Integrated Natural Resource Management in hilly regions of Eastern India

HAND BOOK FOR PRACTITIONERS

igsss
Indo-Global
Social Service Society

Integrated Natural Resource Management in hilly regions of Eastern India

HAND BOOK FOR PRACTITIONERS

igsss
Indo-Global
Social Service Society

Title : **HAND BOOK FOR PRACTITIONERS ON INTEGRATED NATURAL RESOURCE MANAGEMENT**

Published by : Indo Global Social Service Society

Written by : Krushna Chandra Sahu, Head-Livelihood, IGSSS

Edited by : Jagannath Chatterjee, Asim Kumar Mahapatra, Shyam Sundar Barik

Designed by : Ramakrishna Maharana

Year : 2017

FOREWORD

Eastern region mostly covers the undulating topography and sloping lands suffering from high runoff and nutrient losses. The region is richly endowed with two basic natural resources viz. soil and water. Poverty can be acutely seen in this region as the inhabitants are mainly dependent on the natural resources like land, water and forest for their livelihood. Over the last two to three decades, fast depletion of these resources due to several factors compounded by climate change and injudicious utilization of natural resources has put the inhabitants of this region into tight corner with regard to earning their livelihood. To improve the situation, Indo-Global Service Society (IGSSS) has been making deliberate attempts for a long time, to emphasize and demonstrate sustainable natural resource management models with the active participation of the communities across the region. The major effort of IGSSS has been concentrated on the livelihood restoration of the vulnerable communities mostly tribals and dalits.

I am delighted that this handbook is being published for the development practitioners engaged in Integrated Natural Resource Management in hilly regions of Eastern India on the eve of IGSSS's National Partner's meet being held at New Delhi. It is my pleasure to thank the IGSSS livelihood team for bringing out this useful document which I am sure will be beneficial to the field practitioners.

John Peter Nelson
Executive Director

INDEX

PREFACE

The hilly regions of eastern India that comprise of Chhattisgarh, Jharkhand, south western parts of West Bengal and non-coastal Odisha represent mostly undulated hilly landscape. The region is characterized by subsistence economy, high level of run-off water, low water availability for irrigation, less agriculture productivity, vast depletion of forest resources, food insecurity, poverty & unemployment, degradation of land & soil, less of land husbandry, seasonal migration of people for employment etc. The people in the region mostly the tribals, who have remained poor and backward for several years due to the fact that the eco-based natural habitat system that used to sustain their life and livelihood one day is severely stressed upon and impacted by man-made and natural disasters, rapid climate changes over the years and lack of application of appropriate scientific and technology based climate & people friendly adoptive methods to cope with the situation.

IGSSS has been focusing on sustainable livelihood as a key issue to address the rights of the marginalized communities. Majority of the poorest districts shortlisted by the Ministry of Rural Development (MoRD) for implementation of NRM related activities are also in the central and eastern hilly regions of the country. 65 districts of Eastern Plateau and hill region are called as Agro-climatic Zone VII.

Landlessness is not as important as in some other parts of the country, but there are millions of poor people in these belts whose food is not secured. The issue here is failure of productivity and imbalance of natural ecosystem to sustain the life and livelihood of the people. Rainfall is quite high in these areas, yet water is not available for irrigation. The reasons could be attributed to frequent climatic changes, lack of appropriate adoption of technologies to help people to sustain their livelihood system.

However, the regions have high potential for growth as there is vast scope for bio-diversity conservation, integrated farming system, development of forest and its resources etc. But this requires an integrated approach to manage the natural resources. While the vast region manifests the larger problem, it might be prudent to demonstrate appropriate models to promote the development of natural resource management leading to equitable sustainable development by ensuring household level food security. Such an approach requires participatory planning at the hamlet and village level.

IGSSS from its own experience and the experience of other organizations like PRADAN, and AFPRO has tried to consolidate some of the learning and thought of preparing a handbook for the practitioners working in the region to help them plan and intervene effectively.

The hand book contains the concept of integrated natural resource management, the technological inputs that are required to cope with the situation, the methods and techniques, feasible suggestive measures etc.

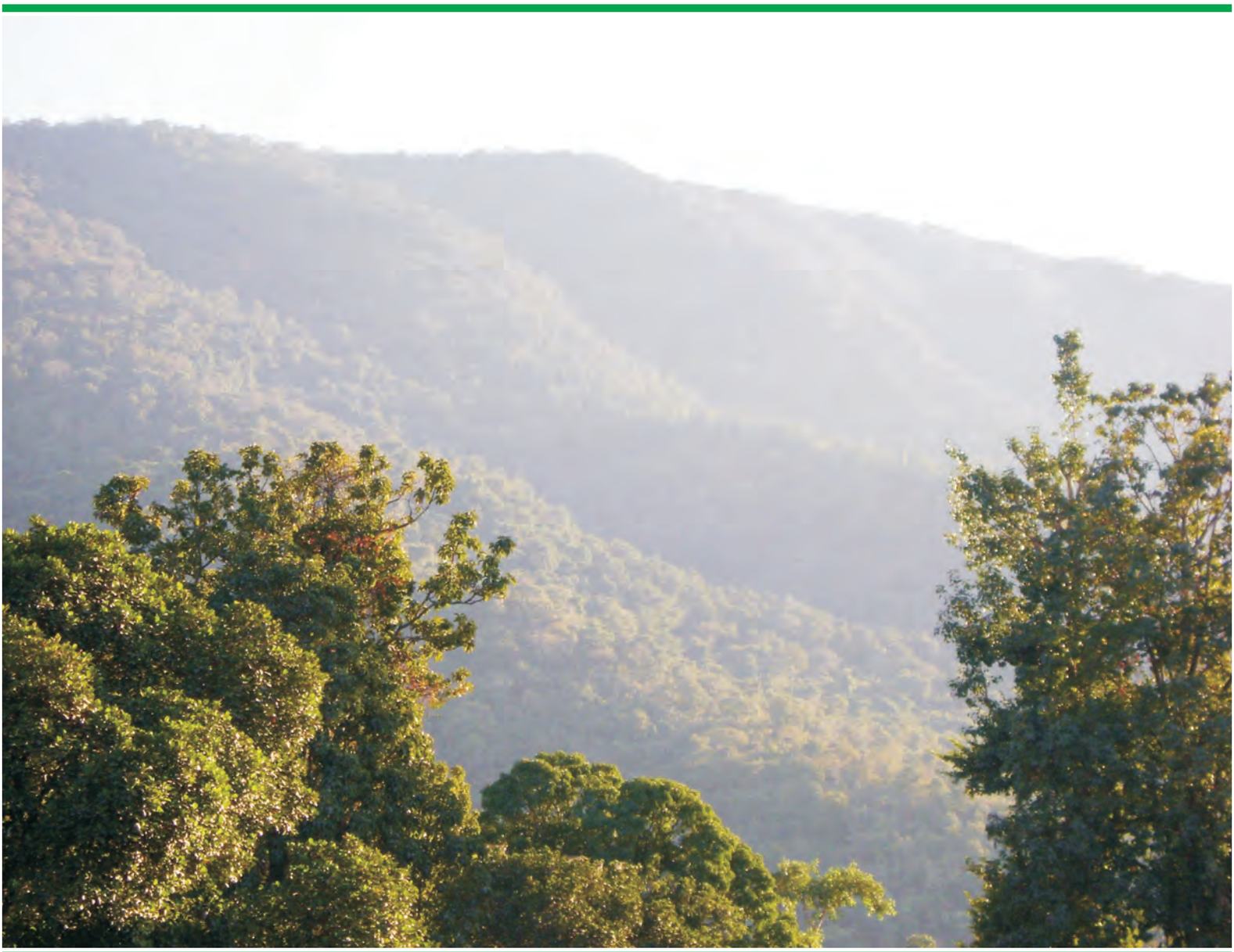
We would like to express our deep gratitude to partner organizations and to the thousands of poor farmers, based on whose experiences IGSSS has been able to develop this document. We would also like to express our thanks to Mr. Jagannath Chatterjee, Mr. Shyam Sundar Barik and Mr. Asim Kumar Mahapatra for editing the document. We also applaud the effort of Mr. Ramakrishna Maharana for designing the whole document.

Krushna Chandra Sahu
Head-Livelihood Programmes

ACRONYMS

AC Zone	:	Agro-Climatic Zone
AFPRO	:	Action for Food Production
BPL	:	Below Poverty Line
IGSSS	:	Indo Global Social Service Society
INRM	:	Integrated Natural Resource Management
MoRD	:	Ministry of Rural Development
NRM	:	Natural Resource Management
NTFPs	:	Non-Timber Forest Products
PEC	:	Primary Environmental Care
PRADAN	:	Professional Assistance for Development Action
SC	:	Scheduled Castes
ST	:	Scheduled Tribes
TAT	:	Technology & Technique
WHT	:	Water Harvesting Tank

Scenario of Eastern Region Plateaus and Hills



Scenario of Eastern Region Plateaus and Hills

Backdrop

For the purpose of Agriculture planning India has been divided in to 15 agro-climatic regions, each with similar resource endowments and constraints. The eastern region plateau and hill covers the undulated and hilly regions of Eastern India. It includes Chattisgarh, Jharkhand, South-Western Districts of West Bengal, and Non Coastal region of Odisha. The important features of the agro-climatic zone are the following:

The topography of this region represents undulating and shallow soil. The uphill regions of this region have limited ground water. The terrain, however, is blessed with good rainfall and is crisscrossed by many seasonal and perennial streams carrying off a huge runoff. Therefore, there are multiple options for harvesting the high runoff from the region in a decentralized manner. These options have largely remained untapped. Presently wells, tanks and rivers are the major sources for irrigation. Usually, the monsoon starts in mid-June and in every alternate year there is a dry spell, either just after the onset of monsoon, or in mid- September. The summer months experiences extreme temperatures. The fluctuating climatic condition often causes crop failure even in the years when the total rainfall is sufficient. The soil in this region is mostly nutrient-poor, red sandy, or red and yellow. The undulating and hilly terrain coupled with high rainfall produces wide variation in soils, slope, water availability, soil depths, etc. even within the boundaries of the smallest village. The overall pattern repeats itself village after village—dry uplands with shallow soils, dry midlands with deeper soils, and wet lowlands with deep soils. In fact, the local terms for land classification incorporate these variations—tand(upland), baid(medium upland), kanali(medium lowland) and bahal(lowland) in Bengali and similar terms in other vernaculars. This makes Natural Resource Management (NRM) a complex process in this region. Agriculture forms the backbone of the economy. There is a greater reliance on paddy and year-round vegetable cultivation.

Natural Resource endowment of different states in Eastern Region

States	Geographical area (000 ha.)	Net cultivable area (000 ha.)	Cropping intensity (%)	Food grain productivity (tones/ha.)	Average rainfall (mm)	Net irrigated area (000 ha.)	Ground water resource (000 ha.	Ground water development (%)
Chhatisgarh	13780	5480	115	0.98	1430	1263	1607	6
Jharkhand	7970	1897	117	1.24	1277	258	653	33
Odisha	15571	6165	152	1.32	1451	2143	2099	23
West Bengal	8687	5127	177	2.50	1750	1911	2309	38

Although official estimates claim that 18% of the net sown area is irrigated, in reality many irrigation schemes are either defunct or irrigate much less land than what they were designed for. Forest is an important source of livelihood of people as it supply timber, fodder, fuel wood and a large number of non-timber forest products (NTFPs). Almost all households living in forest belts depend upon the collection of NTFPs for consumption and sale.

A view of upland management

A substantial portion of this region comprises of hills and valleys. The intense rains during monsoon season generate rapid over land flows on the unprotected hills resulting into sheet, rill and gully erosion. Deforestation and shifting cultivation in the region further accelerate the problems. Water-related constraints are different for different geographical entities.

The above description, thus, calls for scientific management of this region's natural resources for increasing production of food, fiber, fodder and fuel wood without adversely affecting the natural resources is the prime objective. This eastern plateau and hills region needs specific strategy for a diversified agricultural development which falls under Agro-Climatic Zone VII.

An integrated approach to NRM, focusing on the efficient management of soil, water and vegetation resources, becomes extremely important in this situation. INRM not only helps to optimize and increase the productivity of land and water resources, but also ensures household food security, nutrition and eliminates poverty.

Concept and Approach to Integrated Natural Resource Management

Concept and Approach to Integrated Natural Resource Management

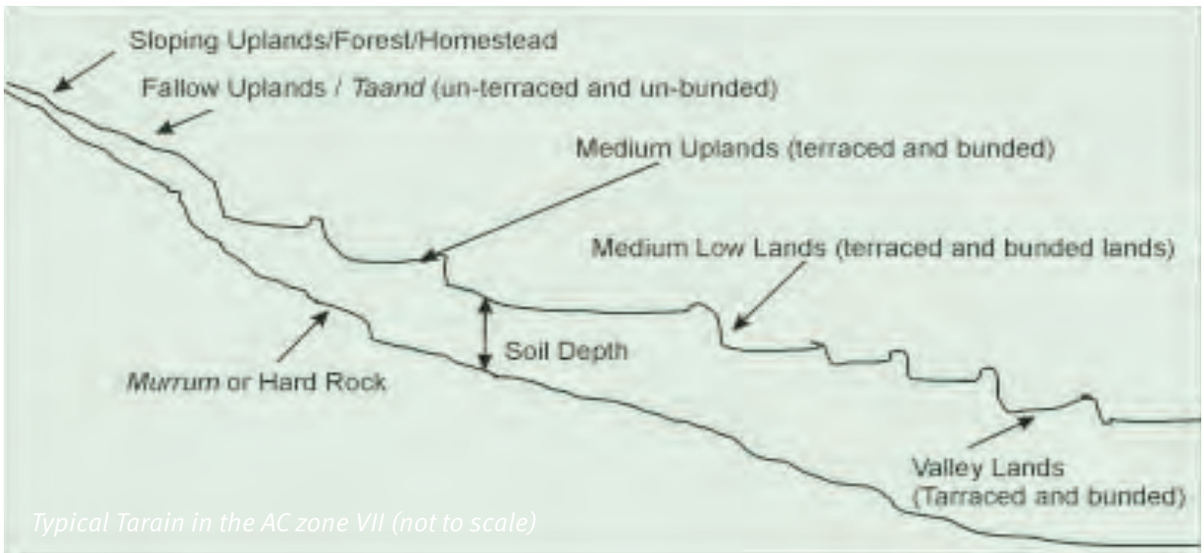
INRM is careful management of land, water, forest and biological resources to achieve and sustain potential agricultural productivity. "Integrated Natural Resource Management (INRM) is a way to ensure that the uses of natural resources are ecologically sustainable. It is integrated because it attempts to manage all the activities that could affect natural resources with conservation."

A view of Eastern Region plateau and hill

INRM recognizes the links between natural resources (soil, water, vegetation) within a natural boundary called watershed. Action in one part affects the other; i.e. deforestation in upper catchment areas increase soil erosion, reduces moisture conservation, and increases water runoff in the lower valleys. The movement of rainwater across time and space is a key factor in this concept.

Uncontrolled, unplanned and unscientific use of natural resources results in their decline. Activities that deplete natural resources include the followings:

- Cultivation of slopes without adequate precautions
- Inadequate bunding of cultivated plots
- Irrational cropping without replenishing soil fertility
- Severe deforestation exposing the hills
- Barren and compact commons due to overgrazing
- Shifting cultivation
- Unscientific mining
- Lack of people's involvement in managing natural resources



Typical Tarain in the AC zone VII (not to scale)

The consequences are soil erosion, siltation of water bodies, less infiltration and the fast disposal of runoff causing floods and droughts resulting in low productivity and the poor health of people and cattle. Therefore, managing natural resources calls for their rational utilization to optimize production and minimize risk.

NRM combines management of natural resources use and their conservation & sustenance

This could include the following;

- Proper land use for protecting it from all forms of erosion
- Enhancing productivity while maintaining soil fertility
- Water harvesting and conservation for effective use
- Safe disposal of runoff water

Land type	Characteristics	Present utilization	Problems
Upland	Highest slope, very thin topsoil. Murom/rocky substrate (often exposed) very low moisture status. Generally not terraced or bunded.	Used for cultivating paddy through direct seeding wherever there is a bit of topsoil. Most part remain fallow. Homestead is used for maize/vegetable cultivation/ private/ government forest.	▪ High erosion due to high slopes and low or no vegetative cover. ▪ Low water-retention capacity ▪ Extremely low productivity
Medium upland	Moderate slopes. Soils are sandy to sandy-loam. Shallow top soil with low organic matter. Low moisture holding capacity. Generally bunded and terraced.	Increasingly brought under transplanted short- duration paddy due to population pressure.	▪ Low moisture-retention capacity ▪ Low productivity. ▪ Lands are not husbanded well: ▪ Shallow and poorly maintained field bunds, unplugged rat holes, little or no manure is applied.
Medium lowland and lowland	Most productive lands: core of the farming system. Soil is rich in organic matter. Suitable for intensive year-round cultivation. Water surplus during monsoon: sourced from direct rainfall, surface runoff and seepage from	Long-duration paddy during monsoon	▪ Low moisture-retention capacity ▪ Land use below potential ▪ Single paddy crop is grown during the monsoons due to the absence of irrigation sources

In short, INRM involves the development of natural resources taking into account the relationship between them mainly the land and water as per the needs and priorities of the people.

Strategies of INRM

Strategies of INRM

The following strategies would help the rational use of land and water resources:-

Strengthening Homestead Cultivation

- Homesteads are very fertile due to the presence of organic material and are also the easiest to protect. Yet, these lands are very poorly managed.
- Intensive cultivation of homesteads (bare)to create year-round income earning opportunities, food and nutrition security is one of the strategies.
- By developing dug wells shared by several families, homesteads could be irrigated and used for the intensive cultivation of vegetables, fruits and flowers.
- This would especially benefit women and offer them an alternative to leaving home in search of wage labour

Developing Uplands

- Developing uplands (taand/goda/dhipa) is the second strand of the strategy.
- Land treatment to harvest rainwater to improve soil moisture locally is the first step towards enhancing the productivity or carrying capacity of these lands.
- Gullies should be plugged and stabilized to prevent any further degradation.
- Agro-forestry, with a combination of trees and grasses, is more suited to such lands rather than paddy or other field crops.
- Tree varieties could be chosen for light timber, fuel wood, tussar silk and horticulture.

Husbandry of Medium Uplands

- The third element of the strategy is to improve the management of medium uplands (baid).
- To enhance and stabilize productivity, these lands need to be treated for water harvesting and the recycling of biomass to ensure good organic content in the soil.
- The promotion of on-farm water resource development (5% model) and green manuring (through field bund plantation or cultivation of sun hemp) would be the required interventions in these types of lands.
- Besides these, alternatives to paddy, such as maize, pigeon pea, and maize mixed with pigeon pea, can be cultivated profitably.

Medium upland management

Managing Medium Lowlands and Lowlands

- Improving the management of medium lowlands (kanali) and lowlands (bohal) is the fourth element of the strategy.
- These provide huge opportunities to harvest both surface runoff and subsurface flow and recycling of water for localized irrigation to support intensive agriculture.
- The most suitable infrastructure here is a chain of farm ponds (over 6 to 8% land area, 2 to 3 m depth) constructed in the valleys along the drainage line. As these ponds can retain water for long duration(up to 10 months), they provide excellent opportunity to promote composite fish farming besides providing irrigation.
- Once this is done, the lowlands would not only produce three crops a year but would also provide life-saving irrigation to adjoining baid lands with low-cost water-lifting devices during late-monsoon failure, which is very common in this region.

INRM Technologies

INRM Technologies

INRM Technologies are of two types:-

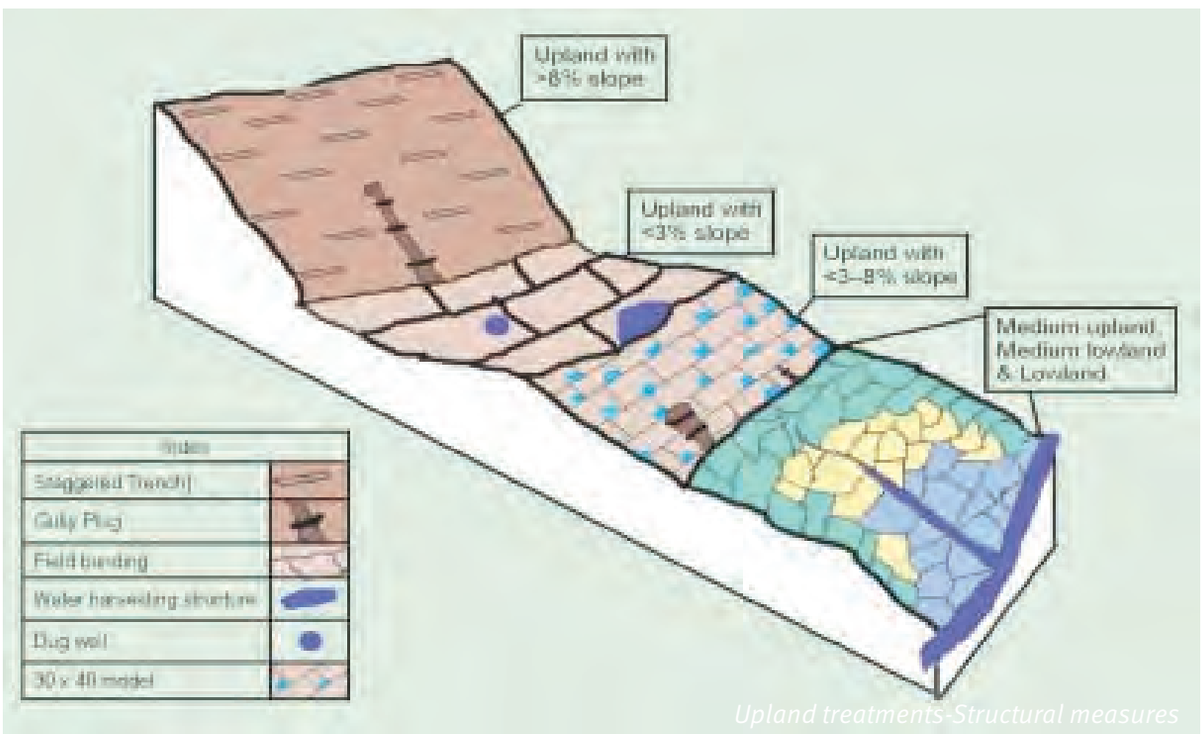
1. **Structural Technologies**

   These involve the construction of different earthen or rocky structures to hold back the runoff water and thereby conserve soil and water.

2. **Vegetative Technologies**

   These involve appropriate land-use practices to conserve different types of land and maximize agricultural production in the interest of the community.

1. Suggestive Model of Structural Measures



Upland treatments-Structural measures

A) Staggered Trench

A staggered trench is a model of in-situ water conservation in which pits are excavated across the slope of the land that is not terraced or bunded to collect runoff during spells of rain to allow gradual percolation into soil masses. It comprises shorter trenches (6ft long) along the contour with 6ft space between them at suitable intervals to impound the runoff from above.

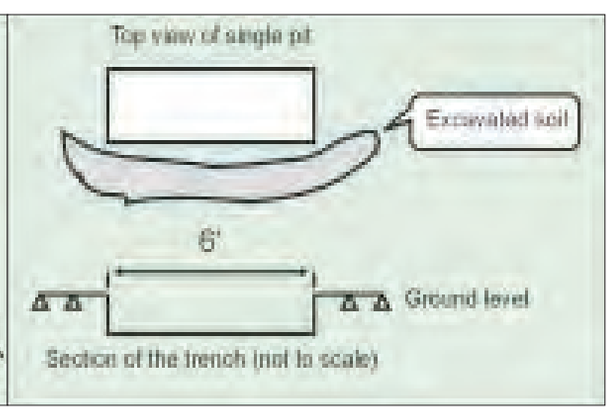
Instructions for the Practitioners

- Ensure the trenches are located directly below one another in alternate rows.
- Place the excavated soil from the trench behind the trench in the form of a bund.
- Have plantations in the space between the trenches and the bunds. The bunds may be planted with grasses.

The dimension of a trench would be as follows:

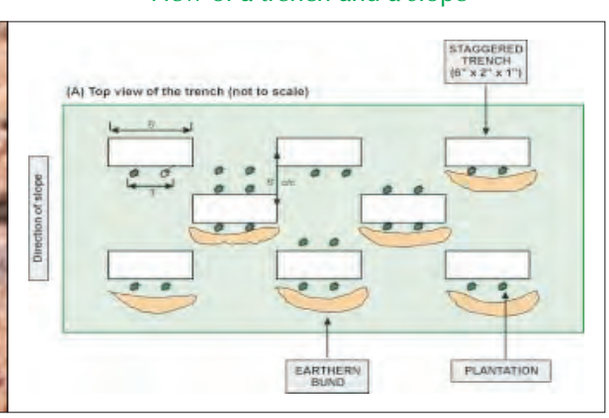
Length	=	6 ft
Width	=	2 ft (top and bottom width are almost same)
Depth	=	1 ft
Total capacity	=	(6 x 2 x 1) cut = 12 cft

Staggered trenches along a slope



View of a trench and a slope

View of several staggered trenches across a slope



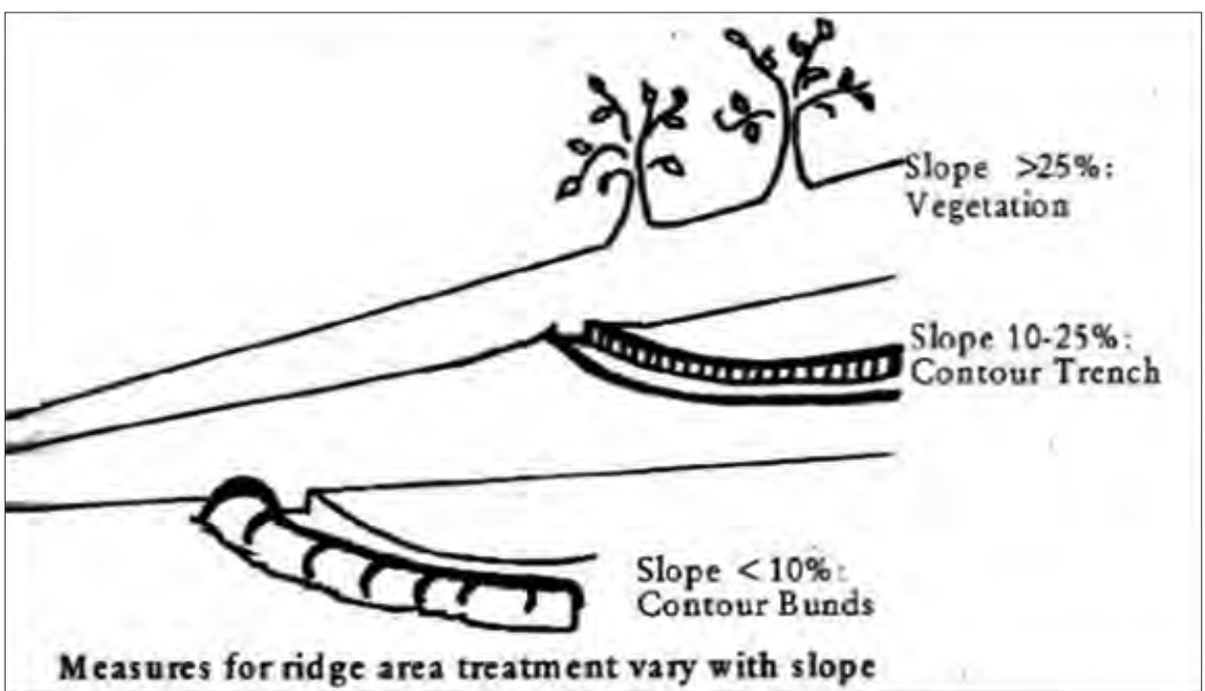
Top view of the trench (not to scale)

Time of construction

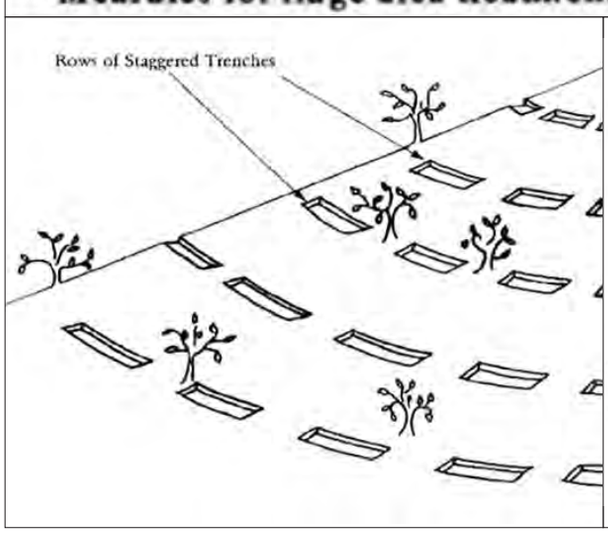
It is preferable to begin the construction of a staggered trench in the month of September when the soil is not too hard and labour is available after paddy transplantation. It is better to complete the work before people get occupied with harvesting paddy so that the treatment of lands under paddy cultivation (medium upland, medium lowland and lowland) can begin after harvesting and end before the onset of monsoon. The labour force is, thus, engaged effectively.

Man days required

A hectare of land will roughly generate 171wagedays of employment



Measures for ridge area treatment vary with slope

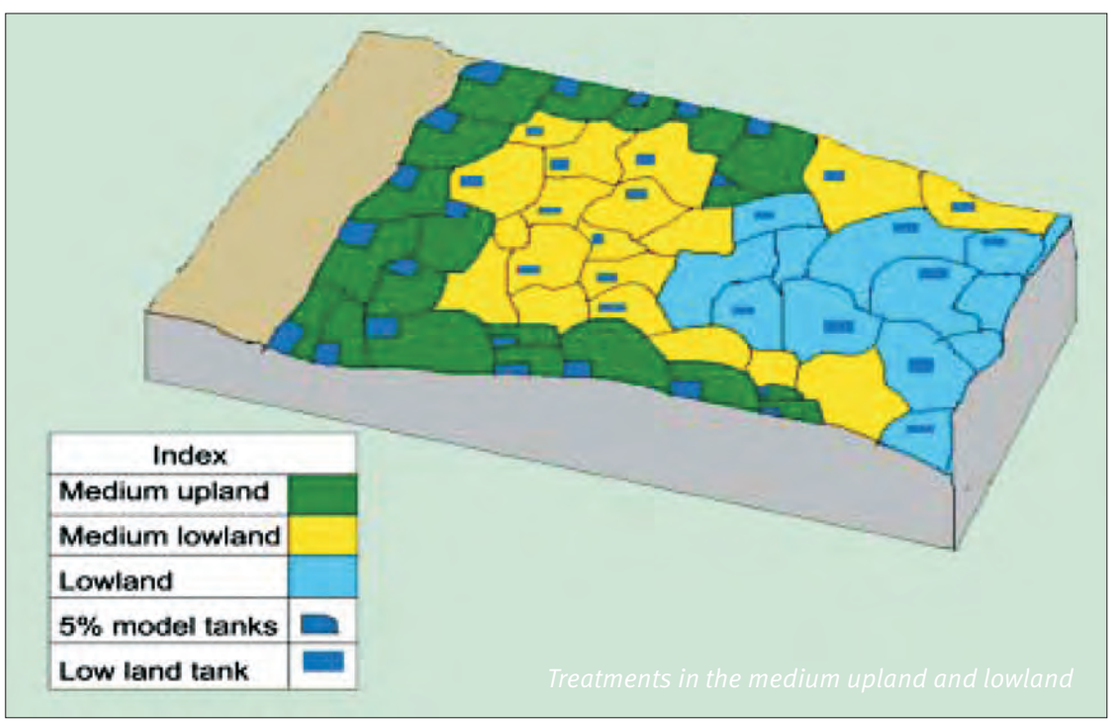


B) 5% Model of Water and Land Management

This is a model of in-situ rainwater harvesting suitable for medium uplands, in which every plot has its own water body, the area of which equals5% of the total area of the plot. The pit is able to hold rainwater that otherwise flow out of the plot as runoff. The water held in the pits irrigates the plots during water scarcity.

Instruction for the Practitioners

- Measure the length and width of each individual plot.
- Demarcate 5% area of the plot at the upper right corner. Mark an area with length of one-fifth and width of one-fourth of the plot. Suppose, a plot is150 ft long and 100 ft wide the demarcated area then needs to be 30 ft x 25 ft or 750 sq ft.

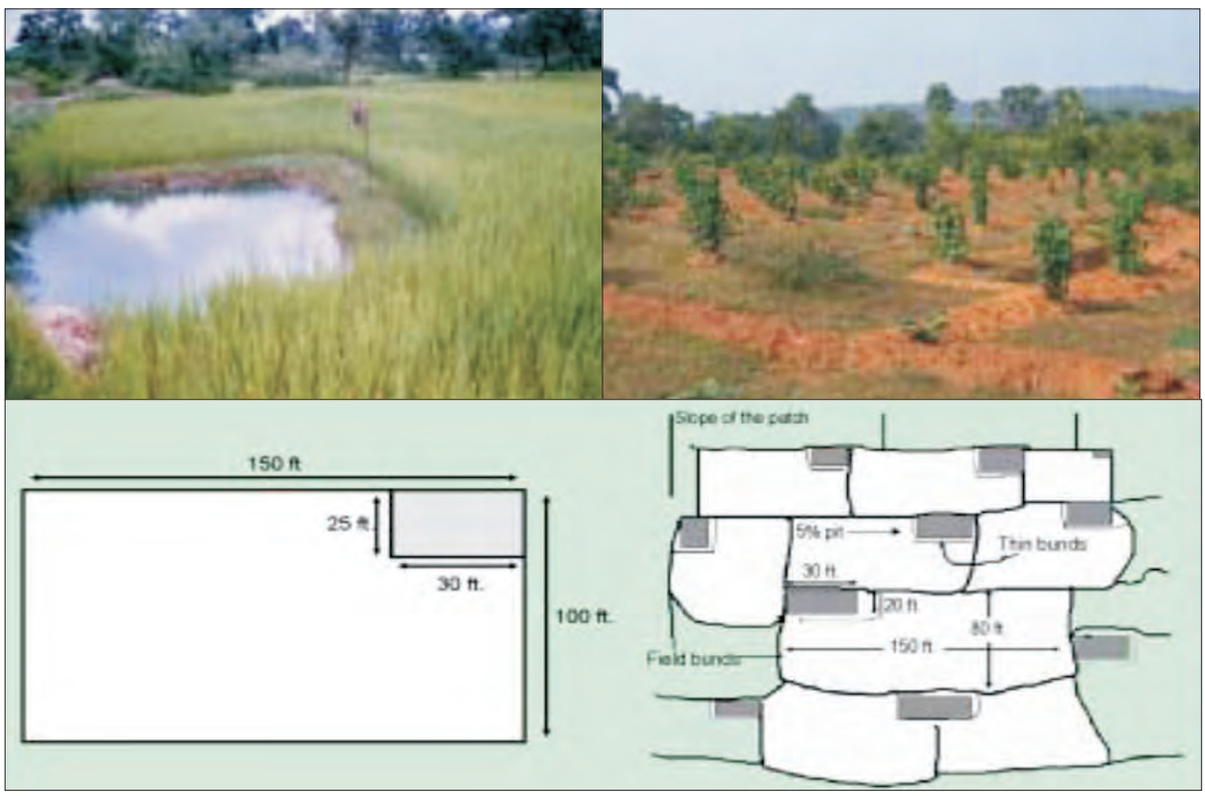


Treatments in the medium upland and lowland

- Dig a pit in the demarcated area with a depth of 5 ft–7 ft depending upon the type of the soil and wall slope.
- Use the excavated earth to strengthen the field bunds.
- Make a small 4-inch high bund around the pit to keep some standing water in the field.
- Ensure that the length is one-fifth of the length of the plot and the width is one-fourth of the width of the plot. For odd-shaped plots the implementers should use their own judgment for giving the layout of the pit. The area needs to be about 5% of the total plot.

Time of construction

The best time to construct a 5% model is between December and June.

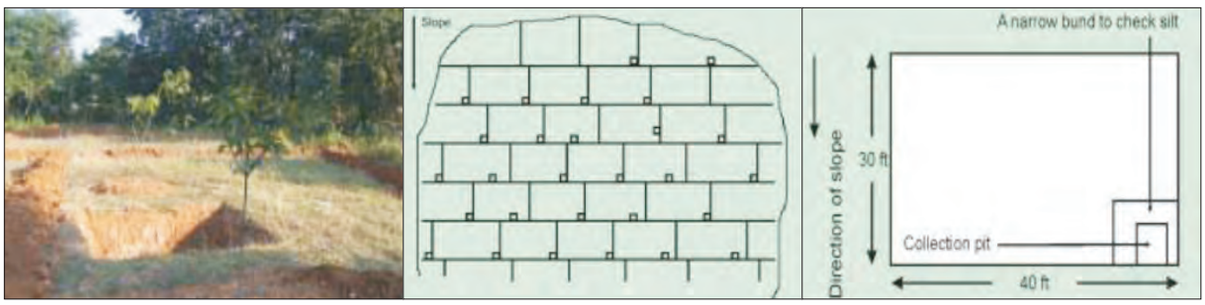


C) 30 x 40 Model

The 30 x 40 model is a method of in-situ soil and water conservation. It involves dividing uplands into small plots of 30 x 40 ft (30 ft along the slope and 40 ft across the slope), digging pits at the lowest point in each plot and bunding the plot using the soil dug out of the pits.

Instructions for the Practitioners

- Divide and mark the selected area into30x40ft., starting from the ridgeline with the help of a measuring tape, rope and lime. The size of the plots may be altered up to + 10% to fit the boundary and ownership.
- Identify the lowest point in each plot.
- Dig a 3-ft deep pit that is 7 x 7 ft at the top. The pit should have a sloping wall such that the bottom of the pit is 5 X 5 ft.
- Bund the plot with the excavated soil from the pit. The bund across the slope should be 1 ft high with a top width of 1ft. and bottom width of 2ft.
- Use the rest of the excavated earth to construct the field bund at the side, along the slope.



Dimensions

Plot : Length = 40 ft, Width = 30 ft.

Pit : Length = 7 ft, Width = 7 ft, Depth = 3 ft.

Time of construction

If the land is fallow, the work can be started in the month of August so that after the rains, the soil becomes loose enough to be excavated. If the plot is under the kharif crop, the work can be started in October or just after harvesting of the kharif crop. The work should be completed before the soil gets too hard in the summer months.

Man days required

A hectare of land generates 90 wage days of employment, the labour component of which is100%.

D) Field Leveling and Bunding

It is a treatment to level out sloppy lands. This increases soil and moisture conservation. A bund is an earthen embankment made around an agricultural plot to conserve soil and moisture.

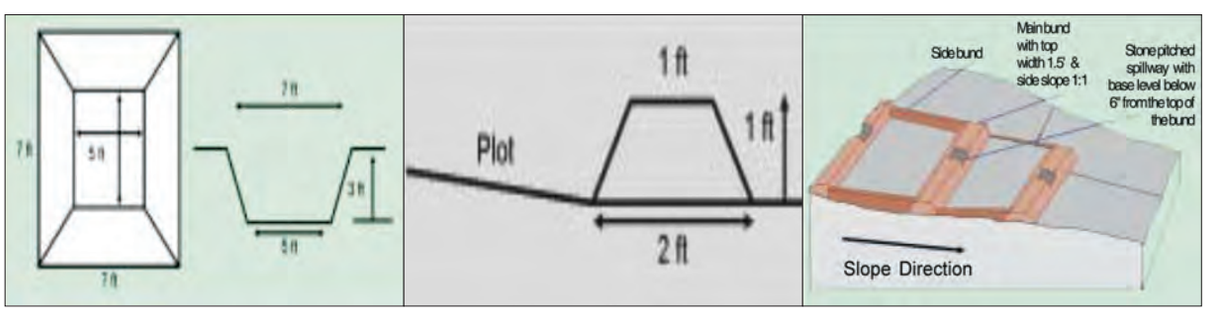
Suggested steps for the Practitioners

- After the selection of the patch for leveling and bunding, plan the plot boundaries and drainage system considering the ownership and topsoil depth. The topsoil depth has to be kept in mind, for deciding the width of the plots along the slope.
- After cutting the earth from the upstream side of the plot for field bunding, at least 6 inch topsoil has to be ensured for crop cultivation. In case of a thin topsoil, plots will be of smaller width.
- Mark the boundaries on the ground with a rope and lime powder, along which bunds have to be laid.
- Make the bund and fill up the depressions of each plot by removing a thin layer of topsoil from the adjacent upper slopes and mounds.
- While removing the topsoil care should be taken not to expose the hard stratum that is not suitable for cultivation. In extreme cases, the topsoil may be kept separately and replaced once the final level of the plot is attained. The top width of the bund ranges from 0.5–1.5 ft depending on its height.

Field bunding activities

- To drain the excess runoff from the field, construct a small spillway on the lower field bund with local stones. The top of the spillway should be at least 6 inches below the top of the bund.
- The small bunds should be protected by establishing grasses and the big ones by providing stone pitching with local material. The exact site of the spillway is to be fixed after discussion with the landowners of the surrounding plots.

The suggested model



Time of construction

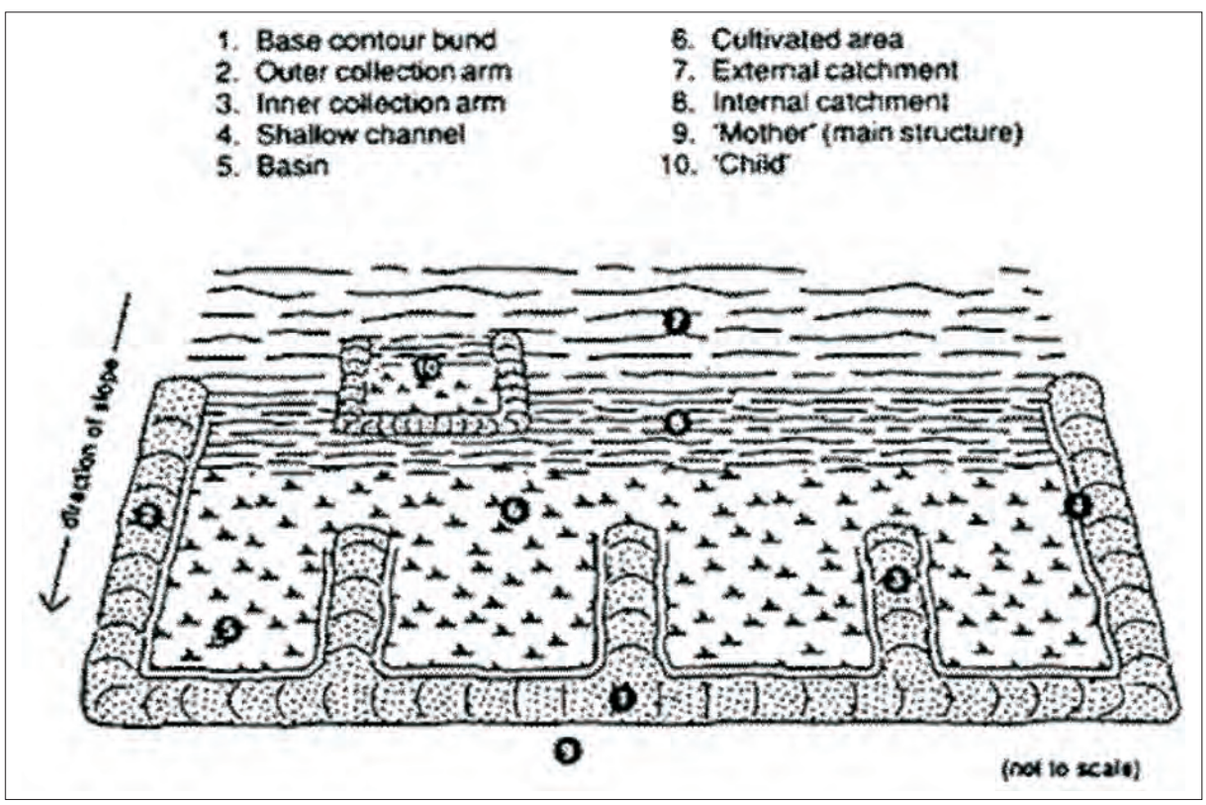
If the land is fallow, this work can be started in the month of August after the onset of the monsoon. If the land is under the kharif crop, work can be started just after harvesting the crop. Work should be completed before the soil gets too hard in the summer months.

Man days required

One hectare of field leveling and bunding generates nearly 210 wage days of employment.

Features of Base Bund

The base bund approximately follows the contour line and impounds the runoff. Two outer arms fulfill the same function and also act as conveyance structures which direct water to the cultivated lands. Sometimes, shorter inner arms are added which divide the land into smaller basins and improve the spread of captured runoff. A shallow channel is left on the inside of the bund to support the conveyance and circulation of runoff. The model of the base bund is as follows:



Excess water is normally drained along the tips of the outer arms which are reinforced with materials such as stones, brushwood or old tyres. Bunds are usually 0.5 m high and 2 m deep at the base, but these dimensions can vary greatly depending on both the slope and the amount of runoff expected in the area. The base can be between 50 to 300 m long, while the arms are usually 20 to 100 m long. The size of the cultivated area serviced by such a structure is 0.2 to 3 ha.

E) Water Harvesting Tanks

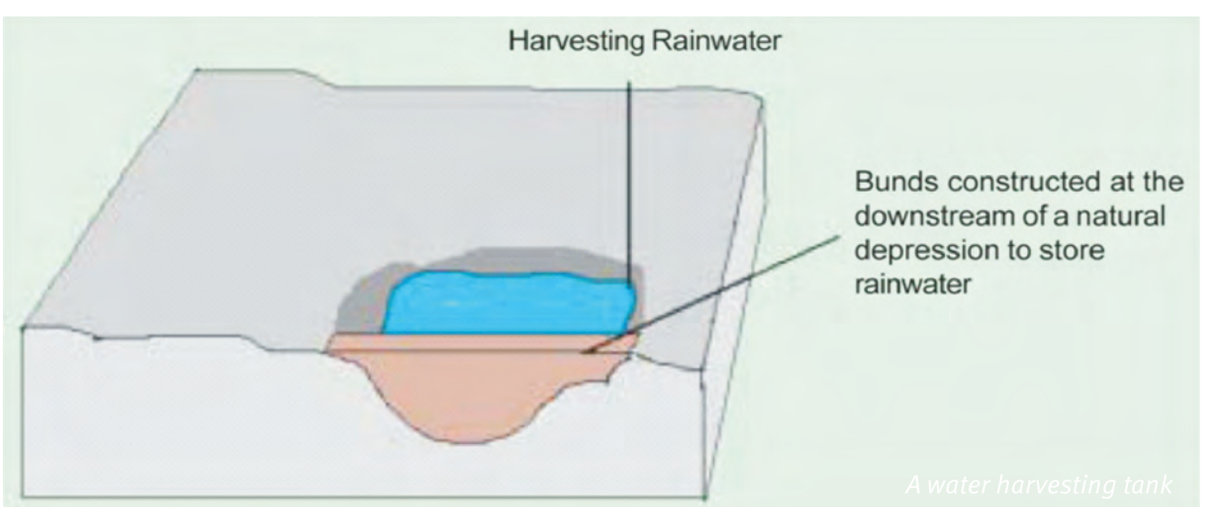
A water harvesting tank is a model of in-situ water conservation in which the area of natural depression can be converted into a water body. These tanks also work as infiltration tanks and increase the moisture content of the soil downstream. Select the site for constructing the WHT. Mark the area on which excavated earth has to be placed to construct the bund. Excavation is done from the proposed storage area, at least 1ft away from the embankment area.

Small Water Harvesting Tanks

For smaller tanks, construct the earthen embankment with 1.5:1 side slopes and3-ft top width by excavating soil from the storage area. The top of the bund is kept1.5-ft higher than the maximum water level in the pond. For very porous soils, a central core wall of clay may be constructed to prevent seepage through or under the dam.

F) Big Tanks

In bigger tanks, protect the embankment with stone pitching on the upstream side and grass on the downstream side. Make the embankment straight when constructing in a valley and extend it upward son either side when constructing around a natural depression. Leave a surplus escape on one side of the tank to pass on the surplus runoff. This is constructed at a point on the embankment where the overflow can be safely taken over the stone pitching without having a masonry structure. The dimensions vary with the terrain, the slope of the land and the amount of rainfall.



A water harvesting tank

Time of Construction

This work can be started in the month of August and should be completed before the soil gets too hard in the summer months.

Man days generated

The construction of one such water body generates 300-500 wage days of employment.

G) Lowland Tank

A lowland tank is a small structure (about 1000 to 1500 sq feet) with an average depth of 6 to10 feet cut out in a corner of an individual field on medium lowland and lowland. It acts as a harvesting structure during the monsoons and also helps to recycle sub-surface flow locally in the post-monsoon months. Lowland tanks are made in a series so that the initial monsoon rains are better harvested and the sub-surface flow can be arrested and recycled effectively in the post-monsoon period. The dimensions are 50 ft in length, 30 ft in width and about 10 ft in depth. This work can be started after the paddy harvest and completed before the onset of monsoon. So the best time to construct these tanks is between December and May.

Construction of tank

Construction of dug well

H) Dug Well

A dug well is an irrigation structure 10 ft–15 ft in diameter and 30 ft–50 ft deep. It catches the sub-surface seepage and the water is lifted manually or by machine to irrigate fields.

Dug wells are constructed on the upland, especially homestead lands, where agro-horticulture or vegetable cultivation is planned. It can also be constructed in the low/valley lands to tap the sub-surface water. Dug wells are normally stone-lined and circular and constructed at the lower-most location of plot.

For irrigation, the diameter of a dug well is normally 20 ft and the depth will vary from 30 to 50ft.

Time of construction

It is constructed before the monsoons, in the months of April and May.

B) Gully Plug

Gully plugs are small check dams made up of loose rocks in a series across the gully. A gully plug is one of the erosion control measures in non-agricultural land.

A gully plug is constructed in series along a gully to change a sloping bed to a series of flat beds. The vertical interval between two such structures is equal to its height. The height of the structure is generally kept less than 1 m.

Instruction for Practitioners

- After clearing the site for constructing a gully plug, excavate the bed to a depth of at least 1ft.
- Pack large local stones carefully from that level upward up to 2 ft–3 ft above the bed level.
- The structure slightly sloped on either side and embedded on both the sides of the gully. Engaging a village mason (experienced in constructing dug wells) helps in packing stones.
- Curve the top surface to provide enough space for the maximum runoff from the catchment above the structure to pass without damaging the banks.
- Stone pitching is done both on upstream and downstream sides of the structure to prevent scouring by the flowing water.
- These structures are made in gullies that are less than 2 m depth and 5 m width.

Time of construction

Gully plugs are constructed before the monsoons and immediately after the paddy harvest.

Mandays

Constructing a gully plug roughly generates 200 wage days of employment.

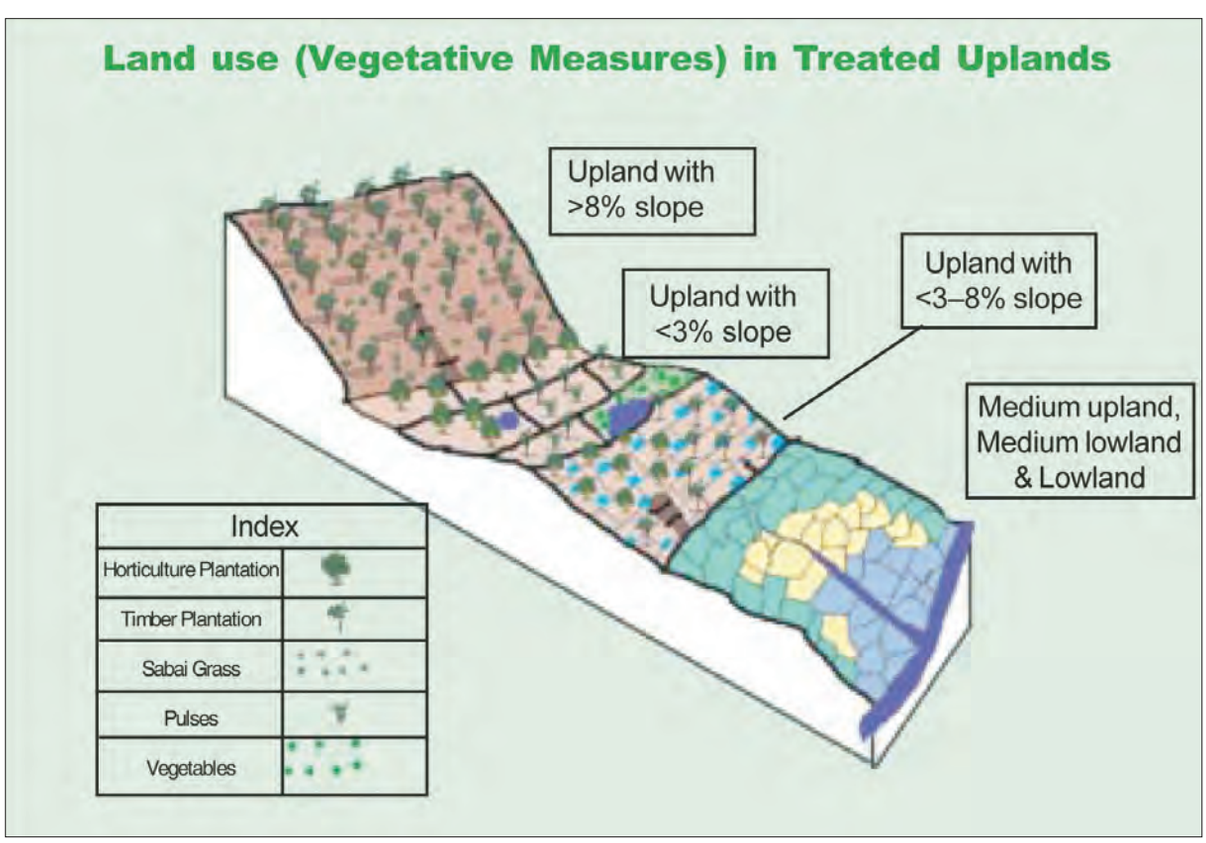
Potential Land use of Treated Medium Land

The medium lands are mostly used for growing paddy in this region. The 5% model pits on these lands protect the crop against dry spells and help to stabilize the paddy production in the land. Paddy production can be further increased if the System for Rice Intensification (SRI) method is adopted. In this method paddy fields have to be dried and soaked alternately and the 5% pits prove to be of immense use.

2) Vegetative Measures for Uplands with Greater than 8% Slope

A) Vegetative Cover

Where the slope is more than 8% a permanent vegetative cover is required to check soil erosion. Plant timber plants at 6 ft x 6 ft intervals on the entire patch, following treatment with staggered trench. One plant will be placed between the trench and the excavated soil and the next one will be placed between two trenches. The entire uncovered area can be brought under grass plantation. Increased soil moisture due to the staggered trenches will facilitate the growth of the plants. Trees and grasses will not require further irrigation.



Instruction for Practitioners

- Dig pits of 1ft x 1ft x 1ft size for the plantation.
- Select timber species based on the type of soil and depth of topsoil. Keep in mind the need of the villagers. Generally, Gamhar, Sisum and Acacia species have been successfully planted in this zone, which along with supplying fuel wood have a good timber value.
- Carefully select the grass species so that it gives some economic return to the land holders. Sabai grass is preferred by the community in some areas. Besides checking soil erosion, it is used for rope-making.

Time of construction

The pit digging should be completed in April so that the pits absorb adequate summer heat to kill insect eggs and other pathogens, which may cause harm to plants. Plantation work is to be done in July after the onset of monsoon.

B) Vegetative Measures for Uplands with Less than 8% Slope

Timber and horticulture plantation

Timber or horticulture plantations are successful in uplands with slopes less than 8%. If the patch is near habitation, horticulture plantation can be done since it needs intensive and regular care. Timber species are planted in the same manner as explained earlier. Select the horticulture species based on the market, the distance of the patch from the homestead, the investment capacity (labour and capital) of the farmer and the availability of irrigation facility. Discuss with the community and finalize the species. A horticulture patch should be surrounded with some straight growing timber species, such as gamhar, teak, etc., to increase the return as well as to create a wind barrier for the fruit crops.

Grass Plantation

It is better to have a mixed plantation of species having different gestation periods, to get periodic yields. Grass can be grown on the field bunds to maximize income and stabilize the bunds. Grass species should be selected according to the need of the villagers. Fodder grasses, such as Dinanath and Stylo, can be grown here.

Fruit bearing plants (Mango and Lemon, Cashew Plantation)

For irrigated uplands, mango and lemon plantations are potential options whereas cashew may be an option for unirrigated uplands. The spacing of the plantation varies according to the selected species.

Pulses and vegetable cultivation (Intercropped)

Intercropping with pulses and other vegetables optimizes the return from the land, increases the soil fertility and enhances the growth of fruit plants.

Slopes and land use measures

Slope	Land use plan (vegetative measures)	Conditions to be considered
>8%	Timber/fodder plantation, sabai grass	The selection of the timber species will depend on topsoil depth also. If the topsoil depth is <6", Acacia species may be grown. Otherwise Gamhar, Sisum, etc. can be planted. The selection of a patch for horticulture will also depend on its distance from the habitation as it requires intensive and regular care.
3-8%	Timber/fodder plantation, horticulture plantation such as mango, cashew	
<3%	Horticulture plantation such as cashew, mango, vegetable	

Steps in INRM Planning

Steps in INRM Planning

The steps for user-friendly INRM planning are ;

- Community organization
- The participatory planning of interventions at the hamlet level (Concept seeding, Baseline data collection, Resource mapping, Ownership mapping, Problem identification, and Option generation)
- The finalization of the action plan at the village level, (Activity plan and proposed land-use map, budget preparation)
- The phasing of the activities as per the implementation plans

The process in details;

Village Selection

The Gram Sabha will prioritize villages according to the poverty and vulnerability status as determined by a set of certain criteria, developed by them.

Concept Seeding

This step involves the intensive interaction among the Gram Sabha members to help the villagers understand the objectives, features, budget and benefits of the programme. During concept seeding, the villagers interact with the Gram Sabha members.

Preparation of a Resource Management Plan

The PEC helps in the development of a resource management plan. This involves planning a set of activities that will augment the carrying capacity of resources and help villagers utilize these resources optimally to get maximum incremental benefit from them. The following is the output expected from the planning exercise.

Name of the Patch:	Patch characteristics	
	Slope %	
	Type of soil	
	Topsoil depth (mt)	
	Erosion status:	

Technology and Technique (TAT) Application for productive land management – Suggested Guidelines

- Follow and improvise the agricultural technologies conducive to the local ecological, economical, social and cultural conditions that include locally developed biological and technical measures. Build on and improve indigenous practices and species, whenever possible.
- Focus on the maintenance of the land's productivity rather than limiting soil loss.
- Work on prevention of land degradation rather than treatment of symptoms
- Use biological (agronomic) technologies, e g agro-forestry and plant species that provide cover, organic matter, wood, fodder, food, soil nitrogen etc
- Emphasize productivity diversity so as to minimize short term risks both for the farmer and the land.
- Invest on physical measures only when it is felt necessary as supplements to biological measures
- While taking up physical measures, try to make it simple and easy to adopt requiring little expense and labour as far as possible. So that farmers could design, construct and maintain the structures without outside assistance
- Promote techniques which can be beneficial to women and other secondary tenures rights holders
- Encourage simple land use planning by land users themselves, with only complementary support from outsiders as locally requested through dialogue. When promoting land husbandry on a catchment basis respect administrative boundaries as being more important than hydrological ones as this reinforces the management capacity of the existing institutions

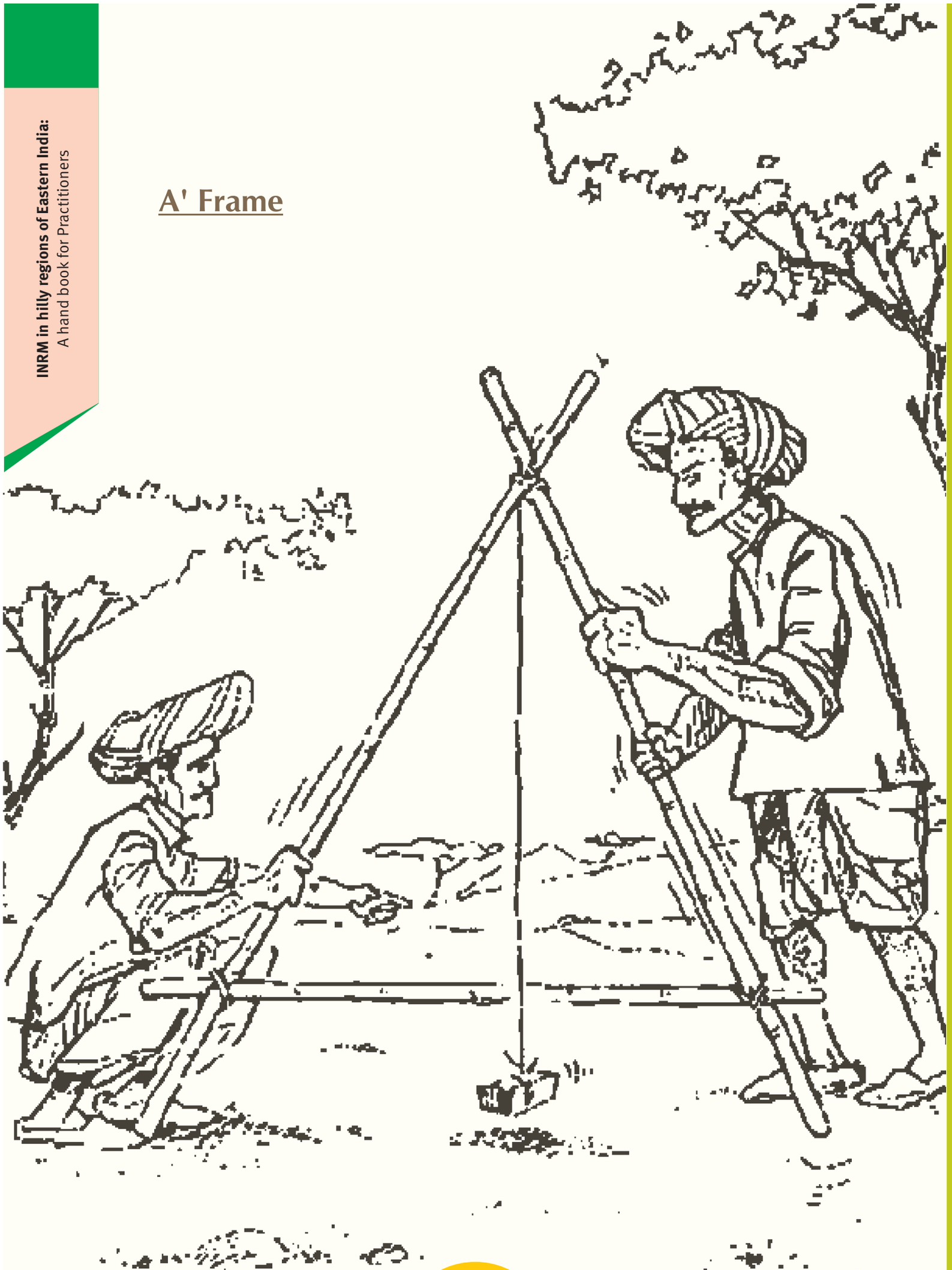
Possible Solution Matrix

Terracing and on- field earth works	
Earth bunds- on contour	Cultivated land from 0 to 15 % slope (possible on steeper land with relatively high infiltration rates) . Note that contour bunds on black clay soils can cause water logging if no adequate provision for drainage of surplus. Using A*- frame (illustrated in the figure given below with diagram) for the contour lines is easily doable.
Earth bunds- field boundaries	Cultivated land possible only on land of 0 to 5 % slope. Often preferred by farmers where field sizes are small and contour bunds would reduce field size by unacceptable amount.
Earth bunds on gradient	Cultivated land. Use where infiltration rate is so low or slope so high that runoff cannot be stopped behind bund. Water is led away into natural water course or artificial waterway.
Store bund on gradient	Cheaper than earth bunds. Contour can be used on either cultivated or uncultivated land. Disadvantage is that water is not so well retained. Advantage is that they can be laid out with minimum of supervision and the land is also cleared of stones. Can be used of steep land upto virtually any slope. Water can flow over top without damaging. Can also build up soil and can be incorporated into earth bund at a later date. Could be used on land with low potential on which earth bunding not justified or if farmers not prepared to construct earth bunds.
Bench Terracing	May be done on slopes up to about 30% if soil is deep. Combination of earth bunds on contour and leveling. Very expensive. Only justified on steep slopes if used with irrigation, otherwise a maximum of about 10 % and then only if rice is grown.
Field leveling	May be asked for by farmers. Only worthwhile if rice production can be either introduced or substantially increased unless the leveling is done in conjunction with irrigation scheme.
Repair of existing terraces	Maintenance of terraces should be taken up by the farmer. However, in some cases, bunds already constructed have not been accurately surveyed. The tops of these should be made level to avoid breaching at low spots.

Gradinies (modified bench terraces)	Inward sloping terraces usually on steep land on which it is planned to plant trees. Trees planted on ridge. Should only be used on soils with high infiltration rates; otherwise overtopping can occur.
Protection to terraces and disposal of surplus	
Diversion ditch (interception drain or cut-off drain)	Required if watershed slope, infiltration and /or size are such that flow from hillside is too large to infiltrate into the soil and/or to discharge surplus using stone weirs in bunds. Usually diversion ditches are disposed of to natural water course or artificial waterway.
Blind interception drain	Ditch above field which does not drain into waterway. Cheaper then diversion ditch. Could be used where runoff is marginal for construction of diversion ditch.
Artificial waterways	Problem with land shortage and establishment. In parts of Maharashtra drainage lines along with field bunds is practiced.
Field weirs	Any field which is not designed to contain all runoff from between the bunds and fields which have runoff from a field or hillside upslope should have either a graded channel or a waste weir usually made of stone.
Activities on water courses	
Stone gully plug(nala plug)	Loose stone weirs' check dams" to slow down water in nalas and where soil can be provided to enable crop cultivation in nalas. Not possible on nalas with a slope of > 3.5%. Maximum with -6 cm. Gully plugs also act as grade stabilization structures and infiltration
Wooden crib gabion structure	Wooden frame field with large stones. Used on large nalas. Cultivation would not normally be considered in such nalas. Mainly for ground water recharge and stabilization of water course.
Temporary check dams	For gully control where gullies are eating into agricultural land and gully not suitable for cultivation. Loose stone, brush wood, logs or other materials may be used.

Permanent check dams	Concrete, masonry or earth dams to store and slow down water. Only justified in conjunction in with life irrigation scheme. Note that many dams, especially before sediment has formed on bottom will also contribute to ground water recharge. Encourage small check dams. Small earth check dams used primarily for water storage are sometimes also called bandhies (ahar).
Flumes and Chutes	Concrete or masonry structures used at head of serious gullies. Expensive. Only justified where gully threatens valuable cultivates land or buildings.
Vegitation Activities	
Reseeding	Use Perennial and farmer accepted species with deep rooting characteristics and which are good for quick vegetal cover. Use in conjunction with tree planting or on pasture land possibly with stone bunds, Seeds planted in shallow furrow at beginning of kharif season.
Grass Strip	Narrow Strips (1 to 2 m) of grass planted o either pasture, forest or cultivated land. Use on cultivated land only when farmers are reluctant to use bunds or where there is doubt in farmers' ability and willingness to do maintenance. Strips may eventually spread outwards. Silt will eventually be deposited on the strip and form downward sloping terrace. There may be a y need of earth movement for stabilization after a few years. Multipurpose species may also be used for sustainable and substantial return.
Tree	Trees should be planted in upper parts of watershed, especially in conjunction with gradinies or contour trenching. On flatter land, use micro- catchments for tree establishment. Fruit or fodder trees especially valued.
Micro shelter	In irrigated, but arid belt ecosystem, use fast growing plants like coaster to reduce evaporation due to blowing winds. This is particularly for vegetables
Strip cropping	In low rainfall areas (200 mm and less) grow crops along with grass strips as mutually agreed to. Brings stability in bio-mass production.

A' Frame



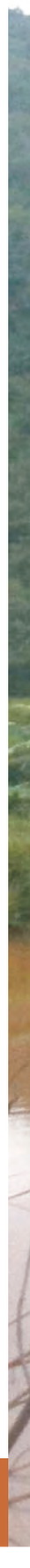
Concluding Remarks

Concluding Remarks

While deeply realizing the need and potential for the development of plateau and hill regions of the eastern parts of India, although we at IGSSS promote priority interventions for the development of these regions, this is an attempt to assimilate our field based learning and learning from other similar organizations and disseminate the same among the practitioners so as to enable them to enhance their knowledge and skills on INRM. The time and effort devoted to develop this handbook shall be best rewarded when some of these are practiced by the practitioners. We have a pool of information related to INRM. Any practitioner willing to receive the same may please contact us.

References:

- Implementing Natural Resource Management projects, A resource book, MoRD, GOI
- Wisdom in traditional Farming System - J Venkateswarlu
- A source book for Soil & water conservation measures, Foundation for Ecological Security (FES)
- Soil Health and Water Quality Issues for Sustainable Agricultural Production in the Eastern Region of India- D.K. KUNDU, B.S. MAHAPATRA, Central Research Institute for Jute & Allied Fibres, Barrackpore, Kolkata-700120, West Bengal, RAVENDER SINGH Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi- 110012 (Vol. 13, No. 1, pp. 1-12 (2013), Journal of Agricultural Physics, ISSN 0973-032X



Indo-Global
Social Service Society

28, Institutional Area, Lodhi Road, New Delhi - 110003
Landline (Direct): +91 11 4570 5025
Website:www.igsss.org
Like us on Facebook: Facebook.com/IGSSS
Follow us on Twitter @_IGSSS