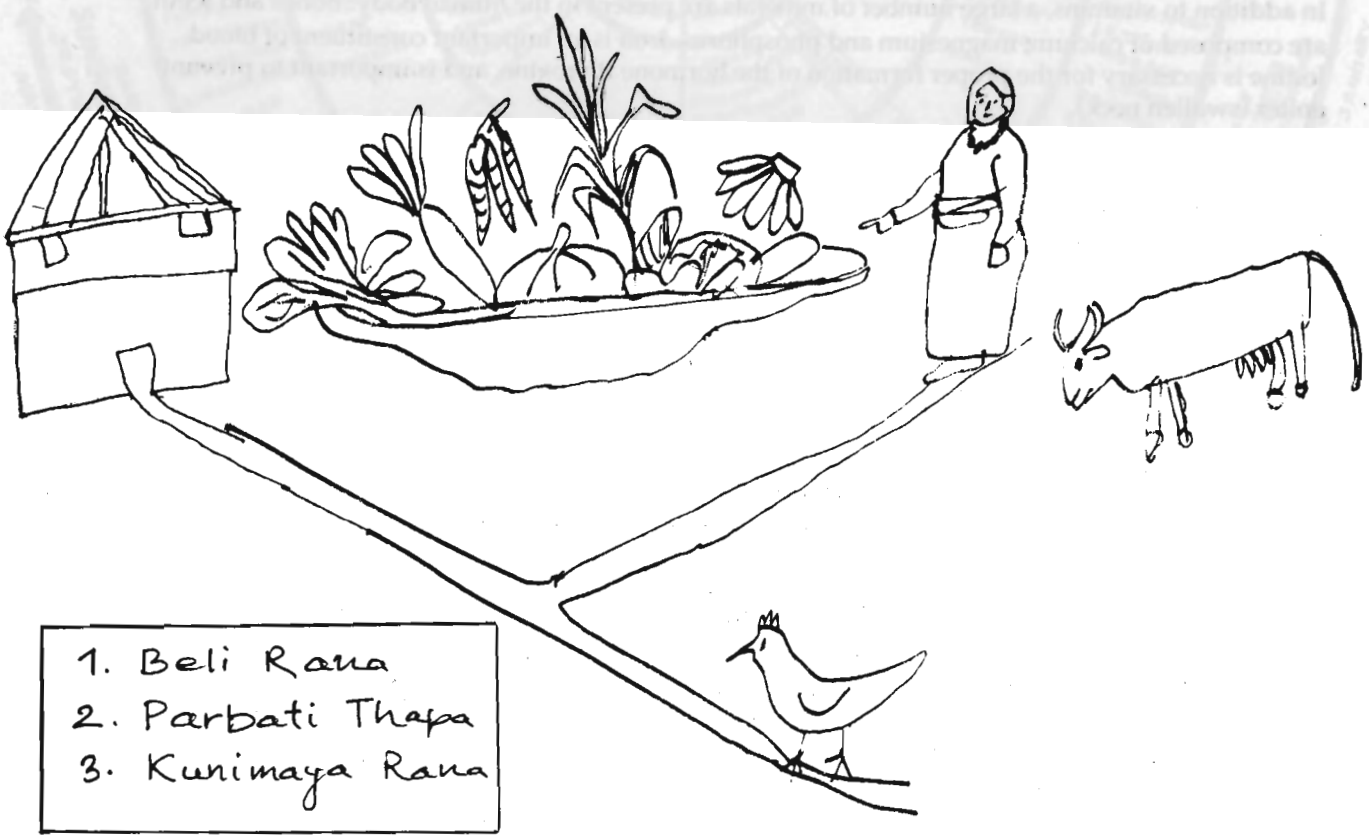
Vitamins are organic substances present in small amounts in several foods and they have important functions in many of the vital processes of life. Therefore, they are essential for health and well being, even though they are only needed in small amounts. Vitamins are commonly named by the letters of the alphabet, i.e. A, B, C, D, E and K. Based on their solubility, vitamins are broadly referred to as water soluble (B, C), or fat soluble (A, D, E, K). Vitamin A is important for good vision and healthy eyes, especially for children less than 5 years of age. Children should eat vegetables from the Vitamin A group everyday.

In addition to vitamins, a large number of minerals are present in the human body. Bones and teeth are composed of calcium, magnesium and phosphorus. Iron is an important constituent of blood. Iodine is necessary for the proper formation of the hormone thyroxine, and is important to prevent goiter (swollen neck).

Vegetables can also serve as sources of proteins and carbohydrates, but do not necessarily serve as primary sources of these important elements. For example, broad beans and soyabeans can provide plant protein, and vegetables such as Chinese leeks and wing beans can be good sources of some carbohydrates. However, the inclusion of grains (wheat, barley, corn, potatoes, buckwheat) is needed to meet the energy needs of the family.

The choice of vegetables for cultivation and consumption can be based on the need for certain nutrients, e.g., carotene, calcium, iron and Vitamin C.

Vegetables for Nutrition



1. Beli Rana
2. Parbati Thapa
3. Kunimaya Rana

NUTRIENT-RICH VEGETABLES BY SEASON

Nutrients	Winter	Summer
1. Protein	cowpea, broad bean, soyabean, rapeseed leaves	broad bean, cowpea, soyabean, rape seed leaves, amaranth, fenugreek leaves, ***bethu***
2. Vitamin A	carrot, knol khol, spinach, radish (leaves), rapeseed leaves, swiss chard, coriander, mustard leaves	tomato, honey melon, amaranth, chillies, pumpkin, beans, ladyfinger, water cress, drumstick, coriander leaves, colocasia
3. Vitamin B	cabbage, broad beans, radish, fenugreek leaves, peas, brinjal, cauliflower	beans, buckwheat leaves, amaranth, Chinese leek, water cress, tree tomato, ***parwar***, colocasia
4. Vitamin C	carrot, spinach, radish, garlic, coriander, rapeseed leaves, cauliflower, pea, radish leaves, knol khol	tomato, bitter gourd, water melon, chillies, capsicum, amaranth, drumstick, coriander, rapeseed leaves, Indian spinach
5. Iron	spinach, Indian spinach, swiss-chard, rapeseed, mustard leaves, onion, broad beans, fenugreek leaves, soyabeans, radish leaves, beetroot	brown bean, cow-pea, lady finger, colocasia, bitter gourd, water cress
6. Calcium	spinach, amaranth, lettuce, rapeseed leaves, swiss-chard, knol khal, cabbage, mustard leaves, radish (leaves), fenugreek leaves	broad bean, cowpea, amaranth, asparagus, colocasia, pumpkin leaves, knol khal, water cress, soyabean
7. Phosphorous	lettuce, onion, cauliflower, peas, beetroot, carrot, broad bean, ***parwar***	beans, water cress, carrot, asparagus, lady finger, pumpkin leaves
8. Carbohydrate	pea, Chinese leek, beetroot, amaranth, broadbean, asparagus, garlic, colacasia, ***pustakar***, chayote root	broad bean, gourds, carrot, cow-pea, ***parwar***, Chinese leek, soyabean, radish

- Remember: A diverse diet is very important to supply the different nutrients, and an adequate diet.
- This is not a complete list. The types of vegetables grown will vary according to the region, rainfall, ethnic preferences, type of soil, etc.
- Always clean vegetables before cutting or nutrients can be lost. Do not overcook vegetables as nutrients can be lost.

Prepared by: NIRMALA UPRETY
April 1992

NUTRIENTS AVAILABLE IN DIFFERENT VEGETABLES (PER 100gm)

English Name (Nepali)	Protein gm	Minerals gm	Carbohydrates gm	Calcium mg	Phosphorus mg	Iron mg	Carotene (Vitamin A) ug	Thiamin (Vitamin B1) mg	Riboflavin mg(Vitamin B2)	Vitamin C mg
Amaranth (*Latte sag*)	4.0	2.7	6.1	397	83	25.5	5520	0.03	0.30	99
Amaranth (*Kande Lunde*)	3.0	3.6	7.0	800	50	22.9	3564	0	-	33
Lamb's Quarter (*Bethe*)	3.7	2.6	2.9	150	80	4.2	1740	0.01	0.4	35
Buckwheat (*Phapar*)	0.3	2.3	65.1	64	355	15.5	0	0.90	0.34	0
Chinese leeks (*Dundu*)	1.8	0.7	17.2	50	70	2.3	18	0.23	-	11
Leaf mustard (*Rayo*)	4.0	1.6	3.2	155	26	16.3	2622	0.03	-	33
Rape seed leaf (*Tori*)	5.1	2.5	5.9	370	110	2.5	1380	0.01	0.03	65
Fenugreek leaf (*Methi*)	4.4	1.5	6.0	395	51	16.5	2340	0.04	0.31	52
Coriander leaf (*Dhaniya*)	3.3	2.3	6.3	184	71	18.5	918	0.05	0.06	135
Colocasia (*Karkalo*)	3.9	2.2	6.8	227	82	10.0	10278	0.22	0.25	12
Mint (*Pudina/Babari*)	4.8	1.9	5.8	200	62	15.6	1620	0.05	0.26	27
Radish (white) (*Mula*)	0.7	0.6	3.4	35	22	0.4	3	0.06	0.02	15
Radish leaf	3.8	1.6	2.4	265	59	3.6	5295	0.18	0.47	81
Turnip (*Salgam*)	0.5	0.6	6.2	30	40	0.4	0	0.04	0.04	43
Peas (*Kerau*)	72	0.8	15.9	20	139	1.5	83	0.25	0.01	9
Indian Spinach (*Doller plant* or *Pawai*)	2.8	18	4.2	200	35	10	7440	0.03	0.16	87
Water cress (*Sim sag*)	2.9	2.2	4.9	290	140	4.6	2803	0.12	0.38	13
Beetroot (*Chukandar*)	1.7	0.8	8.8	18	55	1.0	-	0.04	0.09	10
Knolkhol (*Ganth kobi*)	3.5	1.2	6.4	740	50	13.3	4146	0.25	-	157
Cabbage (*Banda kobi*)	1.8	0.6	4.6	39	44	0.8	1200	0.06	0.09	124
Carrot (*Gajar*)	0.9	1.1	10.6	80	530	2.2	1890	0.04	0.02	3
Carrot leaf	5.1	28	13.1	340	110	8.8	5700	0.04	0.37	79
Broad bean (*Bakula*)	5.6	1.3	11.5	111	149					
Broad bean leaf	4.5	0.8	7.2	50	64	1.4	9	0.08	-	12
Cowpea (*Bodi*)	3.5	0.9	8.1	72	59	2.5	564	0.07	0.09	14
Cauliflower (*Cauli*)	2.6	1.0	4.0	33	57	1.5	30	0.04	0.10	56
Cucumber (*Kankro*)	0.4	0.3	2.5	10	35	1.5	0	0.03	0	7
Brinjal (*Bhanta*)	1.4	0.3	4.0	18	47	0.9	74	0.04	0.11	12
Lady finger (*Ramtoriya*)	1.9	0.7	6.4	66	56	1.5	52	0.07	0.10	13
Pumpkin (*Pharsi*)	1.4	0.6	4.6	10	30	0.7	50	0.06	0.04	2
Pumpkin leaf (*Pharsiko munta*)	4.6	2.7	7.9	392	112	-	-	-	-	-
Onion (*Pyaj*)	1.8	0.6	12.6	40	60	1.2	15	0.08	0.02	2
Spinach (*Palungo*)	2.0	1.7	2.9	73	21	10.9	5580	0.03	.26	38
Lettuce (*Jiriko sag*)	2.1	1.2	2.5	50	28	2.4	990	0.09	.13	10
Pointed gourd (*Parwar*)	7.2	0.8	15.9	20	139	1.5	83	.25	.01	9
Asparagus (*Kurilo*)	2.1	0.7	38	225	-	-	-	-	-	15.4
Garlic (dry) (*Lasun*)	6.3	1.0	29.8	30	310	1.3	0	0.06	0.23	13
Tomato (*Golveda*)	0.9	0.5	3.6	48	20	0.04	251	0.12	0.06	27
Tree tomato (*Tyammatar*)	1.5	1.2	6.7	12	46	1.0	324	0.11	0.06	0
Bitter gourd (*Karela*)	1.6	0.8	42	20	70	1.8	126	0.07	0.09	88
Bottle gourd (*Lauka*)	0.2	0.5	2.5	20	10	0.7	0.3	.01	2	0
Stinging nettle (*Sisnu*)	6.9	4.2	5.0	981.3	-	-	12857	-	-	-
Edible fern (*Neuro*)	4.4	1.3	4.2	30	-		-	-	-	-

Source: 1. Nutritive Content of Nepalese Foods, Central Food Research Laboratory.
2. Nutritive Value of Indian Foods, C. Goaalan, B. V. Rama, S. C. Balasubraminian, National Institute of Nutrition.

LIQUID MANURE

Liquid manure is a plant fertiliser prepared by using animal dung, woodash, and different plant materials with dark green leaves, strong odour and taste, and is quickly decomposed (e.g., *asuro, simali, titepati, timur*, nettle, *khiro*, etc.). These materials are tied in a jute sack and submerged in water for 2-3 weeks. The container should be covered and kept in shade to avoid nutritional losses through evaporation. When ready, it can be poured on the growing vegetable seedlings after adding water (amount of water to be added depends on the size and age of seedlings).

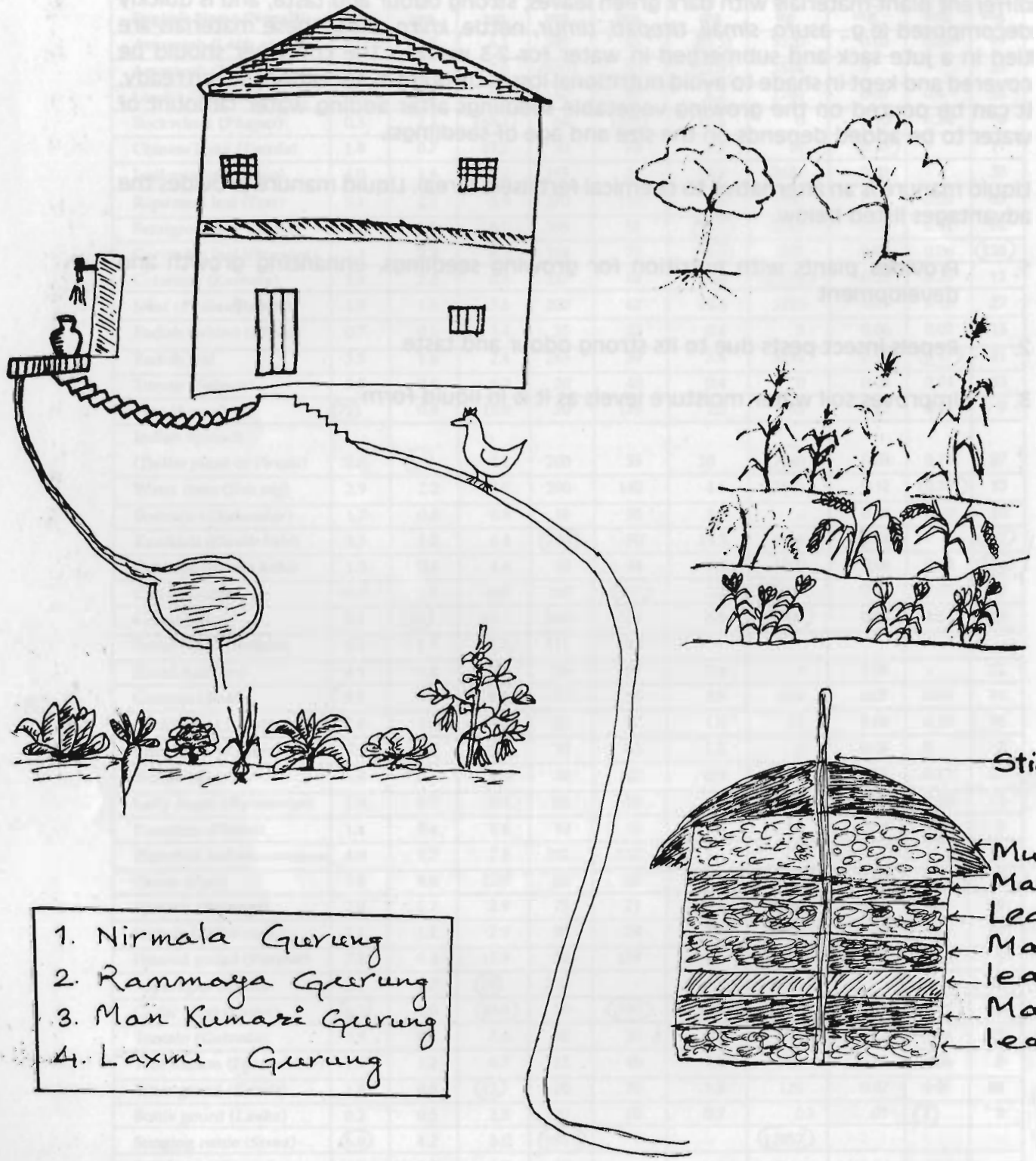
Liquid manure is an alternative to chemical fertilisers (urea). Liquid manure provides the advantages listed below.

1. Provides plants with nutrition for growing seedlings, enhancing growth and development

2. Repels insect pests due to its strong odour and taste

3. Improves soil water moisture levels as it is in liquid form

Compost Manure



1. Nirmala Gurung
2. Ranmaya Gurung
3. Man Kumari Gurung
4. Laxmi Gurung

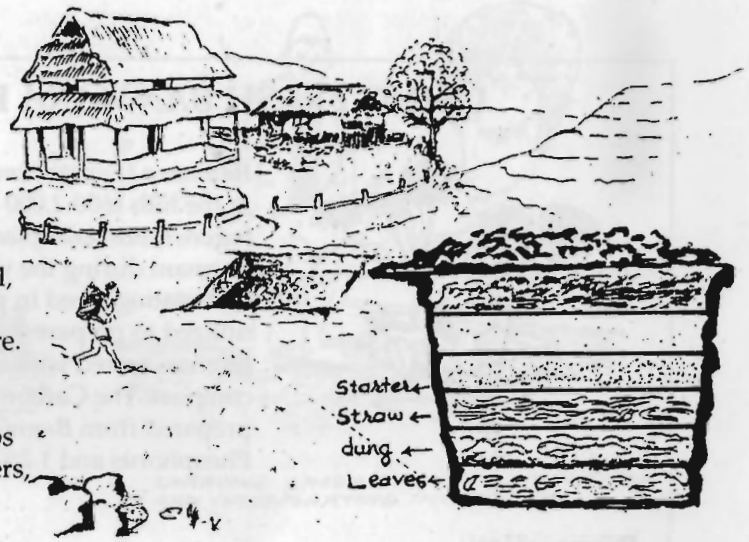
PREPARATION OF ORGANIC MANURES

Organic manures are composed of dead plant and animal remains and contain plant nutrients. They are applied to the soil to increase crop production. Farmyard manures from cow or buffalo dung, compost made from plants, leaves and kitchen waste, and leguminous crops used as green manures are some examples of organic manures.

Most farmers in the hills of Nepal use compost and other forms of organic manures as supplements to mineral fertilizers. However, compost prepared by traditional methods is not well-decomposed and has a poor nutrient content. Well-decomposed compost will reduce weeds and insects. Also, there are serious insect and weed problems when undecomposed compost is used. (The average nitrogen content of the compost prepared by farmers is 0.5%. Using improved methods can increase the nitrogen content of the compost to 1.5%.)

BENEFITS FROM COMPOST

- Maintains soil fertility level.
- Increases the nutrient level of the soil or improve the soil's physical condition by improving soil structure and aeration.
- Increases the infiltration capacity of the soil, thus reducing surface runoff.
- Helps to retain plant nutrients and moisture.
- Well-decomposed compost buffers soil reaction and controls soil temperature.
- Increases soil microbial activity which helps mineralization of applied chemical fertilizers, making them more available to crops.



IMPORTANT POINTS TO CONSIDER IN THE PREPARATION OF COMPOST

- Arrange composting material in a pit or heap. If composting is done in a heap, the site should be levelled and protected from rain by a roof so that nutrients will not leach.
- Compost is decomposed by fungi and bacteria. For proper microbial growth, add starter materials [Complesal (a few handfuls), lime or top soil] at each layer. Decomposed compost and wood ash can also be added if chemical fertilizer is not available.
- Add enough water to keep compost moist; the material should be spongy — not too dry, not too wet.
- Turn the compost pit or heap at 30-40 day intervals for proper aeration.
- Cover the compost pit or heap with mudor straw or plastic sheets. This practice enhances decomposition. In the midhills, it may take approximately 3-4 months for complete decomposition.

WELL-DECOMPOSED COMPOST IS:

- Friable
- Does not stick in the hand
- Dark grey or blackish in color
- Original material cannot be distinguished.

Prepared by: S.L. MASKEY
KRISHNA B. KARKI and
SRIBINDU BAJRACHARYA

REGENERATIVE AGRICULTURE TECHNOLOGIES FOR THE HILL FARMERS OF NEPAL
NERRA/IIRR

April 1992

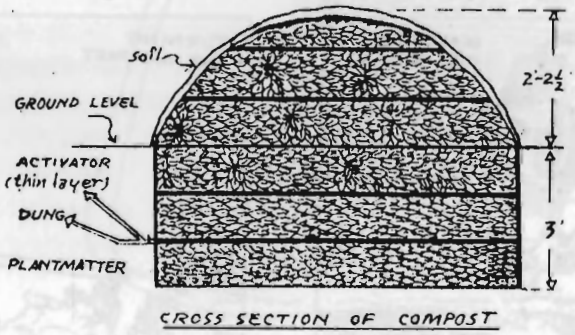
USING FRESH *BANMARA* FOR COMPOSTING

Banmara (*Eupatorium adenophorum*) is a perennial shrub found in the hills (600-2,000 masl). Its vigorous vegetative growth and regeneration take place during the rainy season but remain dormant during the winter. Largely considered as a devastating weed in pastures and forests, this plant can be utilized to prepare compost. Studies reveal that fresh ***Banmara*** biomass mixed with cattle dung can produce a good quality compost. The Carbon: Nitrogen (C:N) ratio of the compost prepared from ***Banmara*** was 14.2 with 2.0% Nitrogen, 0.02% Phosphorus and 1.2% Potassium.

Preparation:

1. Place fresh ***Banmara*** biomass (preferably new sprouts; but add a few woody stems to improve aeration) in a 3 ft deep pit in 1 —1.5 ft layers alternated with thin layers of cattle dung at a ratio of 10:1 (by weight). Use small amounts of other organic materials (lime, wood ash, soil, etc.) and chemical fertilizers (if available) as compost activators.
2. Continue placing alternate layers of ***Banmara*** and cattle dung until the materials are about 2—2.5 ft above the soil surface.
3. After 6 weeks, turn the materiai. One month later, the compost will be ready for use.

If done in the midhills (1,100-1,700 masl), ***Banmara*** filled in August will only be ready in December, after 5-6 months. ***Banmara*** can also be composted in a heap situated in a well-drained spot. Similar materials and alternating layers should be heaped up to four feet above the soil. Other practices associated with the production of good compost should also be practiced.



CROSS SECTION OF COMPOST

By: G. B. GURUNG

INDIGENOUS SPECIES FOR GREEN MANURING

With the introduction of high-yielding varieties (HYV) of cereals and vegetables that fit into multiple cropping systems, there has been a significant reduction in the fertility status of soil in the hills. Also, heavy pressure on forest resources has resulted in a drastic depletion of forest and green vegetation, causing a decrease in the productivity and number of livestock in the hills. Both of these factors contribute to declining soil fertility.

The use of chemical fertilizers in the hills of Nepal is minimal owing to the low purchasing power of the farmers, the high cost of transportation, high chemical fertilizer prices and the unavailability of these fertilizers at the proper time. In this context, it is important to look for **locally available, sustainable** sources for maintaining soil fertility. Among the locally available sources of maintaining soil fertility, indigenous green manure species occupy an important place.

CHOPPING GREEN MANURE

CARRYING GREEN MANURE TO THE FIELD AND INCORPORATING INTO THE SOIL

Green manuring is the process of incorporation of green vegetation, either from cropped land, from marginal land or forest, into the soil for the purpose of improving soil structure and fertility.

More than 20 indigenous plant species having green manure values have been identified and studied. Seven of these species, identified as most important, will be briefly described.

ASURO

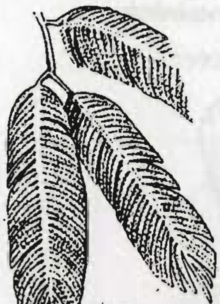
1. ***Asuro*** (*Adhatoda vasica*). *Acantheceae* family. Research suggests that the use of *Asuro* (10 t/ha) increased rice yield by 39% over farmers' traditional practice (10 ton compost/ha) and 49% over the use of inorganic fertilizers (60:30:30 kg NPK/ha). Planting *Asuro* as a live fence, can provide a substantial amount of green leaf material. The optimum time for *Asuro* propagation is from April to mid-June. *Asuro* is more commonly used in rice and finger millet nurseries and as a mulch in potatoes, transplanted chilis and other vegetables. Its leaves and flowers are highly valued as traditional medicine for cough and asthma.

TITEPATI

2. ***Titepati*** (*Artemisia vulgaris*). *Compositae* family. Experiments have shown that the use of ***Titepati*** (10 t/ha)in rice enhances vegetative growth and increases rice yield by 23% as compared to inorganic fertilizers (60:30:30 kg NPK/ha). However, increases in rice yield is low as compared to *Asuro*. Like *Asuro* it also readily decomposes. Whole plants should be collected, chopped into pieces and buried in the puddled field before transplanting rice. *Titepati* is also used in rice and finger millet nursery beds and as a live mulch in maize+soybean cropping systems and for garlic cultivation. It has good pesticidal and medicinal values.

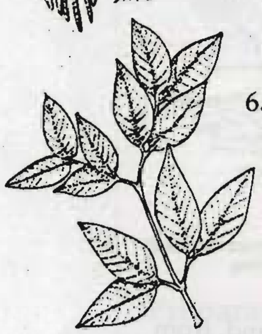
3. ***Khirro** (kapium insigne)*. Research shows that the use of 10 t/ha of ***Khirro*** as a green manure increased rice yield by 21% over the use of inorganic fertilizers (60:30:30 kg NPK/ha). ***Khirro*** leaves decompose easily and can reduce the incidence of rice blast in nursery beds. It is also commonly used to control crab problems. The milky sap of ***Khirro*** is irritating to human beings.

4. **Rice bean** *(Vigna umbellata)*. An important green manure with prolific nodulating potential, Rice bean can be grown as a sole crop in a rice-wheat system and incorporated into the soil after the wheat harvest. Or, it can be grown as a relay crop under spring maize at the second earthing-up operation and ploughed under after the maize harvest to serve as a green manure for normal rice planting. The use of rice bean increases rice yield by 21% over the farmer's practice and is comparable to the use of (60:30:30 kg NPK/ha).



SIRIS

5. ***Siris** (Albizia lebbeck)*. A multipurpose leguminous tree species used for fuelwood, timber and as a green manure. The effect of *siris* leaves on rice yield has been found encouraging; however, its distribution and availability is limited. Use of *siris* increases rice yield by 34% over farmers' practice and 18% over the use of inorganic fertilizers (60:30:30 kg NPK/ha). Since it does not shade other crops as much as other species, it may be suitable for agroforestry.



PADKE

6. ***Padke** (Albizia odoretissima)*. A multipurpose leguminous tree, it is valued as fodder, fuelwood and green manure tree. It is rich in nitrogen and decomposes easily. However, the crop response is inferior to Asuro. Padke is more suitable for mulching potato crop. Padke twigs can be left in the field to drop their leaves and later incorporated into the soil.

7. ***Ankhitare*** *(Walsura trijuga)*. It is mainly used for rice nurseries and the oil extracted from the seed is valued for medicinal use. It decomposes easily, however its availability is limited.

OTHER SPECIES WITH GREEN MANURING VALUES

Bakaino *(Melia azaderach)*
Bakula simi *(Vicia faba)*
Banmara *(Eupatorium adenophorum)*
Bardelo *(Ficus clavata)*
Chilaune *(Schima wallichii)*
Dhondia *(Aeschynomene aspera)*
Jhuse Til *(Guizotia abbysinica)*
Kanike phool *(Sambucus hookeri)*
Pumpkin (Cucurbita moschata)
Rato siris *(Albizia procera)*
Sajion *(Jatropa curcas)*
Saljiwan *(Origanum vulgare)*

HOW TO GREEN-MANURE RICE FIELDS USING INDIGENOUS PLANTS

1. Plough the field at least once and irrigate where green manuring plants are to be incorporated.
2. Collect fresh, succulent twigs and leaves of the plant.
3. Chop twigs and leaves into small pieces. Spread the material uniformly over the field.
4. Plough the field well to incorporate green biomass into the soil at the rate of 10 t/ha (if available, increase the amount of green biomass up to 20 t/ha). Maintain a shallow water level for 7-10 days.
5. Puddle the soil and transplant rice seedlings.

Prepared by: G. B. GURUNG

Prepared by: K. D. JOSHI
April 1992

COMPARATIVE INFORMATION OF INDIGENOUS GREEN MANURE SPECIES

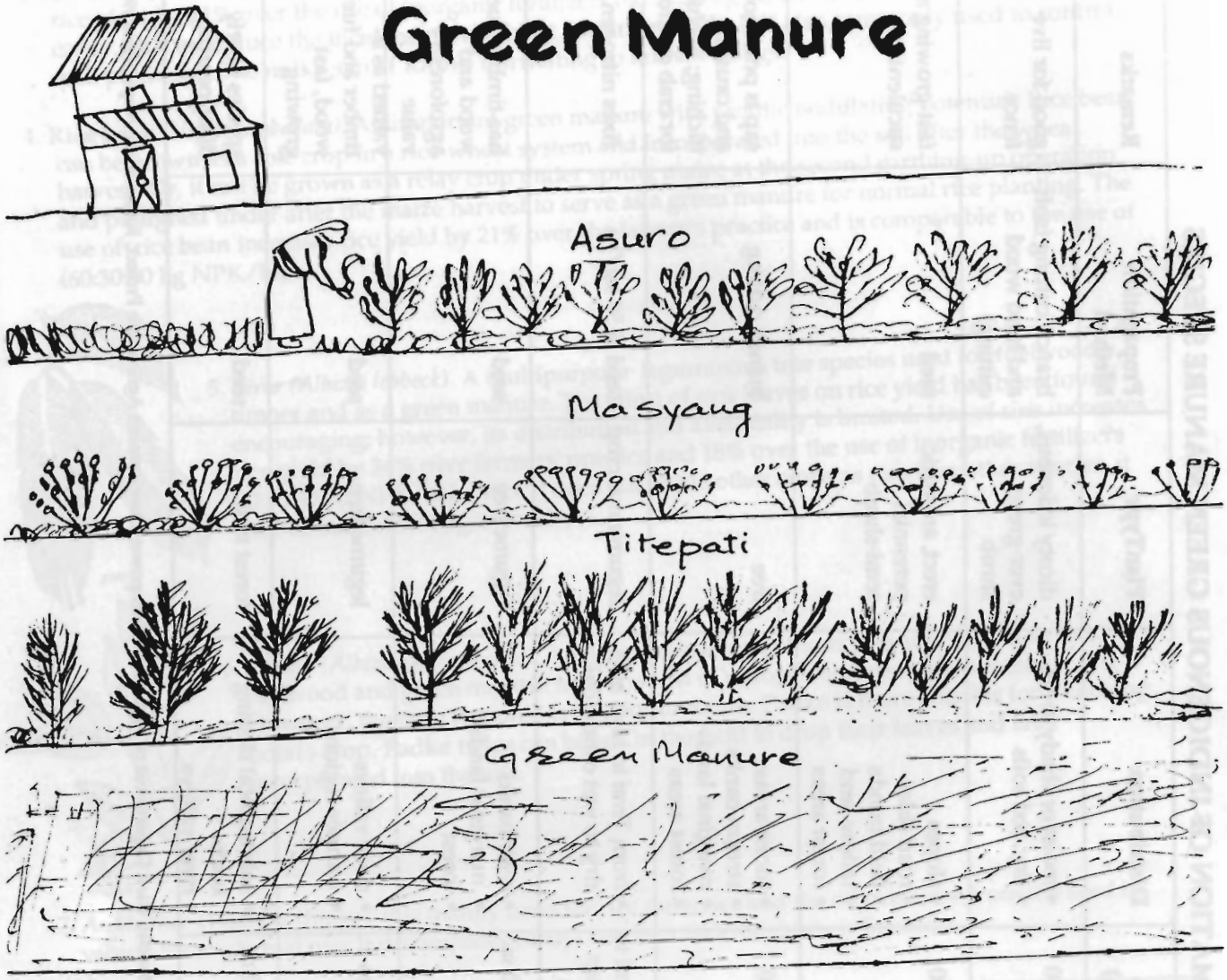
Species (Local Name) (Botanical Name)	N (%)	P (%)	K (%)	Elevation Range (m)	Distribution	PlanType	Propagation Method	Remarks
1. ***Asuro*** (*Adhatoda vasica*)	4.3	0.9	4.5	up to 1,300	• moist or shady areas • dry, red soils	dicoty ledonous, ever-green shrub	branch cutting (soft and hard wood cutting)	good for live fence
2. ***Titepati*** (*Artemisia vulgaris*)	2.4	0.9	4.9	up to 2,000	• slopes • road sides • field bunds • fallow land • forest areas	erect, aromatic perennial semi-shrub	seed	fast-growing and suculent
3. ***Khirro*** (*Sapium insigne*)	2.8	0.8	2.9	up to 1,500	• moist areas • stream banks • marginal lands • forest areas	tree	branch cutting	sap is poisonous and causes itiching; useful for crab control
4. Rice bean (*Vigna umbellata*)	-	-	-	sub-tropical to mid-hills up to 1,800 m	• from *Terai* to high hills, dry to wet conditions	leguminous crop	seed @ 50 kg/ha	fixes nitrogen
5. ***Siris*** (*Albizia lebbeck*)	2.9	4.5* 0.65§	4.5* 2.6§	up to 1,500 m	• river banks • marginal lands • forest	legume tree	seed	has timber, fuel wood and agroforestry value
6. ***Padke*** (*Albizia odoretissima*)	-	-	-	up to 800 m	• river valleys • warmer regions	legume tree	seed	valued as a timber and fuel wood, fast growing
7. ***Ankhitare*** (*Walsura trijuga*)	2.6	0.49	1.2* 2.4§	up to 1,300 m	• sub-tropical sloping lands • river valleys	forest tree	seed	species nearly disappearing

Prepared by: K. D. JOSHI

* From author.

§ From **Trainer's Manual: Rice**, Department of Agriculture, Manpower Development Agriculture Project, Kathmandu, Nepal, June 1987.

Green Manure



1. Gita Gurung
2. Sanumaya Shrestha
3. Sukmaya Gurung
4. Gyanu Gurung

PROPAGATION OF FODDER GRASSES

The demand for fodder grasses in the Eastern hills has recently become overwhelming. The principal reasons seem to be: the ease of propagation; they are less demanding of resources than trees and, therefore, compete less with food crops; they produce good returns rapidly; they provide fodder, if properly managed, in the most critical period of fodder deficit; they can be planted in a wide variety of sites; in the case of ***Amliso*** (*Thysanolaena maxima*) have a relatively high financial value, and are excellent in soil conservation.

To match this rapid increase in demand, there is a need to establish easy-to- manage and low-cost nurseries (stocking areas) that can be managed by local people. The following is a simple guide to propagating grass seedlings. Examples of propagation from seed, culm cuttings and rhizomes are given. The species mentioned are an example of those which can be propagated by the method described.

PROPAGATION METHODS

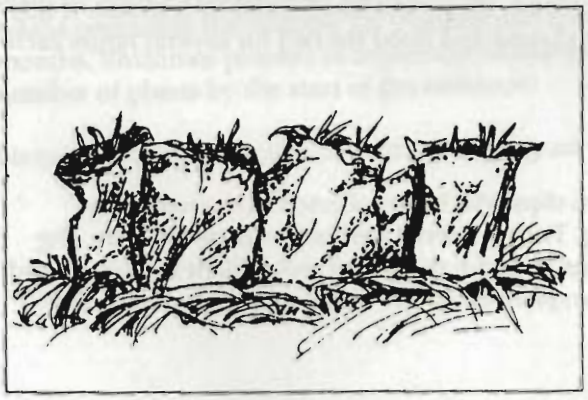
1. SEED COLLECTION AND PLANTING.

Most grass seed ripens between September-March (***Bhadra-Phagun***) depending upon the species. To ensure supply, a specific source area should be identified and reserved until seed has been collected. Alternatively, develop seed plots within existing nurseries on terrace risers and bare ground.

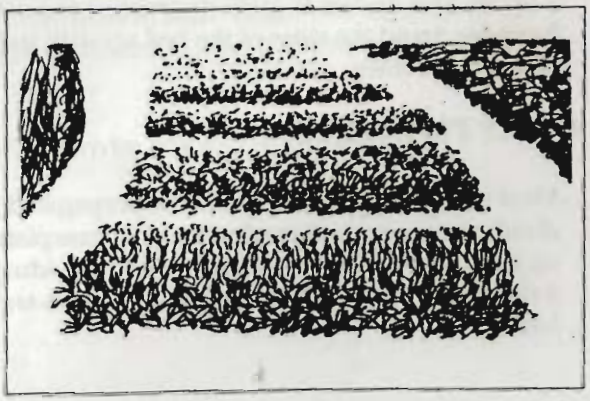
Setaria *(Setaria anceps*). Collect seeds between September-January (***Bhadra-Poush***). The seed head should be cut and dried immediately on a polythylene sheet or ***nanglo*** in the sun for 4 -6 days. When the seed begins to come off the seed head easily, it should be threshed with a small stick and stored in a dry place. Sow from September. Seed is good for about 9 months.

Amliso. Cut in February-March (***Margh-Phagun***) Amliso seeds are very small and easily carried away by the wind. The seed head should be protected while it ripens. One system is to wrap the inflorescence in a polythylene sheet until it is fully mature. At this time, the seed should begin to come off in the hand when gently tapped. When ripe, cut the seed head and dry the seed carefully under cover. When dry, put into a polythylene bag for storage.

Pakhribas Agricultural Center and ERRM are currently experimenting with seed propagation. The advantage of propagating ***amliso*** from seed is that it is cheaper, easier and undestructive to existing plants unlike the traditional method. Once the seed is dried, it can either be sown on a bed and



Amliso seed collection system



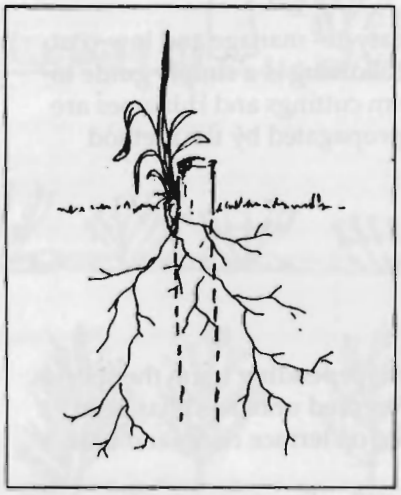
Setaria grass sown from seed in beds, 1 m wide and 30 cm high

Note: *Amliso* inflorescence is wrapped in polythylene sheet to protect and preserve against the wind.

covered with jute sacking or mulch or mixed in a bucket with 1:10 manure to water mixture and 10 gms seed sown on a bed and covered with jute sacking. Continue to water daily for 3 months.

It has also been reported that if the ***amliso*** seed is mixed with manure and water, it can be directly thrown on to terrace risers where it will germinate. If you intend to try this, it is recommended that the riser is first scarified with small contour grooves a few centimetres deep scratched into it and after sowing, cover with hessian jute sacking and water gently every day until germination.

2. CULM CUTTINGS.



Napier culm cutting

Napier after 2 months on terrace risers

Napier cuttings after 1 year ready to re-cut. 3.5 m tall

Napier .(*Pennisetum purpureum*). Take cuttings any time as long as they are watered). Napier is very easy to propagate from culm cuttings. The culm must be at least 6 months old. Single node culm cuttings maximise the number of cuttings available for planting. To prepare planting stock, make a clean straight cut 3 cm above the node. Napier can also be propagated from seed but this is slower than cuttings.

3. RHIZOME CUTTINGS.

Amliso. July-October (***Srawan-Kartik***). ***Amliso*** is traditionally propagated from rhizome cuttings. Cuttings are made by splitting a clump 6 months or older in age and dividing it into single plants of between 10 - 15 cm in length. The root portion should be between 5-10 cm, and the shoot between 5 - 10 cm. This system is quite destructive to existing plants. Plants can be attacked by termites. If this happens, build the sides of the bed up with stone and mud and flood the bed for several hours each day until problem ceases.

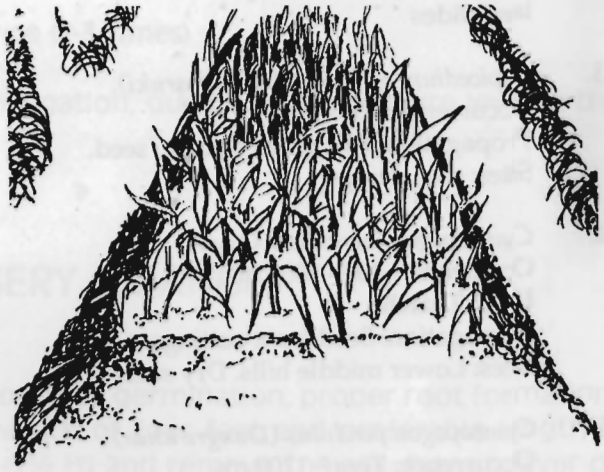
4. SLIP PLANTING.

Most clumping grasses can also be propagated from slips which are collected in the field or by dividing nursery bed production and transplanting. Trim the aerial part of the grass to 15 cm, dig up the grass, separate the clump into individual slips and trim the lateral roots. Plant between 2 and 4 shoots per slip at 10 cm centers. Examples are ***khar, phurke, babio***, lemon grass, ***narkot, sito*** and ***boude***.

NURSERY BED PREPARATION FOR SLIP OR RHIZOME PRODUCTION

The preparation of a bed for grass production is very simple. All that is needed is a flat piece of ground at least 2 metres wide and any length, a readily available source of forest soil, compost and a perennial supply of water. Compact the ground to inhibit root development beneath the bed and, if available, put down a layer of bamboo sheaths. Place some gravel on top of this and mix compost with forest soil which should be built up to 30 cms high and a metre wide. Level the soil. If the bed is prepared in August (*Srawoon*) and planted in August-September (*Srawoon-Bhadra*), it will not require watering in the dry period. To maximise production and seeding, water and compost should be added regularly.

***Amliso* rhizome ready for planting.**



***Amliso* rhizomes planted in nursery bed.**

Sowing of Seed

One handful of seed is required per 5 square meter of bed. Cover with hessian cloth or mulch. Within two weeks, the seed should start to germinate. When the seedlings are about 3 cm high, remove the hessian and weed as necessary. Thin out the bed twice: three weeks and six weeks after germinating. If sown during the monsoon, the thinning from one bed of seedlings can be transplanted so that three beds of seedlings can be produced from each bed sown and will be ready to plant in the next monsoon. Space transplants at 10 cm centres.

Planting Rhizome Cuttings

Plant in September (*Bhadra*) or mid March (*Magh*) with root stock of at least 6 months old. Keep wet whilst preparing the rhizome for planting and space 10 cm apart in beds. Water two times daily for 4 months. Rhizomes planted in September (*Bhadra*) can be redivided in March to produce twice the number of plants by the start of the monsoon.

Note: For seed production or culm cuttings, grass can be sown on any sort of ground.

LIST OF INDIGENOUS GRASS SPECIES USED IN EAST NEPAL

1. *Arundo clonax* (***narkato***)
   Occurrence: ***Terai*** - 1000 ms.
   Propagation: Seed, rhizome, stem cuttings.
   Sites: Hot, south, south-east facing slopes

2. *Arunduella nepalensis* (***Phuke***).
   Occurrence: 700-2000 ms.
   Uses: Thatch, fodder.
   Propagation: Seed/root cuttings (slips)
   Sites: Damp, cool sites, colonizes landslides

3. *Capioedium assimile* (***thulo kharuki***).
   Occurrence: 600 - 2000 m
   Propagation: Rhizome cuttings/seed.
   Sites: cool damp.

4. *Cymbopogon microtheca* (***khar***)
   Occurrence: 400 - 2000 ms.
   Uses: Thatch.
   Propagation: Seed/root cuttings.
   Sites: Lower middle hills. Dry sites.

5. *Cymbopogon pendulus* (***Dangre khar***)
   Occurrence: ***Terai*** -1200 ms.
   Propagation: Seed/root cuttings.
   Sites: Hot, harsh, dry sites. Landslides.

6. *Cynodon dactylon* (***dhubo***)
   Occurrence: ***Terai*** - 1500 ms.
   Uses: Fodder.
   Propogation: root/stolon node cuttings
   Sites: Fertile soils, good spreader.

7. *Desmodium intortum*
   Occurrence: ***Terai*** - 2000 m
   Uses: Fodder.
   Propagation: layering from stolon node/ transplant root.
   Sites: Exotic to Nepal. Dense on fertile soils. Open areas.

8. ***Dhungre***: Botanical name unknown
   Occurrence: 1500 - 2500 ms.
   Propagation: Rhizome cuttings
   Sites: Damp, good sites, deep soils.

9. *Eulaliopsis binata* (***babiyo, Sabai grass***)
   Occurrence: ***Terai*** - 1500 ms
   Uses: Rope, paper, fodder.
   Propagation: Split roots, slips
   Sites: Terai, Siwaliks and lower river valleys. Hot dry sites. Steep slopes.

10. *Neyraudia arundinacea* (***sito***)
    Occurrence: ***Terai*** - 1500 m.
    Uses: Poor thatch/fodder.
    Propagation: Rhizome cuttings/culm cuttings/seed.
    Sites: Forest damper areas.

11. *Neyraudia reynaudiana* (***dhonde***).
    Occurrence: ***Terai*** to 1500 m.
    Uses: Fodder, poor ththatches.
    Propagation: culm cuttings, rhizome, seed
    Sites: Dry forest types. Very harsh, dry sites.

12. *Pogonatherum paniceum* (***Musekharuki***).
    Occurrence: ***Terai*** - 2500 m.
    Uses: Poor fodder.
    Propogation: rhizome cuttings
    Sites: Steep difficult rocky sites. Slow growing.

13. *Sacchasum spontaneun* (***kans***)
    Occurrence: ***Terai*** - 2000 m
    Uses: Poor fodder and thatch.
    Propogation: root cuttings (slips)
    Sites: Coarse alluvial soils, gravel by rivers. Survives on hot dry sites. very wide ranging.

14. *Vetiver zizanioides* (***katara, sinki***)
    Occurrence: ***Terai*** - 200 ms.
    Uses: Poor fodder. when young.
    Propagation: Root cutting (slips) seed.
    Sites: Grows along rivers, and seasonal water logged sites. Wide range of climates.

OFF-SEASON ONION CULTIVATION

This is a method of growing onions when the price is high. The onion seedlings are raised in a bed in early spring until they attain thumb size. Then they are uprooted, tied in small bundle and hung in a open, airy, rain-proof place, till the end of the monsoon season. Soon after the monsoon recedes (end of August) the sets are planted in a well-manured bed. Bulbs will be ready for harvest by early November when the price is high in the market.

1. These onions fetch good market price (2-3 times)

2. Does not need too much watering/irrigation, due to good moisture level in the soil

CITRUS NURSERY (ORANGE)

A well-prepared nursery bed is important for good germination, proper root formation, and the healthy growth of seedlings. A width of four feet and preferable length is suitable. Dig upto one hand length deep (1½ ft) and remove the soil. Place a layer of well-decomposed compost (about 4") then place another layer of topsoil (about 4"). Repeat this process one more time. Another layer of the soil, compost, and sand mixture is laid where seeds are planted at a depth of two to three centimetres. Mulch the bed with any available plant material and water it (the mulch should be removed when seeds begin to sprout). This type of bed will produce good roots and therefore facilitates easy uprooting.

OFF-SEASON VEGETABLE PRODUCTION

The majority of the mid-hill farmers rarely have a balanced diet, due to the lack of vegetables. Vegetables are rare in the period from January to June, when cold temperatures and little rainfall make production difficult. Techniques that overcome these condition can help provide food and income during the time of the year when they are especially needed.

Off-season production requires the same management practices as ordinary vegetable production, with extra attention paid to the following factors: **temperature** and **moisture**

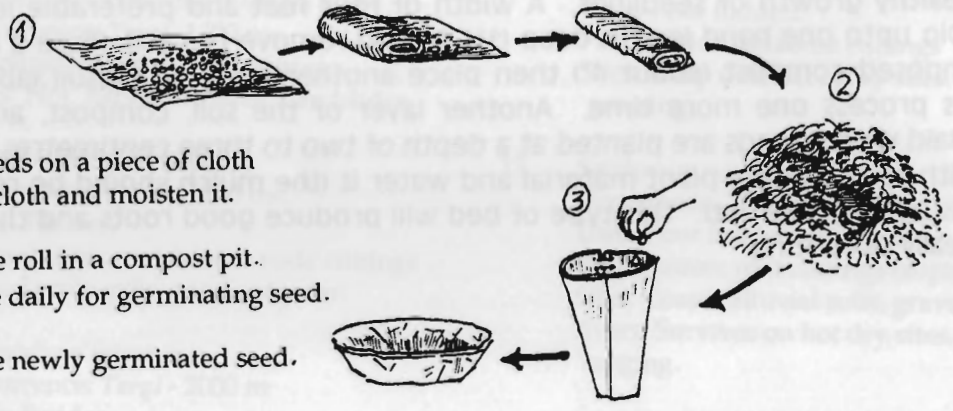
TEMPERATURE

Temperature is important for seed germination and plant growth. Different vegetables require different temperatures for germination. Beet, cabbage, cauliflower, celery, parsley, pea, radish, swiss chard, turnip require a min. of 4°C and an optimum of 27-29°C. Bean, cucumber, brinjal, okra pumpkin, pepper, squash, tomato, need a minimum 16°C and optimum range of 24-35°C.

TECHNIQUES FOR WINTER SEASON

Seed germination in the cold can be improved by germinating seed in compost piles or plastic tunnels.

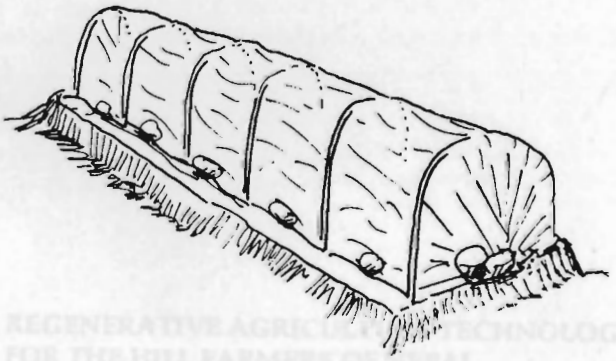
A. Seed germination in compost pit



1. Place seeds on a piece of cloth roll the cloth and moisten it.
2. Keep the roll in a compost pit. Examine daily for germinating seed.
3. Plant the newly germinated seed.

B. Germinating Seeds and Growing Seedlings Under Plastic Tunnel

A tunnel of half hoops of bamboo set in the ground/nursery and covered with plastic sheet in cold weather helps to keep the soil warm and promotes germination. Close the ends at night and open them during the day for ventilation.



Costs for materials for 5 m plastic tunnel are around 70 rupees. The tunnel can help produce approximately 5,000 seedlings.

Whole bamboo	8 piece	50	400
From the whole bamboo cut			
— 2 m pole	6 pc		
— 8 m split	21 pc		
— 12 m split	14 pc		
— 1 m pegs	21 pc		
500 gauge plastic	20 kg	80/kg	1600
Plastic ropes	2 kg	100/kg	200
Construction labor and misc		-	200
		Fixed cost	Rs 2400
		Variable cost (inputs and labor)	Rs 250
		Total cost	Rs 2650

RETURNS FROM PLASTIC HOUSE

1. Tomato production

- At 4 plants/m/ with 2.5 kg yield/plant, the total production during season (May to October) will be 250 kg which will give Rs. 2500/-

2. Seedling production

- Tomato/sweet pepper seedling in 10 m/ produces 5000-10000 seedlings @ 15 paisa/seedling Rs. 750 - 1500/-
- Cucurbit seedlings 15 m/ which accommodate 4500 bags @ Rs. 1 Rs.4500/-

Total annual return Rs. 7750 - 8500/-

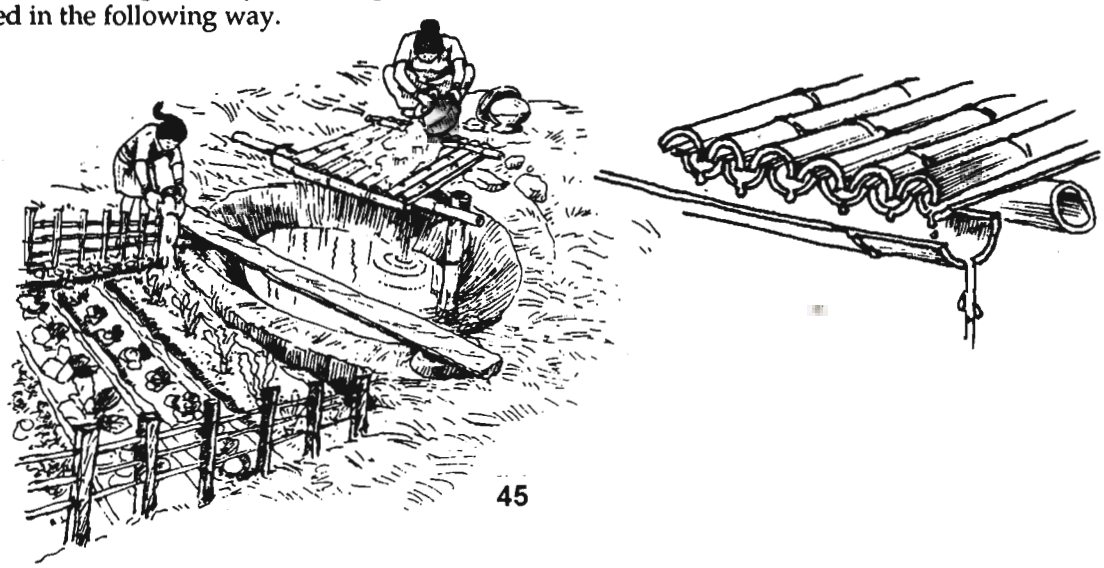
Plastic may be used for two seasons only, whereas the bamboo frame may used for four seasons provided careful management is practiced.

TECHNIQUES FOR DRY SEASON PRODUCTION

Techniques that conserve water or make use of water that is normally wasted are important to dry season vegetable production.

1. Recovery of waste water

About 40 liters of water is used to wash hands and dishes in an average family. They can be collected and re-used in the garden by restricting washing activities to one location. This water can be then collected in the following way.



Protection of Seedlings From Cold

Young/tender seedlings need protection during cold nights for which the following can be practiced:

Place two pieces of Banana sheath on two sides.

Put small stones around the plant provides heat, retains moisture

sticks and sal leaves/ tapara

Plastic cap 3 sticks and a plastic held down

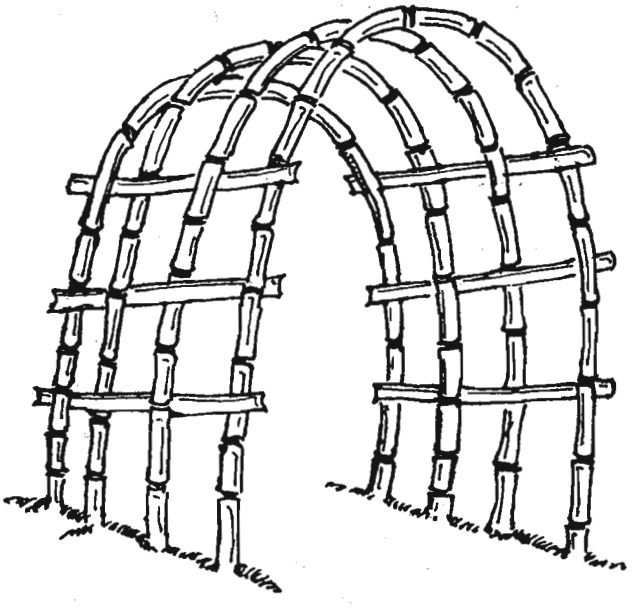
Seedling Production in Plastic House

For those areas where a ready market is nearby (such as in the vicinity of urban centres/along trekking trails) large-scale production of off-season vegetables might be both feasible and profitable. The large number of seedlings needed can be produced in a plastic house. High value vegetables can be produced during the off-season in that house.
Method

- Seedlings are produced in the plastic house during the cold season and even during the peak of the rainy season.
- During rainy season high value crops like sweet pepper and tomato and, during winter, cucumber may be produced by forcing culture.

Construction and Use

1. Make the bamboo frame as shown in the picture.
2. Spread the plastic over the bamboo frame and fix it with the help of small nails and tube pieces.
3. Tie the plastic across with ropes.

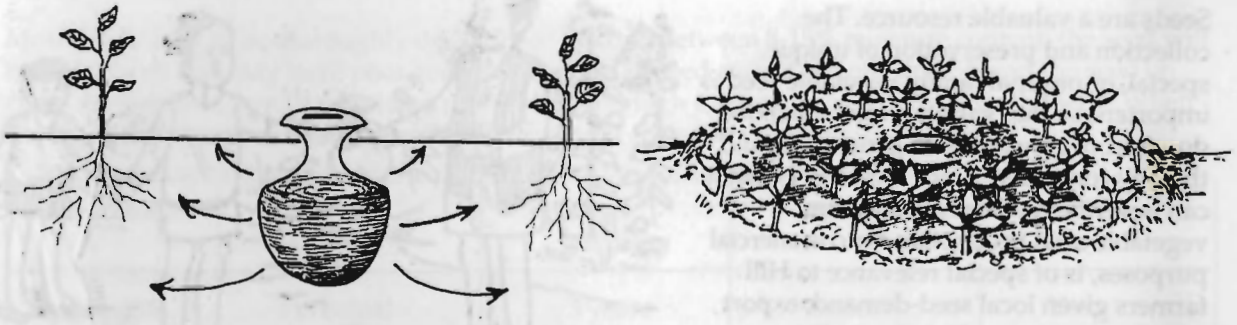


To reduce humidity and provide air circulation,this house may be opened from the side during day and may be closed during the night.

The initial cost of the plastic house is relatively high but net income from the sale of seedling and off-season vegetables can also be quite high. A list of materials, costs and sample returns follows.

2. Pot Irrigation

Buried clay pots serve as drip irrigation systems, providing a small steady supply of water to plants surrounding them.

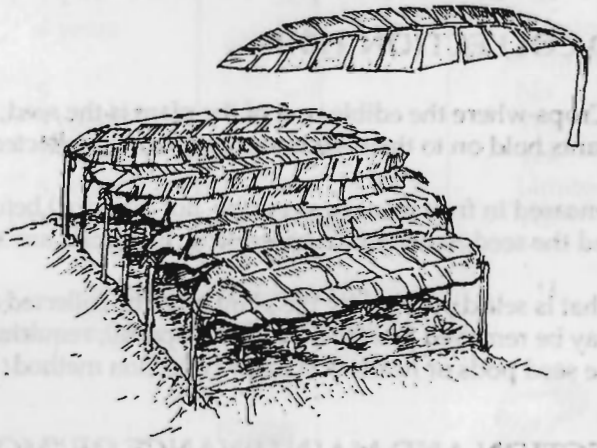


- Sink the pot having four minute holes in the middle of the pot.
- Mulch over the bed.
- Plant around the pot.
- Fill the pot twice a week.

3. Sun Shading

Young seedlings and vegetables which like cool temperature require some shading in the hot dry months. Two materials which can inexpensively provide that shade include jute sacking and banana leaves.

Make a roof of sacking with some sticks for shading.



Banana leaves
The stem partly cut and bend and struck overlapping the ground to provide shade.

VEGETABLE SEED PRODUCTION

WHY SAVE SEED?

Seeds are a valuable resource. The collection and preservation of unique, special, or original family vegetable seed is important so that varieties can be handed down from generation to generation, and thereby conserved. Once a variety is lost it can never be replaced. In addition, vegetable seed production for commercial purposes, is of special relevance to Hill farmers given local seed-demand, export potential and agro-climatic conditions.

HOW A SEED IS MADE

Self-pollination: Plants that are self-pollinated have perfect flowers - both male and female reproductive organs in same flower. The pollen of a flower fertilizes that same flower. Examples include: pea, tomato, wheat, soybean, lettuce, cowpea, oats. Isolation techniques are usually not required to collect pure seeds.

Cross-pollination: Pollen from one flower fertilizes the flower on another plant. Pollen is transported via insect or wind from either perfect, self-sterile (Brassica) or imperfect flowers. Imperfect flowers have either male or female functioning reproductive organs. These can be monoecious, with male and female organs in different flowers (squash), or dioecious, with male and female organs on different plants (asparagus). For production of true seed types, isolation methods are needed.

SEED COLLECTION TIME

Seed Crops-where the edible part of the plant is the seed, such as, corn, beans, pulses, and wheat. The plants hold on to their seeds and they can be collected easily when the seeds are thoroughly dry.

Seed enclosed in fruit must be very ripe (not overripe) before the seed is collected. The fruit is opened and the seed removed for processing. Examples are: tomato, eggplant, and peppers.

Seed that is self-dispersed by the plant must be collected *before* the plant releases the seed. The seed may be removed just prior to seed dispersal, requiring daily inspection. Cloth bags placed over the seed pods or heads is another collection method.

SELECTION AND MAINTENANCE OF "MOTHER"-PLANTS

- Select superior plants as the source of seed, In order to do this, the plants should be observed throughout the growth period.
- Some factors to consider are **fruit characteristics, plant height, number of tillers, color, vigor, timing, insect and disease resistance.**
- In order to maintain genetic diversity, select and save an equal amount of seed from as many plants (typical of the population).
- Maintain seed purity in cross-pollinated crops by ensuring geographic or mechanical isolation.

SEED EXTRACTION

Special preparation is needed in some cases. Seed-containing fruits such as tomatoes, melons, peppers and squashes need to be separated from the pulp. Tomato seeds need to be fermented by leaving the

seed for 3 to 4 days in 1/4 cup of water. The seeds that sink to the bottom are for saving. The seeds on the surface can be thrown away. Cucumber and melon seeds can be treated in the same manner. Washing, threshing, and sorting are the procedures that some seeds may need.

DRYING SEEDS

Most seeds need to be thoroughly dried. If not dried to between 8-15% moisture content, the seed will not store well and may have poor germination. Dry all seed even if it looks dry. Spread the seed on clean dry paper in a well- ventilated room. Heat and high temperatures will damage the seed. When the seeds are dry place them immediately in airtight containers.

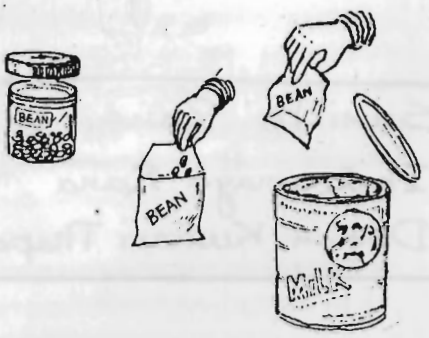
Vegetable	Life	Seed viability	Pollination	Isolation
Asparagus	Perennial	3 years	Insect	Yes
Bean	Annual	3 years	Self	Limited
Beet	Biennial	4 years	Wind	Yes
Broccoli	Annual	5 years	Insect	Yes
Cabbage	Biennial	5 years	Insect	Yes
Carrot	Biennial	3 years	Insect	Yes
Cauliflower	Biennial	5 years	Insect	Yes
Celery	Biennial	5 years	Insect	Yes
Cucumber	Annual	5 years	Insect	Yes
Eggplant	Annual	5 years	Self	No
Lentils	Annual	3 years	Self	Limited
Lettuce	Annual	5 years	Self	No
Okra	Annual	2 years	Self	No
Onion	Biennial	3 years	Insect	Yes
Pea	Annual	1-2	Self	No
Peanut	Annual	4 years	Self	Limited
Pepper	Annual		Insect	Limited
Potato	Annual	5	Self	No
Pumpkin	Annual	5 years	Insect	Yes
Soybean	Annual	3 years	Insect	Yes
Spinach	Annual	5 years	Self	Limited
Tomato	Annual	4 years	Wind	Yes

This is a partial list.

*There are seeds that cannot be dried and therefore require special treatment.

SEED STORAGE

Store the containers in a cool, dark, dry room. Seeds must be protected from moisture, heat, and insects. Label all containers!

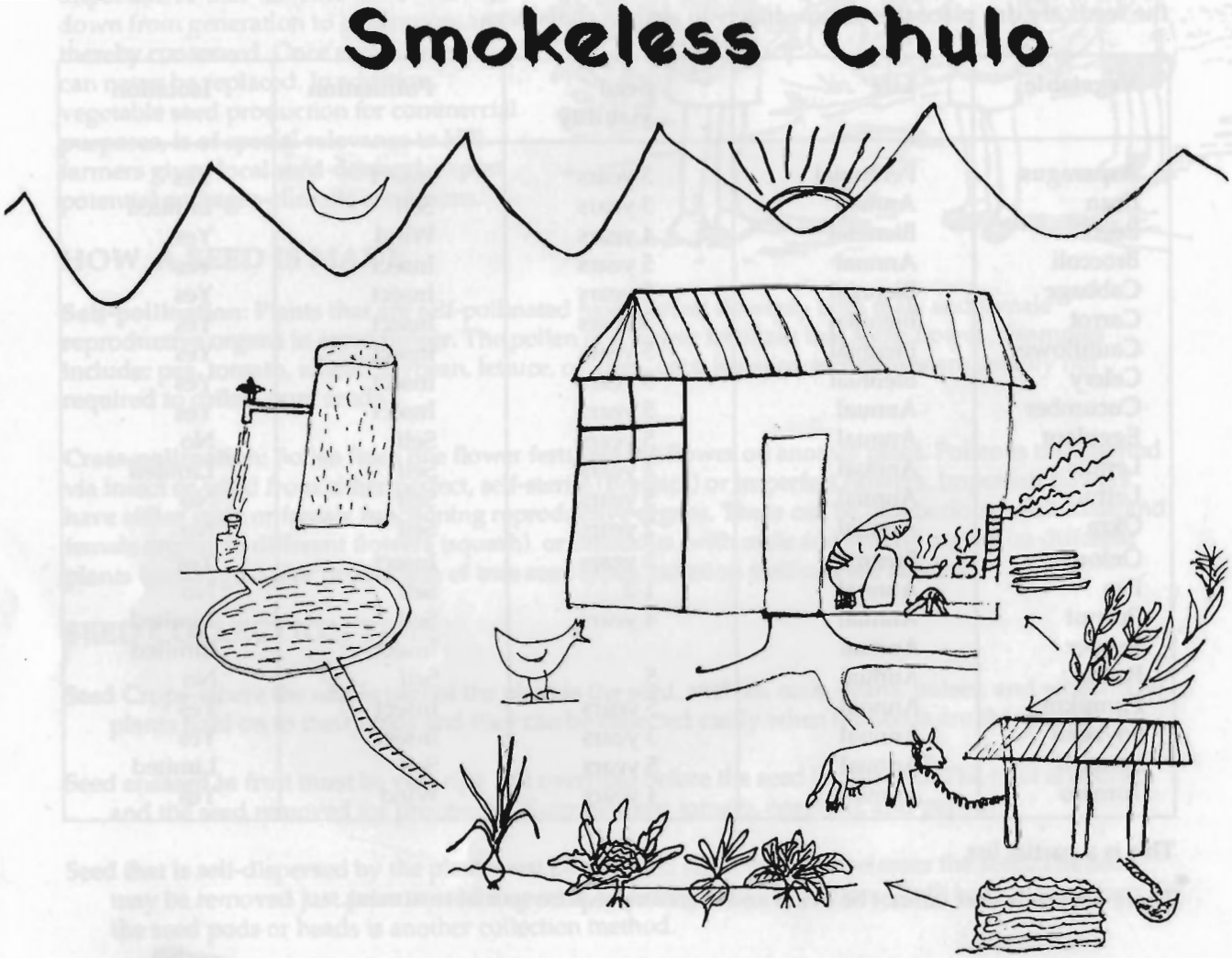


Prepared by: KAREN CONNIFF-MOLDEN
April 1992

REGENERATIVE AGRICULTURE TECHNOLOGIES FOR THE HILL FARMERS OF NEPAL
NERRA/IIRR

SMOKELESS *CHULO*

An improved *chulo* to make the cooking areas smokefree by expelling the smoke through a chimney. The smokefree condition is important for health reasons as well as for reducing fuelwood compsumption (by 50% according to villagers). Added advantages are: easy to construct, needs only local materials, two items can be cooked at a time, and can use small pieces of wood from livestock fodder (which are normally discarded).

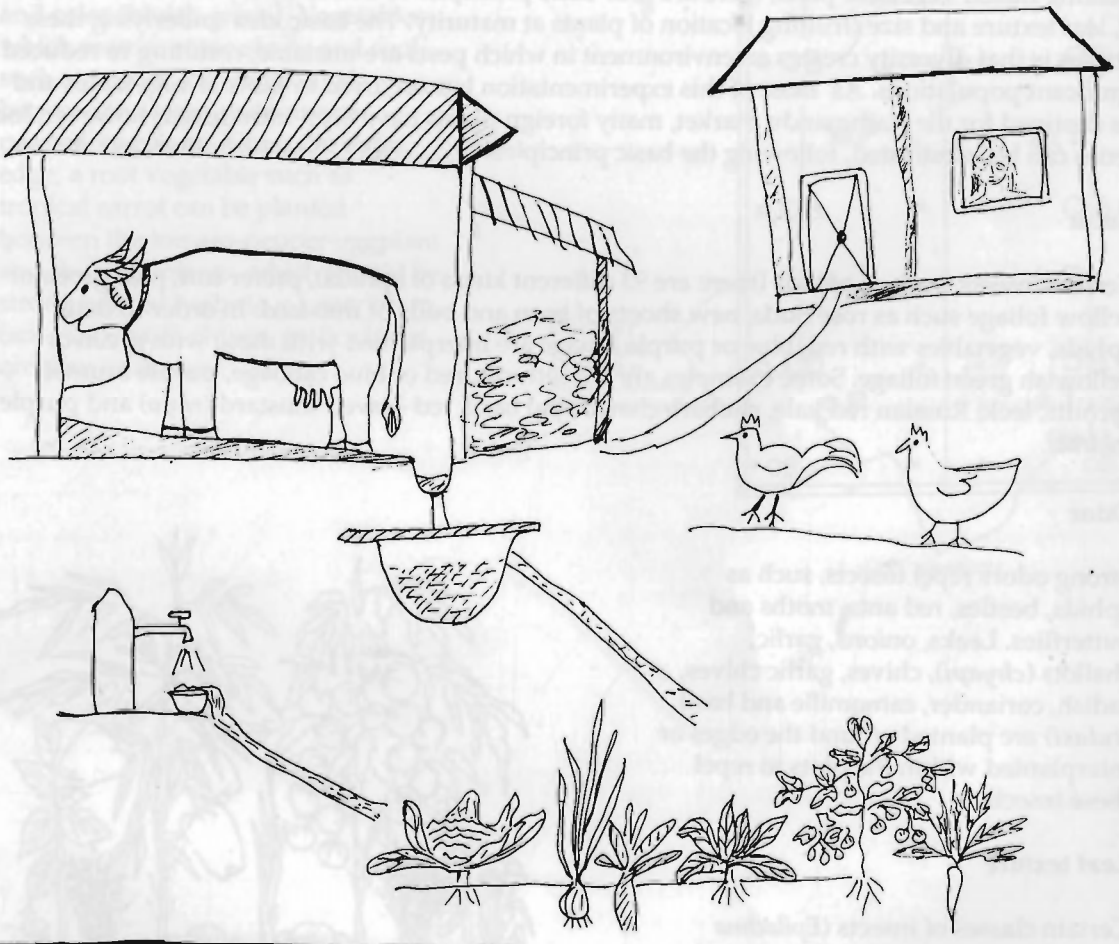


1. Sumitra Rana
2. Indramaya Rana
3. Doman Kumari Thapa

IMPROVED SHED

A proper shed is important in livestock management. A well-constructed shed keeps the animal comfortable; a smooth and dry floor is constructed, along with a channel for urine collection. The floor can be made out of wooden planks or flat stones with a gentle slope towards the tail end of the shed. A small channel should be made just below the floor level, so that the urine will collect at one corner in a pond. This urine pond should be covered to protect it from rain water and sunlight. Beside the urine channel dung is deposited in a heap and covered by an artificially constructed shed or by growing vines on a trellis to protect the nutritional loss by rain washing and evaporation.

Improved Shed



1. Santa Kumari Shrestha
2. Sunmaya Gurung
3. Gunmaya Shrestha

AYURVEDIC PEST MANAGEMENT IN NEPAL

Ayurveda, the traditional medicinal system of India, Pakistan, Nepal and Tibet, offers a unique view of using plants or plant combinations to repel insects. For instance, it is mentioned in the Ayurvedic texts that dark basil (*Krishna tulasi*) can be used to repel mosquitoes. Kamini Vaidya is an ayurvedic practioner by family lineage and an entomologist by profession. Combining these two disciplines, she is developing systems of both treatment and prevention.

Methods of pest control have been developed based on a combination of entomological observations and a knowledge of ayurvedic principles. Even though this experimentation is in the beginning stage of investigation, the results have been convincing enough to indicate the significance of this approach. The advantages of prevention over treatment are twofold: 1) no extra labor or expense, and 2) no weakening of the plants.

FOUR BASIC PRINCIPLES

In planting mixed vegetable plots, there are four basic principles to be observed. These are color, odor, leaf texture and size/fruiting location of plants at maturity. The basic idea underlying these principles is that diversity creates an environment in which pests are unstable, resulting in reduced or insignificant populations. As most of this experimentation has occurred in plots of vegetables and herbs destined for the Kathmandu market, many foreign plants have been introduced; however, local varieties can be substituted, following the basic principles.

1. **Color**

   Certain insects, such as aphids (there are 93 different kinds of aphids), prefer soft, pale green or yellow foliage such as rose buds, new shoots of bean and buds of mustard. In order to deter aphids, vegetables with red, blue or purple foliage are interplanted with those with green or yellowish green foliage. Some examples are red lettuces, red or blue cabbage, purple brussel sprouts, leek, Russian red kale, rhubarb chard, opal basil, red-leaved mustard (*rayo*) and purple *kohlrabi*.

2. **Odor**

   Strong odors repel insects, such as aphids, beetles, red ants, moths and butterflies. Leeks, onions, garlic, shallots (*chyapi*), chives, garlic chives, radish, coriander, camomille and basil (*tulasi*) are planted around the edges or interplanted within the plots to repel these insects.

3. **Leaf texture**

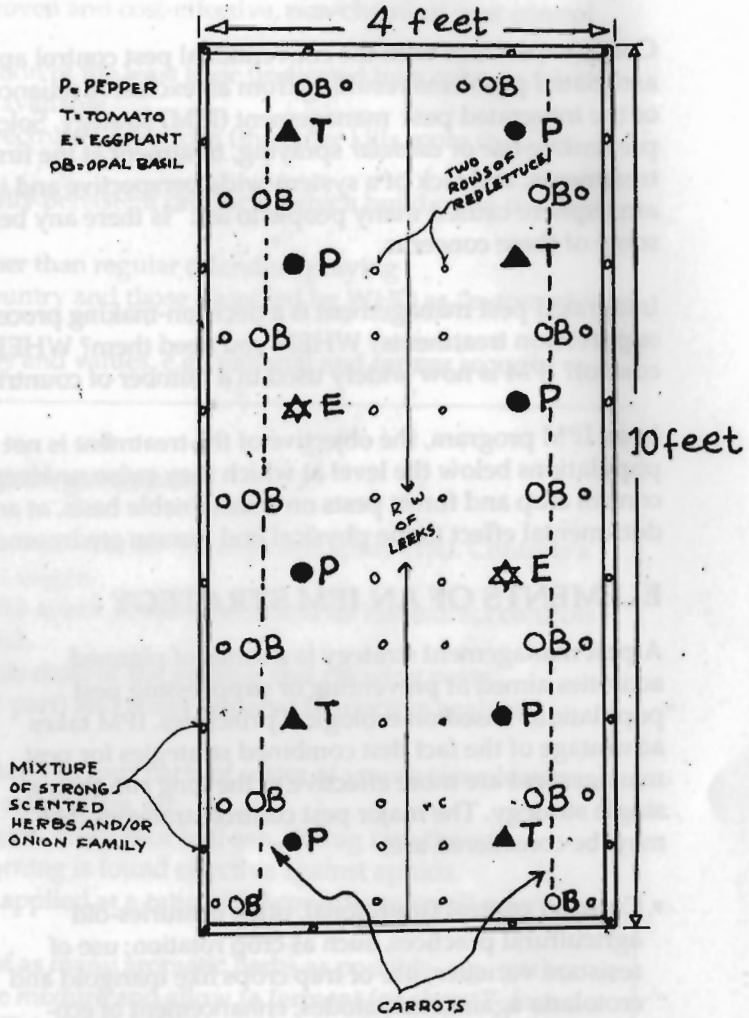
   Certain classes of insects (*Epilachna* caterpillars and aphids) are attracted to vegetables with soft leaves (e.g., bell pepper, lettuce, spinach, beets, basil and members of the cole family) and repelled by rough, cuticle (e.g., radish, tomato, eggplant, kale, fenugreek, beans and cucurbits) or finely broken leaves, while other insects like borers, beetles, scale and leaf miner prefer these plants. If we interplant rough and smooth-

VIEW FROM END OF PLOT
(above and below soil surface)

leaved plants, we deter both classes of insects. For example, *Epilachna* moves through the soil; if both soft and hard leaves are interplanted, their movement is broken.

4. Diversity of level of fruiting and rooting

If we imagine a cross-section of a vegetable plot at maturity to a depth of two feet, plants are ordered to fill the space with roots, leaves or fruits evenly distributed. Begin by planting those vegetables which produce at the highest level. For example, tomatoes, bell peppers and eggplant are space at two feet in the row. A row of leeks can be planted down the middle of the row to provide odor and color (bluish green). Vegetables which require some shade and cool, such as lettuce, can be planted between the leeks and tomato-pepper- eggplant. Along the outer edge, a root vegetable such as tropical carrot can be planted between the tomato-pepper-eggplant and the edge plants, which should be strong odored herbs (e.g.) marjoram (***mu swa***), basil, chives, garlic chives, oregano or thyme.



AN INTRODUCTION TO INTEGRATED PEST MANAGEMENT

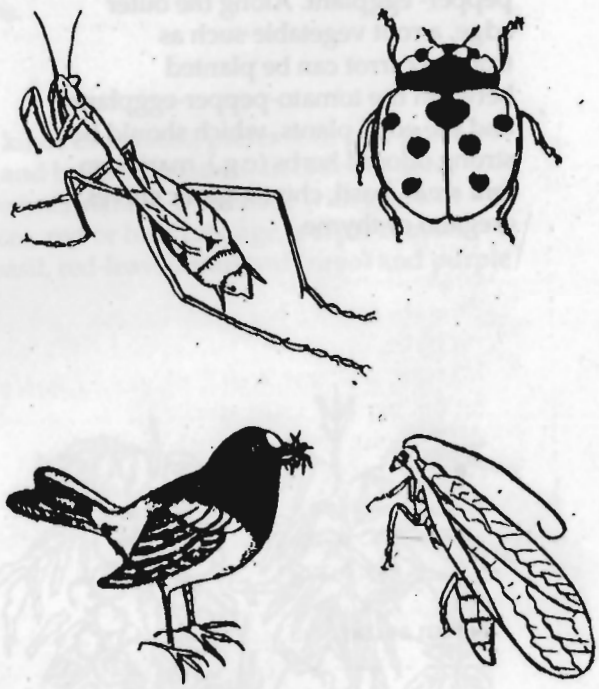
Costly experience with the conventional pest control approach of the 1950s and '60s and the associated problems resulting from an exclusive reliance on chemical control led to the development of the integrated pest management (IPM) strategy. Sole reliance on a chemical control strategy, preventive use or *calendar* spraying, treatment at the first sign of pest, little or no evaluation of the treatments, and lack of a system-wide perspective and its negative impact on the surrounding atmosphere caused many people to ask "Is there any better way?" IPM was developed to address some of these concerns.

Integrated pest management is a decision-making process for determining: IF you need pest suppression treatments? WHEN you need them? WHERE you need effective, environmentally sound control? IPM is now widely used in a number of countries, e.g., Indonesia, United States, etc.

In an IPM program, the objective of the treatment is not to eradicate pests but to suppress pest populations below the level at which they cause unacceptable damage. The goal is to effectively control crop and forest pests on a sustainable basis, at an acceptable cost and with minimal detrimental effect to the physical and human environments.

ELEMENTS OF AN IPM STRATEGY

A pest management strategy is a series of planned activities aimed at preventing or suppressing pest populations based on ecological principles. IPM takes advantage of the fact that combined strategies for pest management are more effective in the long run than a single strategy. The major pest control strategies that may be considered are:



NATURAL PREDATORS OF INSECT PESTS

- **Cultural control** (traditional, often centuries-old agricultural practices, such as crop rotation; use of resistant varieties; use of trap crops like marigold and crotolaria against nematodes; enhancement of eco-system diversity; design of the agriculture system; etc.)

- **Biological control** (natural and artificially produced predators, parasites, and diseases; using plant products; conservation of the natural enemies of the pest through proper selection of materials; and timing and placing of treatments)

- **Mechanical control** (direct mechanical action, such as fences, creating block and screen; reduction of pest harborage, food or other life support requirements)

- **Human behavior change** (education about the effect of hazardous pesticides; creating awareness at all levels: farmers to policy makers, etc.); and desired behaviour of extension worker.)

- **Physical control** (barriers; traps; mechanical action; manual removal; temperature; moisture; sound; light; etc.)

- **Chemical control** (Pheromones and other attractants to lure/confuse the pest; using insect repellents; using safe pesticide, i.e., pesticides based on plant derivatives or pesticides from organic formulations)

POINTS TO CONSIDER IN THE SELECTION OF PEST MANAGEMENT STRATEGIES

- promote the utilization of locally available, proven and cost-effective, non-chemical pest control methods
- when pesticides are used, promote the utilization of the least toxic (indicated by a color code), cost-effective chemical products which are locally available
- promote the use of "selective" over "broad-spectrum" pesticides (the latter kills more than the targeted pest)
- promote reduction in the use of environmentally persistent products (which build up in the food chain and environment over decades)
- need-based use of chemical formulations, rather than regular calendar spraying
- prohibit the use of pesticides banned in the country and those classified by WHO as "extremely" or "highly hazardous"
- takes into account national resources, priorities and values, e.g., national and farmer security

Some alternatives to chemicals for small-gardeners

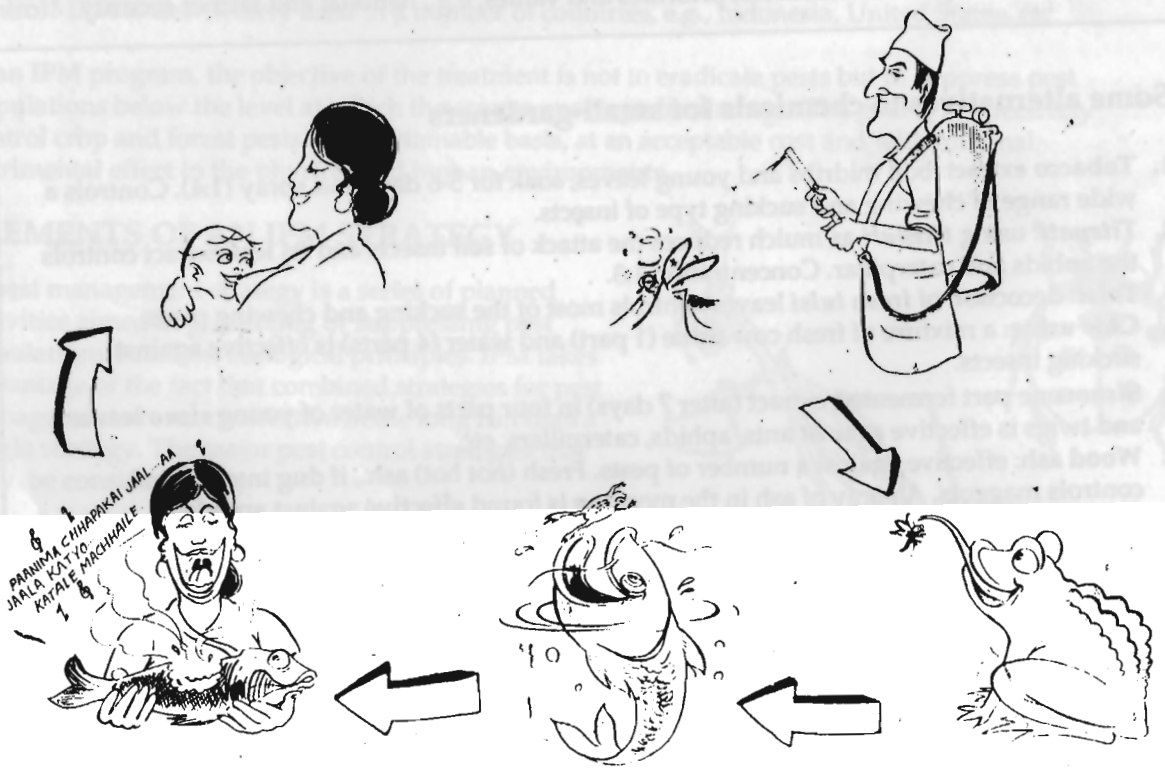
1. **Tobacco extract**: boil midribs and young leaves, soak for 5-6 days and spray (1:4). Controls a wide range of chewing and sucking type of insects.
2. ***Titepati***: using ***titepati*** as mulch reduces the attack of soil insects and its leaf extract controls the aphids and caterpillar. Concentration 1:3.
3. ***Tulsi***: decoction of fresh ***tulsi*** leaves controls most of the sucking and chewing pests.
4. **Cow urine**: a mixture of fresh cow urine (1 part) and water (4 parts) is effective against sucking insects.
5. ***Sisno***: one part fermented extract (after 7 days) in four parts of water of young ***sisno*** leaves and twigs is effective against ants, aphids, caterpillars, etc.
6. **Wood ash**: effective against a number of pests. Fresh (not hot) ash., if dug into the soil, controls maggots. A spray of ash in the morning is found effective against aphids.
7. **Tomato extract**: boiled leaves and stems if applied at a ratio of 1:2 controls caterpillars of cabbage.
8. **Mixture of Brew**: roots, stems and leaves of as many aromatic herbs as possible, e.g., garlic, onion, pepper, mint, mustard, etc. Brew the mixture and allow to ferment for about 7 days. Add liquid detergent for better spreading. This is effective against most of the common pests.
9. **Kerosene and soap spray**: 1/4 cup of soap, 1/4 tablespoon kerosene, mix with one liter of water and spray.
10. **Garlic and marigold**: 3-4 cloves garlic, 2-3 small onion, 2 handfuls of marigold leaves and pepper (2), bring to boil, mix with 4-5 times water and spray. It controls many of the sucking pests.
11. **Neem extract**: as published in various books

Prepared by: NETRA CHHETRI
April 1992

THE PESTICIDE PROBLEM

One way to control pests and diseases is to use a pesticide. However, some of these chemicals are very dangerous and may cause short or long-term health damage and death if the person applying them is not careful. Many of them can be absorbed through the skin or directly breathed. It is not safe to apply pesticides unless full protective clothing and a mask are worn. Many years after exposure to the pesticide, some people are still affected and may die. Cancer, birth defects and sterility may all result from pesticide exposure.

Some pesticides take a long time to break down and they may remain in the soil, rivers and living creatures for many years. The pesticide DDT, which has been widely used for malarial control, is present now in virtually all living things and has become concentrated as it passes up the foodchain, reaching high levels in some birds and mammals. This has caused some species to become very rare, as the DDT has killed them or prevented them from reproducing. High levels of DDT have been found in human breast milk.



The more we use pesticides, the more we poison ourselves, our children, and our environment.

Some pesticides are worse than others. The most dangerous ones have been banned in many countries for some time, but some of them are still available in Nepal. (See table on opposite side).

Prepared by: JANE POWELL
April 1992

PESTICIDES

Name	Acute effects	Long-term effects	Banned
• Aldrin	Nerve damage, convulsions, death	Cancer, birth defects	34 countries (1989)
• Chlordane (Heptachlor)	Nerve poison	Cancer, infertility, stillbirths	25 countries
• Parathion methyl (Metacide, Metapar, Poratht, Nepcil Porathian	Nerve poison. Extremely hazardous	Birth defects. Toxic to birds and bees	5 countries
• Parathian-ethyl (parathian, folidol, parathane, paramar)	Nerve poison. Extremely hazardous	Birth defects. Extremely hazardous	17 countries
• BHC (HCH, Gammexane, Nepcil gammacide, Nepcil CH)	Nausea, convulsions, irritability	Found in human breast milk in India. Highly toxic to bees	28 countries
• Lindane	Similar to BHC		8 countries
• DDT	Paralysis, convulsions	Cancer, infertility, tremors, death, kills fish and birds	28 countries
• Aldicarb	Fatal nerve poison	Damage to the immune system, poison to mammals, birds, fish	3 countries
• Camphechlor (Toxaphene)	Vomiting, convulsions	Cancer, birth defects, liver and kidney damage. Very persistent (20 year +)	28 countries
• Chlordimeform (CDF)	Nausea, coma, death	Cancer, birth defects	21 countries
• DBCP	Dizziness, vomiting, death	Cancer, infertility, miscarriage	27 countries
• EDB	Skin reactions	Cancer, birth defects	14 countries
• Paraquat	Liver, kindey, lung damage, death	Lung damage. Toxic to birds and fish	3 countries
• Pentachloraphenol	Skin irritation, excessive sweating, death	Birth defects. Toxic to fish, present in ground water.	10 countries
• 2, 4, 5—T	Toxic when absorbed through skin, nose bleed, fatigue, seizure	Birth defects, still births, cancer	32 countries

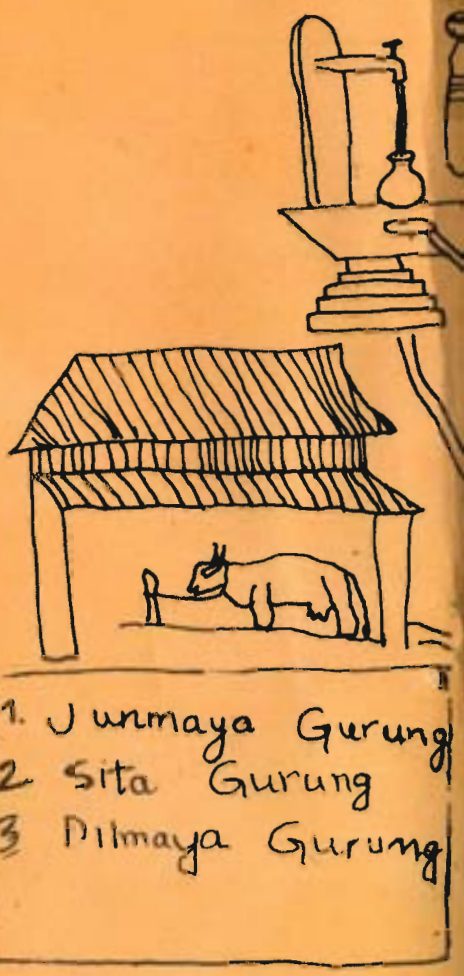
Aldrin, Chloradane, Parathion-methyl, Parathion-ethyl, BHC. Lindane and DDT are all on sale in Nepal. The only one banned in India is 2, 4, 5-T.

PRESSURE COOKER

The participants learned about this device from the women's group of Lwang during their tour there. As explained by the Lwang women, the cooker saves time as any item can be cooked in a short time; it saves fuelwood, thus reducing collection work; and therefore helps to conserve forest resources. The Gorkha women have liked the cooker, and hope to procure several using the resources of the women's group funds in the future.

Participating Countries of the Hindu Kush-Himalayan Region

- Afghanistan
- Bangladesh
- Bhutan
- China
- India
- Myanmar
- Nepal
- Pakistan



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