


INTEGRATED NATURAL RESOURCE MANAGEMENT

A TOOLKIT FOR PRACTITIONERS

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A Toolkit for Practitioners

PRADAN
Professional Assistance for Development Action

About us

As a nation, we have achieved food sufficiency, based on our aggregate food grain production, which received a major boost with the Green Revolution that started in late sixties and continued until late eighties. However, the rate of growth of the population and the resulting increase in food grain requirement far exceeded the rate of food grain production in the early nineties. This situation has only become more serious since then. The per capita food grain availability has dropped from about 500 gm per day to about 450 gm per day during first 10 years of the new millennium.

In India, small (< 2 ha) and marginal (< 1 ha) farms account for 82 percent of all holdings, and only six percent of all farms are larger than 6 ha (Ministry of Agriculture, 2006). The per capital land availability has declined from 0.89 hectares in 1951 to 0.37 hectares and it is projected to slide down to 0.20 hectares by 2035. The problem is also acute in populous states like Bihar and West Bengal where per capital land has gone down to as low as 0.07 hectares.

We also need to consider the fact that not all lands are equally productive given the current levels of technology use. Enhancing the productivity of the land owned by the small and marginal farmers is going to be the biggest challenge being faced by the agricultural policy makers of the country in the coming years if we are to address the problems of food insecurity and hunger among the millions.

Most of PRADAN's operations are spread out over the undulating terrains of Agro-Climatic Zone VII and Zone VIII. Special attention is required in devising new approaches and methodologies to rejuvenate the natural resource based livelihoods production systems of the local people. In terms of their demonstrated potential, the technologies and processes adopted to promote Integrated Natural Resource Management (INRM) in these two agro-climatic zones have shown that sustainable livelihoods can be generated from the meager resources owned by majority of the smallholders (about 80% of the total holding).

Enriching local production systems require locally appropriate, thoughtful, and judicious use of technologies. This toolkit presented here by PRADAN, is an effort to provide the new practitioners with references on the basic beliefs, philosophy and social processes, and technologies that helped PRADAN take up INRM as a primary approach to enhance the livelihood of millions of smallholders.

PRADAN's experience of working on the theme of enhancing rural livelihoods in these regions for over 30 years forms the basis for this toolkit. It discusses ways to promote the integrated development of natural resources, which has the potential to bring about equitable and

sustainable economic growth and eliminate mass poverty and hunger in the region. Such an approach requires participatory planning, at the level of hamlets and villages, to develop production and management systems suitable to the resources in order to meet people's needs and preferences. The movement of rainwater over time and across space is a key consideration in resource management in such a terrain.

The processes of intervention adopted by PRADAN are:

- Mobilization of the community at the grassroots into women's Self Help Groups (SHGs)
- Livelihood planning, keeping in mind local resources and community skills, and market characteristics
- Help the community to improve production practices; develop and nurture sustainable backward and forward linkages; and deal with emerging sub-sector issues related to the interventions

This toolkit aims at supporting practitioners and other stakeholders interested in promoting rural livelihoods through sustainable management of natural resources. The toolkit will help professionals and practitioners to:

- Develop a conceptual basis of INRM
- Identify opportunities, with an INRM perspective, for livelihoods promotion for rural communities
- Enhance technical understanding of INRM measures
- Plan and implement INRM measures with the help of the community
- Build capacity of the community to utilize and sustain interventions

The toolkit guides implementers in the field by giving detailed descriptions of the various technological measures that are suitable for the different types of lands. It also provides insights into the lives of farmers, who have benefited by adopting these measures. The footnotes provide further explanations of technical and special terms.

Abbreviations

APL	:	Above Poverty Line
BPL	:	Below Poverty Line
CSP	:	Community Service Provider
DAP	:	Diammonium Hydrogen Phosphate
FGD	:	Focus Group Discussion
FYM	:	Farm Yield Manure
GL	:	Ground Level
GS	:	Gram Sabha
HI	:	Horizontal Interval
HLA	:	Hamlet Level Association
HYV	:	High Yielding Variety
INRM	:	Integrated Natural Resource Management
IT	:	Individual Task
MB	:	Measurement Books
MRP	:	Maximum Retail Price
NPK	:	Nitrogen Phosphorous Potassium
PEC	:	Program Execution Committee
PI	:	Peoples Institution
PIA	:	Project Implementing Agency
PoP	:	Package of Practices

PPT	:	Power Point Presentation
PRADAN	:	Professional Assistance for Development and Action
PSB	:	Phosphate Solublizing Bacteria
RMP	:	Resource Management Plan
SC	:	Scheduled Caste
SG	:	Sub- Group
SGA	:	Small Group Activity
SHG	:	Self Help Groups
SRI	:	System of Rice Intensification
SRTT	:	Sir Ratan Tata Trust
SSP	:	Single Super Phosphate
ST	:	Scheduled Tribe
VCC	:	Village Core Committee
VDC	:	Village Development Committee
VDF	:	Village Development Fund
VI	:	Vertical Interval
VLA	:	Village Level Association
VRP	:	Village Resource Person
WDC	:	Watershed Development Committee
WDF	:	Watershed Development Fund
WHS	:	Water Harvesting Structure
WHT	:	Water Harvesting Tank

Preface

PRADAN (Professional Assistance for Development Action) is a voluntary organisation registered under the Societies' Registration Act. PRADAN works in selected poverty pockets across seven states of India's through small teams based in the field. Our focus is on working with the rural poor to improve their existing livelihoods and promote new ones. This involves organising the people, enhancing their capabilities, introducing ways to improve their incomes and linking them to banks, markets and other mainstream economic services.

PRADAN comprises a group of motivated professionals who use their knowledge and skills to alleviate poverty in rural areas by working directly with the poor. PRADAN's 36 decentralised project teams, comprising 398 development practitioners trained in management, engineering, agriculture, social sciences etc, follow a four-pronged approach:

- Promoting Self-Help Groups (SHGs) of women in geographically compact clusters, and strengthening them as organisations to meet members' need for small flexible loans and to leverage institutional finances for livelihood;
- Developing and introducing locally suitable economic activities to increase productivity and income among SHG members;
- Mobilising finances for creating livelihood assets and for infrastructure development from government bodies and banks;
- Setting up mechanisms to sustain the livelihood gains made by poor people. Land, water, livestock and forests are the main resources available to poor people. There is considerable potential to increase the productivity of these, to diversify into more remunerative productions systems and to expand the asset base, especially in case of livestock and water resources.

The emerging demand for newer goods and services also presents opportunities to set up home-based enterprises outside the normal traditional farming activities. PRADAN's livelihood promotion programmes can thus be broadly classified into the following sectoral activities:

- Integrated Natural Resource based livelihoods including strengthening land and water infrastructure, promotion of improved agricultural and commercial farming and horticulture.
- Forest-based activities (e.g. tasar cocoon and yarn production, siali leave plate making, lac production, etc.
- Livestock based livelihoods (e.g. diary, goat rearing, etc.)
- Micro-enterprises (e.g. mushroom cultivation, broiler rearing, yarn production, etc.)

Each year, the project teams pilot new activities in several of these areas, and expand the outreach of mature sectoral programmes across locations and families.

Knowledge about how to promote such programmes and the learning's lie scattered amongst individual practioners responsible for programme implementation, and remain tacit. Very little information is available for others to use, in the form of systematic documentation of efforts to promote such activities. This tool kit is an attempt to put this knowledge together in a easy to use format. This tool kit can be used as a guideline for the practioners and can be adopted depending upon the usage and geographical area.

This tool kit has been written by a task force of practioners with rich experience in enhancing household incomes around a specific sectoral livelihood intervention through a process of customized writing workshops and rigorous peer review.

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Introduction

1.1. Context, Challenges and Opportunities

A major proportion of India's poor live in the central and eastern plateau and the hilly regions across the southeastern part of Rajasthan, most of Madhya Pradesh (MP), Chhattisgarh, Jharkhand, South Bihar and western West Bengal. The region falls under the agro-climatic zones VII and VIII (see Figure 1.1).

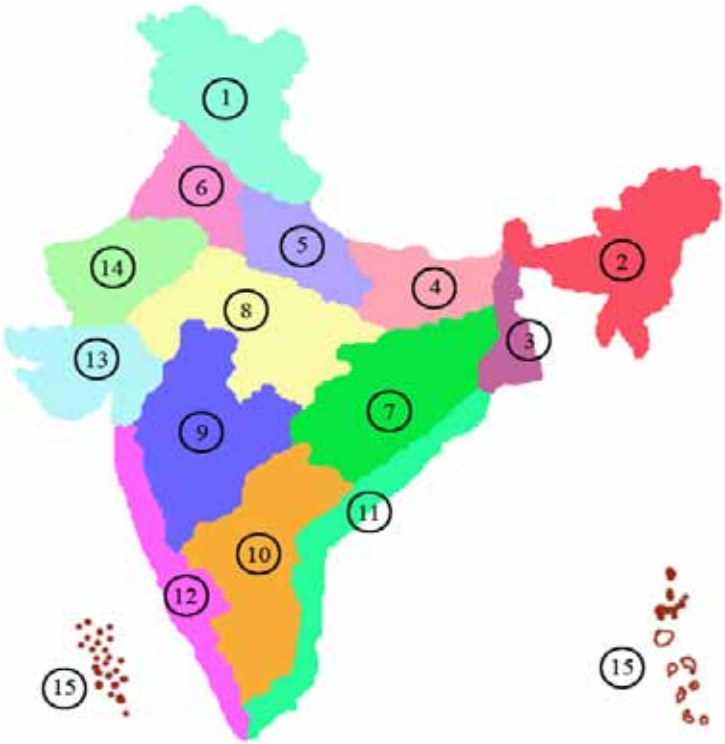


Figure 1.1: The agro-climatic zones of India as worked out by the Planning Commission as part of the mid-term appraisal of the planning targets of VII Plan (1985–90)

1. Western Himalayan Region: J&K, HP, UP, Utranchal
2. Eastern Himalayan Region: Assam Sikkim, W. Bangal & all North-Eastern states
3. Lower Gangetic Plains Region: W. Bangal
4. Middle Gangetic Plains Region: UP, Bihar
5. Upper Gangetic Plains Region: UP
6. Trans-Gangetic Plains Region: Panjab, Haryana, Delhi & Rajasthan
7. Eastern Plateau and Hills Region: Maharastra, UP, Odisha & W.Bangal
8. Central Plateau and Hills Region: MP, Rajasthan, UP
9. Western Plateau and Hills Region: Maharastra, MP & Rajasthan
10. Southern Plateau and Hills Region: AP, Karnatak, Tamil Nadu
11. East Coast Plains and Hills Region: Urissa, AP, TN,& Pondicheri
12. West Coast Plains and Ghat Region : TN, Kerala, Goa, Karnatak, Maharastra
13. Gujarat Plains and Hills Region: Gujrat
14. Western Dry Region: Rajasthan
15. The Islands Region: Andman & Nicaobar, Lakshya Deep

The broad features of these zones are given in the following table.

Table 1.1: Features of various economic zones

Parameter	Features for Agro-climatic Zone	
	VII	VIII
Annual rainfall (mm) Range	1200-1400	500-1600
Rain-fed cultivated area (1000 ha)	11,803	19,012
Average maximum temperature (ºC) in summer	32	35
Average minimum temperature (ºC) in winter	20	16
Name of representatives state	Jharkhand, Odissa and western part of West Bengal	Madhya Pradesh, Rajasthan
Soil type and terrain condition	Sandy, red and yellow, shallow soil with undulating topography	Mixed red and black, red and yellow, medium black alluvial. Ravenous lands and soil erosion
Cropping systems	Rain-fed: Rice-fallow, rice-linseed/lentil, rice-horse Gram/green gram. Irrigated: Rice-wheat, rice-mustard	Rain-fed: Fallow-wheat, fallow-mustard, Fallow-gram Irrigated: Soybean-wheat, rice-wheat

The regions have the following similarities in terms of the nature of livelihoods, extent of poverty and broad developmental challenges.

1. The population density is comparatively low, with a high percentage being rural and tribal population.
2. Most districts here have more than 30% of BPL families which is more than the national average. Three-fourths of India's tribal people, who live here, are below the poverty line.
3. The economic relationships are more egalitarian, with less sharp disparities, a lower percentage of landless and with the average holding size of around 1 ha. (The national per capita average is 0.19 ha)
4. Most of the region receives an annual rainfall of more than 800 mm; more than 80% of the rainfall occurs during 60–70 days of the four monsoon months.
5. Agriculture is the mainstay of the families here, with about 80% of the population being dependent on agriculture for their livelihood.
6. The irrigation coverage is between 20% to 30% of the net sown area whereas the national average is 36%. There is limited scope for large and medium irrigation projects due to the nature of the terrain.

7. The regions are devoid of well-developed aquifers and are often underlain with impervious substrata. The terrain, however, is criss-crossed by many seasonal and perennial streams and has many dispersed sites for harvesting rainwater on a small scale. These water resources remain largely untapped.
8. The combination of an undulating, hilly terrain and high rainfall causes soil erosion and drought in many parts of the area because of less storage available, and poor land and water management. The map below (Figure-2) shows that a greater part of these regions falls under severely eroded areas. In addition, it produces high micro-ecological variability in the region due to the drainage and accumulation of rainwater. One encounters diverse conditions with regard to soil, slope, water availability, soil depth and so on within the boundaries of even the smallest village. Though there are variations across upper-, middle- and lower watersheds, the overall pattern repeats itself in micro-watershed after micro-watershed, village after village—that is, *dry uplands with shallow soils, dry upper midlands with deeper soils, seasonally wet lower midlands with deep soils and wet lowlands or valleys with deep soils.*
9. In the absence of irrigation and other means of water control, agriculture is almost entirely rain-fed and mono-cropped and, thus, is an uncertain enterprise characterized by low levels of productivity, low input uses and poor crop and resource husbandry. Moisture stress, drought, soil acidity, iron toxicity, unavailability of electricity, high population growth, poor roads, poor input delivery and poor communication infrastructure are the major factors that result in low productivity.
10. There is little diversity in the farm sector, little value addition, and the region is a net importer of most farm products. Crop yields are between one-half to a third of the national average. All indices of agricultural development such as fertilizer consumption, farm credit, spread of high yielding crop varieties and seed replacement are far below the national average.
11. Seasonal migration is a significant source of income for a large section of the population. Because farm productivity is low under the current management regime, farmers often neglect their own fields and migrate to the better-endowed regions during peak farming periods. Women bear the burnt of poverty as homemakers, going hungry when there is less food and bearing the trauma of dealing with hunger when husbands migrate. Children are condemned to relive the lives of parents they are born to.
12. Other well-being indicators, for example, literacy and health are, in general, lower than the national average.

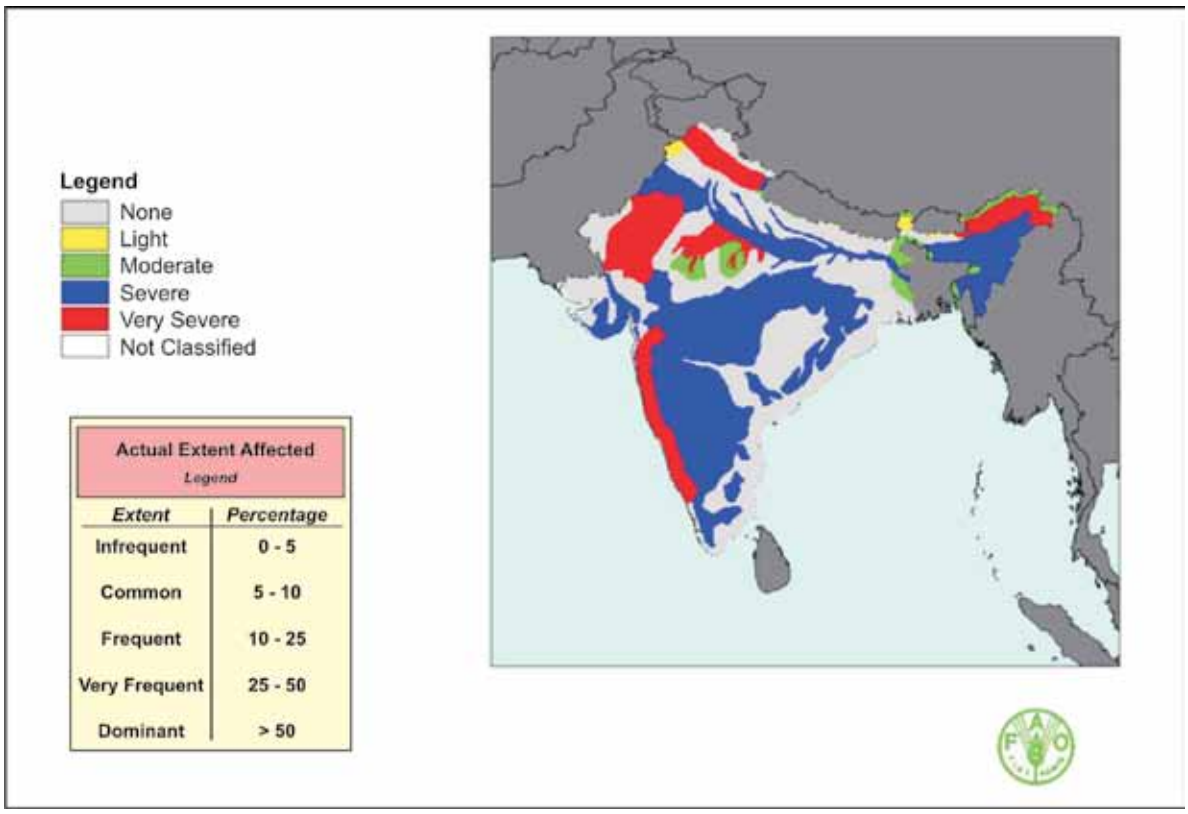


Figure 1.2: Soil Erosion Map of India

Table 1.2: Characteristics, Present Utilization and Problems in Various Land Types in the Central India Plateau Region

Land type	Characteristics	Present Utilization	Problems
Upland	Highest slope, very thin topsoil. Morrum/rocky substrate (often exposed), very low moisture status. Generally not terraced or bunded.	Used for cultivating paddy through direct seeding and millets wherever there is a bit of topsoil. Most part remains fallow. Homestead is used for maize/ vegetable cultivation in private/ government forest.	High erosion due to high slopes and low or no vegetative cover. Low water-retention capacity. Extremely low production.

Land type	Characteristics	Present Utilization	Problems
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. Paddy crop in these lands is highly vulnerable to rain failure.
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 run-off and seepage from upper catchments. Surplus water has to be drained out to ease farming operations in the lower valleys during monsoon.	Long-duration paddy during monsoon.	Land use below potential. Single paddy crop is grown during the monsoons due to the absence of irrigation sources. Water logging and crop damage during heavy rain.

1.2. What is INRM?

INRM is the careful management of land, water, forest and biological resources, considering the linkage between them within a natural boundary called 'watershed' and their linkage with different stakeholders, to achieve and sustain potential agricultural productivity. Its objectives are to bring about economically productive, socially equitable and environmentally sustainable uses of the natural resources.

"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, taking natural processes into account as well. It combines managing the uses of natural resources with conservation. To do this, it cuts across artificial distinctions such as government agency responsibilities, government or property boundaries, industry sectors and scientific disciplines. In defining management areas, it gives priority to the nature over human boundaries, for example, using river catchments or bio-regions as the

primary basis for planning and management." ~ Department of Environment and Heritage, Government of Australia.

The current definition of INRM: "INRM is an approach to research, which aims at improving livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services. In other words, it aims at augmentating social, physical, human, natural and financial capital. It does this by helping solve complex real-world problems that affect natural resources in agro-ecosystems. Its efficiency in dealing with these problems comes from its ability to:

- Empower relevant stakeholders
- Resolve conflicting interests of stakeholders
- Foster adaptive management capacity
- Focus on key causal elements (and thereby deal with complexity)
- Integrate levels of analysis
- Merge disciplinary perspectives
- Make use of a wide range of available technologies
- Guide research on component technologies
- Generate policy, technological and institutional alternatives."

(Source: www.inrm.cgiar.org)

PRADAN defines INRM as "Optimizing the use of the natural resources of an area to maximize the income of a large number of residents, generation after generation."

Promoting INRM-based livelihoods— PRADAN's Experience

PRADAN's focus is to improve the returns from land and water resources in the plateau and hilly regions of central India. PRADAN is working with 2.17 million families impacting their well-being. It has set up a target of ensuring food security for 90% of the target families, and ensuring an income of about Rs 40,000 per annum per family. At the same time, PRADAN will work in such a manner that the productive resources of the family are handed over to the next generation in safe and enriched condition. The modern hybrid- and agro chemical-based agriculture seems inadequate to meet this mission.

Eighty per cent of the agricultural population of the country lives in three major farming systems, namely, **rice-based, rice and wheat-based,** and **rain-fed mixed.** These areas are also the focus of PRADAN's work till 2017. Some of the areas that are included in these farming systems are West Bengal (rice-based), Bihar (rice and wheat-based), and the entire central and peninsular India (rain-fed mixed). There are numerous subsets of these local farming systems, which have evolved over generations, to suit the local conditions. On a large scale, lower access and control over water and soil moisture are the major hurdles to Green Revolution technologies, even if these may succeed on a limited scale.

Considering the above facts, following an INRM approach for promoting livelihoods among poor families rather than a crop-based approach seemed more sensible. This would strengthen local farming systems in each of the agro-ecological zones and would provide better foundation to the farmers to exercise diverse choices, including adopting commercial agriculture to take advantage of emerging market. Adopted on larger scale, it holds the promise of rejuvenating each holding and enhancing productivity, thereby taking

the pressure off the local natural resources. The Figure 1.3 below shows a typical terrain of the area; the table 1.2 presents the use and problems in each type of land.

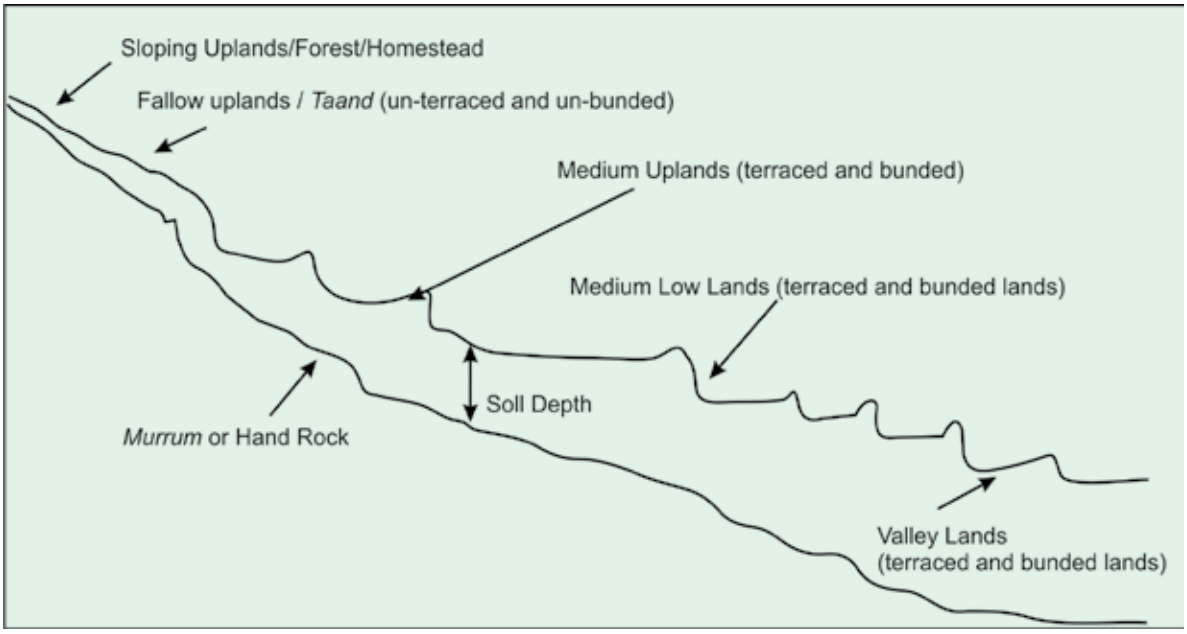


Figure 1.3: Typical Terrain in the AC Zone VII (not to scale)

Chapter 2

INRM Technologies

In order to promote INRM-based livelihoods, a strategy that strengthens the synergy among the three components, namely, family, area and sector, is needed. The process of implementation starts with a visualization by the target families of the *'end state/desired state'* of their villages and the local area (a cluster of say 40 villages). The process then considers both the biophysical (soil, water, etc.) and the socio-economic (food security, gender, profitability) dimensions at the household, village and area levels. Once the vision is established, plotting a roadmap in a participatory manner is easier. The basic unit of all privately owned resources is the household, in which most agricultural production and consumption decisions are taken. Village-level entities take care of the commons and other public resources. Involvement of other stakeholders becomes important at the area and sub-sector/sector levels to bring about bigger change at the community level, scale up and gradually withdraw.

All the elements of a farm, including people, crops, livestock, vegetation, wild life and environment, have social, economic and ecological interactions with each other and, therefore, form a part of the system. Optimizing the use of natural resources at the family level in large numbers will strengthen the local farming system, ensuring increased productivity, environmental sustainability and enhanced family well being. This reduces the pressure on the commons, making it conducive for regeneration/rejuvenation.

Raising agricultural crops (including fodder) and livestock form the other two major components of farming activities. Whereas crops provide food security and seasonal income, livestock generates cash for daily requirements and exigencies. Unfortunately, the productivity of both the crop and livestock enterprises is low and seriously constrained by underdeveloped water resources.

Developing an innovative mix of crops and fodder on small farms through the optimum utilization of available water resources can produce enough fodder to meet the requirement of high-value livestock and generate substantial additional income. Well-managed common property resources in and around villages through appropriate soil and water conservation measures, participation of the stakeholders and establishment of viable management institutions can meet the feed requirements of grazing animals. Each household should keep some animals to recycle its farm waste/crop residue and improve the returns from the farming system. A smallholder can manage two big animals (buffalo or cow) or a herd of 10 small animals and earn an additional Rs 5,10,000 per annum. The promotion of improved rain-fed fodder (dinanath, stylo, glyricidia, etc.) cultivation on wastelands and degraded forest lands and the promotion of dual-purpose maize on private uplands can help meet any shortfall of feed and fodder. Encouraging such integrated and intensive farming systems will increase job opportunities, to absorb the many underemployed job seekers in the area.

Let us take a case in example:

The available resources for an average small-holder family (assumed):

- Land Resources
  - Upland (Class-IV): 0.5 hectares
  - Medium Upland (Class-III): 0.30 hectares
  - Lowland (Class-I and II): 0.20 hectares
- Human Resources
  - Two working adults
  - Two children
  - One old Person
- Livestock
  - A pair of scrub animals

Given the above available resources, the options that the family might have for utilizing their resources in an optimum manner are:

Table 2.1: Options for Land Use in Different Seasons

Area Available (in Ha)	Options for Land Use in Different Seasons			Envisaged Output (in Rs)		
	Kharif	Rabi	Summer	Kharif	Rabi	Summer
Upland 0.50	Horticulture: 0.20 ha + inter-crop: vegetables/ non perishables (such as turmeric)– 0.10 ha Pulse/oil seed: 0.10ha Trees: 0.10 ha Legume hedge Water body: 0.10 ha	Vegetables: 0.04 ha		6,000 (average/yr, considering 10 years production) + 5,000 2,000 2,500 (average/yr, considering harvesting in 15 years)	5,000	
Mid–upland 0.30	Paddy/maize/ soybean Water harvesting in 0.02 ha land Bio-mass recycle	Pulse/oil seed 0.30 ha	*Green manure (Dhaincha: Sesbania bispinosa)*	1.2 Tons paddy/ equivalent	15,000	
Lowland 0.20	SRI Paddy Green manure 0.008 ha land under farm pond that captures subsurface flow		Veg 0.08 ha Pulse/ oil seed 0.12 ha	1.2 Ton paddy		6,000 6,000

The important fact is that there is significant emphasis on producing for the market and, therefore, production has to be in tune with the demands of the market. Important sub-sectors of the area need to be studied/understood before short-listing the production systems to be established.

A very important step in the management of natural resources is the analysis of the nature, the strengths and the weaknesses of the village and the local area, in terms of major land use and its linkages with sub-sectors and the market. These will guide and subsequently determine the activities to be taken up, to realize the desired impact.

2.1. Activities for INRM

There are a number of activities, which helps in soil conservation and enriching the productivity of each of the land types. Different options/technologies can be used to address the problems on different land types in the short term and long term. INRM technologies may be divided into two types.

2.1.1. Structural measures: These refer to land and drainage line treatment that address immediate issues such as reducing the velocity of water, stopping further erosion of soil, and increasing water (moisture) availability in the soil. These measures involve the construction of different earthen, rocky or masonry structures to reduce soil erosion and conserve or harvest water. These bring quick results but are temporary in nature because these have a limited life, that is, until the vegetative measures are fully effective.

2.1.2. Vegetative measures: These deal with different kinds of vegetation and crop husbandry, to check erosion and sustain productivity of the soil. These long-term, land-use measures help to conserve and improve soil quality, soil depth, biomass content and moisture concentration in the soil. These measures involve plantations of different species, for soil and water conservation. The results take time to show but are permanent in nature. These, especially the grasses, are most effective in combating soil erosion.

Both structural and vegetative measures complement each other in managing the natural resources better and are simultaneously planned and put in place.

2.2. Structural Measures

2.2.1. Land Treatment

Table 2.2 describes different classes of land mostly found in agro-climatic zones I, II, III, IV and V, their characteristics, objectives of intervention, visualized land use and different land treatments.

Table 2.2: Physiography of Land and Treatment

Land Capability Classification	I	II	III	IV	V
Slope in % [1]	**<1**	**1-3**	**3-5**	**5-15**	**15-25**
Erosion[2]	None to slight sheet erosion	Slight sheet erosion	Moderate rill erosion	Severe small gullies	Very severe gullied land or sand dunes
Soil texture [3]	Loamy	Loamy	Clayey and loamy sands	Clayey and sandy	Rocky or stony
Soil depth (cm) [4]	Very deep>90	Deep 45—90	Moderate 22.5-45	Shallow 7.5—22.5	Very shallow <7.5
Climatic limitations on soil use and management	Favorable for growing many common field crops	Slight limitation for field crops	Moderate limitation for field crops	Moderately adverse for field crops	Adverse for field crops
Local names	*Beda, Nali, Bohal, Don*	*Kanali, don*	*Dhipa, Baid*	*Guda, Tan, Tora*	*Dungri, Pahar*
Visualized land use	Paddy following SRI principle, gram, green manure in kharif, wheat in rabi and vegetables, pulses, oilseeds in summer season	Paddy following SRI principle, Soybean, gram in kharif; vegetables, pulses, oilseeds in summer season	Paddy, maize, pigeon pea, sorghum in kharif season; grams, pulse and oil seeds in rabi; green manure in summer season	Permanent cover with fruit trees, timber; fodder, perennial grasses; vegetable inter-crop, pulse, oil seed, legume hedge in kharif; vegetable in rabi.	Permanent cover with timber or fruit trees, fodder, perennial grasses

[1] See page no. 13 for description
[2] See page no. 13 for description
[3] See page no. 13 for description
[4] See page no. 13 for description

Land Capability Classification	I	II	III	IV	V
Objectives of intervention	Tap sub-surface water and recycle to irrigate second crop after paddy	Save paddy crop from dry spells by providing life saving irrigation. Improve soil moisture regime	Check erosion and avoid siltation of the water bodies down stream Diversify land use to grow timber/fruit tree or grass Reduce runoff and enhance percolation	Check degradation and avoid siltation of downstream tanks/ponds Diversify land use to have profitable permanent vegetation Retard runoff and enhance percolation	Check erosion through permanent forest cover
Structural measure	Farm pond or shallow well	Farm pond	5% model, field bunding and land leveling	30 x 40 model, contour/graded bunding, gully plugging, WHT	Staggered trench, waterways
Vegetative measure	Intensive crop production with proper soil health management	Intensive crop production with proper soil health management	Crop production, bund plantation	Agro forestry, orchards, silvi pasture	Grassland, contour hedges, fuel wood/ timber plantation

2.2.2. Soil Texture

Soil texture is the relative composition of soil particles e.g. Sand (particle size varies from 2.0 - 0.05 mm in diameter), Silt (particle size varies from 0.05 - 0.002 mm in diameter)and Clay (particles are smaller than 0.002 mm in diameter) in a given soil mass. Depending on the composition, the soil is called Sandy, Clayey, Loamy etc. Loams are made up of a mixture of sand, silt and clay, while sandy loam has more amount of Sand than Clay, and Clayey loams have more proportion of Clay than Sand.

How to identify soil texture:

- Take a handful of soil.
- Add a small amount of water and mix well. Stop adding water as soon as the soil starts sticking to your hand.
- Try to form different shapes as shown, with the sample.

Table 2:3 Soil Texture

Shape		Texture
Soil remains loose and can only be given the shape of a pyramid		Sandy
Can be shaped into a ball that falls apart easily		Sandy loam
Can be rolled into a short, thick cylinder		Silt loam
Can be rolled into a cylinder of 15 cm length		Loam
The cylinder can be bent like U		Clayey loam
The U can be bent into a circle		Clayey

2.2.3. Soil depth

The depth of soil up to which it is made of sand, silt and clay, this facilitates crop growth.

2.2.4. Slope

$$\text{Slope in \%} = \left(\frac{\text{Difference in elevation}}{\text{Horizontal distance}} \times 100\right)$$

This can be measured with a flexible tube water level that comprises two 2 m high staffs and a 14 mm diameter and 14 m long transparent flexible tube (with both sides open). The 2 m long ends of the tube are firmly fixed to the staff and the balance 10 m remains loose in between. The tube is filled with coloured water so that the water level is 1 m high in each of the tube ends. Air bubbles need to be removed by tapping the tube with a finger. It is better to fix a 10 m long rope to the staffs to limit the distance between the staffs and prevent damage to the tube.

Measuring the difference in elevation:

Mark two points along the slope at 10m distance. Place the staffs on those points and measure the height of the colored water at both ends of the tube. The difference of the heights is the elevation difference between the two points. Then measure the horizontal distance between those two points.

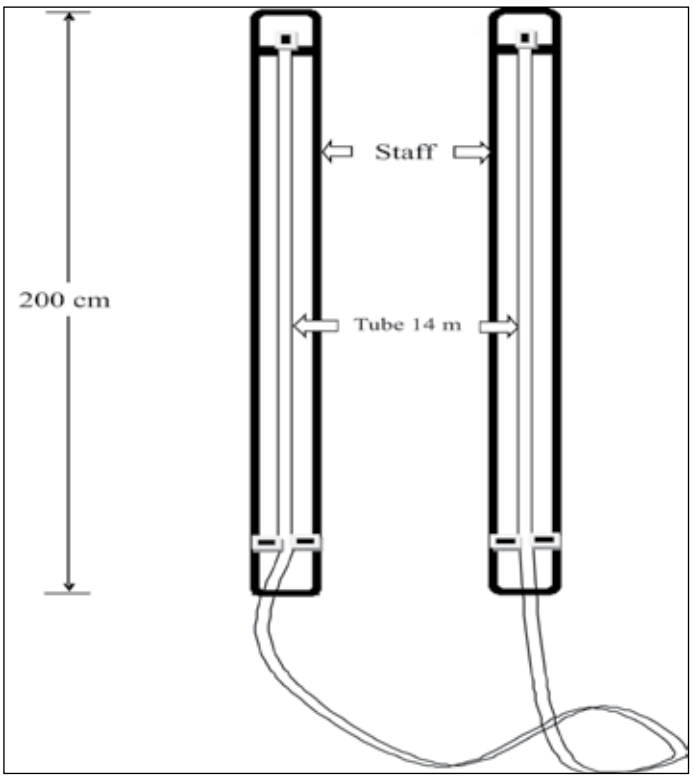


Figure 2.1: Flexible tube water level

2.2.5. Soil Erosion

Soil erosion is the process of weathering and transport action of soild (sediments, soil, rocks and other particles) in the natural environment or their source and depositing them elsewhere. It usually occurs due to transport by wind, water or ice, by down-slope creep of soil and other material under the force of gravity.

Soil erosion is common in areas with steep slopes, where trees have been cut down, in droughts when crops and other vegetation grow poorly and in rural areas which are overpopulated.

Types of Soil Erosion

1. Sheet erosion: In this, a thin layer of soil gets evenly removed.
2. Rill erosion: In this, rain water concentrates in depressions and then begins to flow taking the path of least resistance and making rills.
3. Gully erosion: This is an advanced stage of rill erosion. In this, unattended rills deepen and widen gradually, leading to gully formation. Gullies, if not treated, lead to ravines.

Soil erosion in an area depends upon rainfall, soil characteristics, length of flow, land slope, vegetative cover and structural measures.

This chapter describes various structural measures to conserve soil and water in different reaches of a terrain. For each land type, the treatment is described first followed by a description of the possible land use.

Each structural measure is described with its purpose, design, construction, unit cost and so on. Similarly, for different vegetative measures, the rationale, key considerations for selection of species, estimated cost, rate of return and time-lines are provided.

2.3. Treatment for Land Capability Class IV, V

The purpose of the treatment of uplands is to:

- Check erosion.
- Diversify land use to reduce vulnerabilities.
- Enhance income of poor families through timber/fruit tree or grass plantation.
- Check siltation of the water bodies downstream.
- Enhance percolation to enrich soil moisture regime and augment ground water.

The following figure shows different structural measures in the uplands:

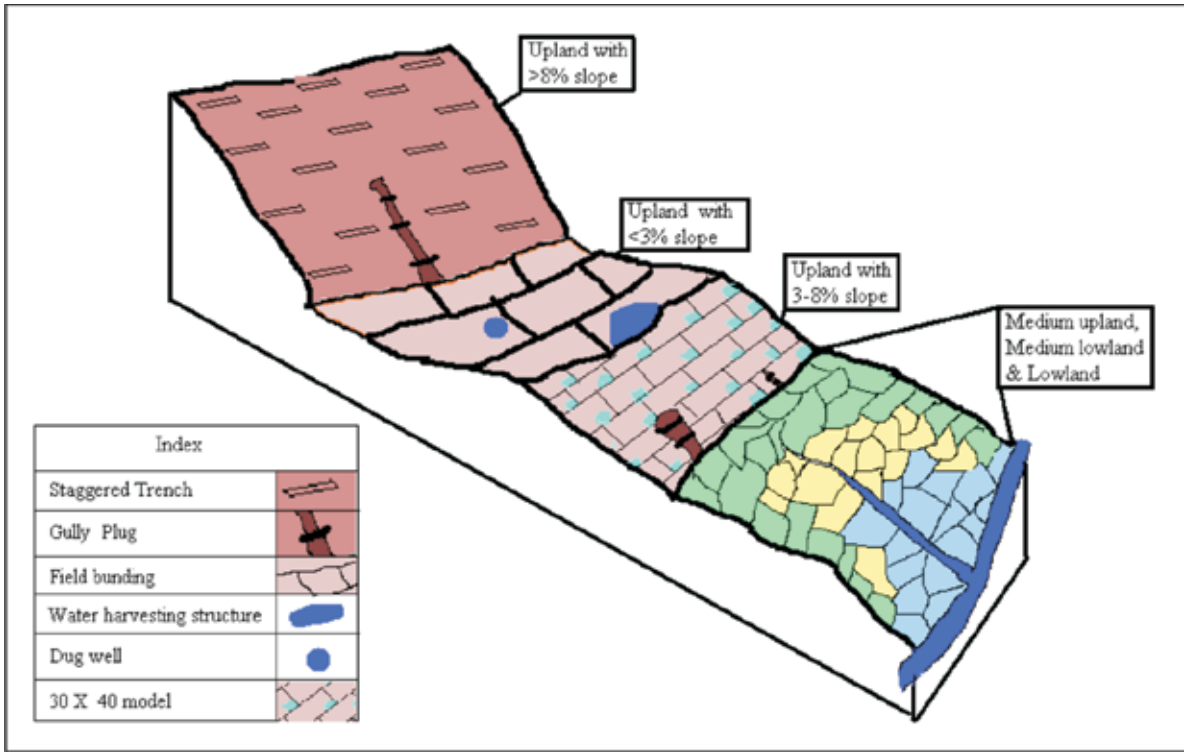


Figure 2.2: Structural Measures in Upland

The following activities have been experimented successfully in the uplands of this agro-climatic zone.

Table 2.4: percentage of slope and structural measures

Slope	Structural Measure
>8%	Staggered trench
3-8%	30 x 40 model, contour bund
<3%	Field bunding, water harvesting structures, dug well

2.3.1. Staggered Trench


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 bunded or terraced to collect runoff during spells of rain. Such a trench allows gradual percolation into the soil mass. It is a low-cost method of soil and water conservation to substitute the conventional measures such as contour bunding/trenching in greater than 8% slope.

Design

The dimensions of a staggered trench would be as follows.

Length of the trench = 1.83 Meters

Width of the trench = 0.62 Meters (Because the depth is only 0.31 Meters, the top and bottom width is almost the same)

Depth of the trench = 0.31 Meters

Total capacity of the trench = (1.83x 0.62 x 0.31) Cubic Meters
= 0.35 Cubic Meters …… (i)

As

Length of the catchment = (1.83 + 1.83) Meters
= 3.66 Meters

Width of the catchment = 1.83 Meters

So, the available catchment area of a trench (See diagram)
= 3.66 x 1.83 sq Meters
= 6.7 Sq Meters

Considering average rainfall in 24 hrs = 0.05 Meters

Available run off in 24 hrs = 6.7 x 0.05 Cubic Meters
= 0.34 Cubic Meters …….(ii)

As (ii) is greater than (i), the entire run off can be collected in the pits.

Process of Construction

A staggered trench comprises shorter trenches (1.83 Meters long) along the contour with 1.83 Meters space between them at suitable intervals (1.83 Meters) to impound the expected runoff from above.

- Draw a line along the longest section of the hill slope with the help of rope and lime. This may be called reference line.
- On the reference line demarcate points at a distance of 1.83 meters down the slope.
- Keep one of the staff (say, S1) of the pipe level on the reference line at the first point, which is 1.83 m away from the top point. The other staff (Say, S2) has to be placed on one side (say, right side) of the reference line at a place so that the reading of the two staffs is same. In that case the two staffs are standing on same height. Demarcate position of S2 with lime. Keep S2 in the same place and shift S1 to right side of the S2 to get another point with same reading. Demarcate position of S1. Repeat this exercise unless you come across a drainage line. Also repeat the same exercise in the left side of the reference line. Now draw a line adding all these points. This is a contour line. Repeat the exercise for all the points at 1.83-meter distance on the reference line to get other contour lines down the slope.
- Locate the trenches directly below one another in alternate rows of contour.
- Place the excavated soil from the trench behind the trench in the form of a bund. Have plantations in the space between the trench and the bund. The bunds may be planted with grasses.

The trench and the bund together act as a barrier to the runoff and check soil erosion. The accumulated water in the trench and behind the bund percolates down the soil to enhance soil moisture, which increases biomass production on the otherwise unproductive lands.

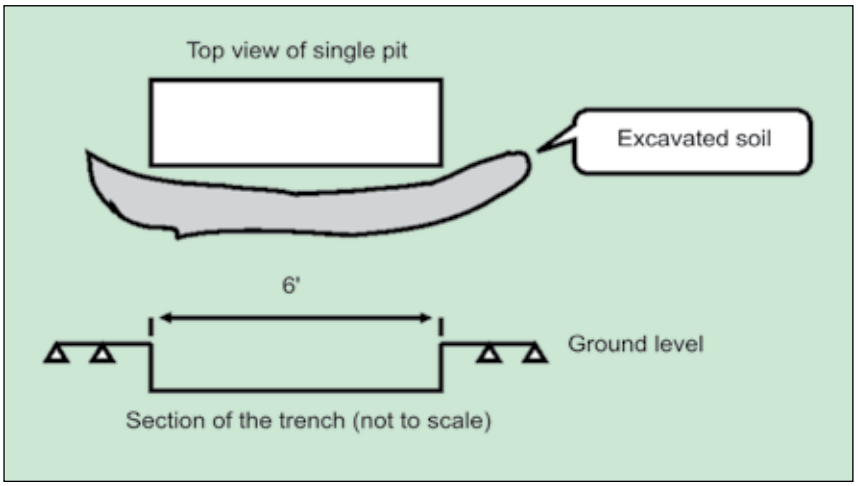


Figure 2.3: Top View of Single Pit

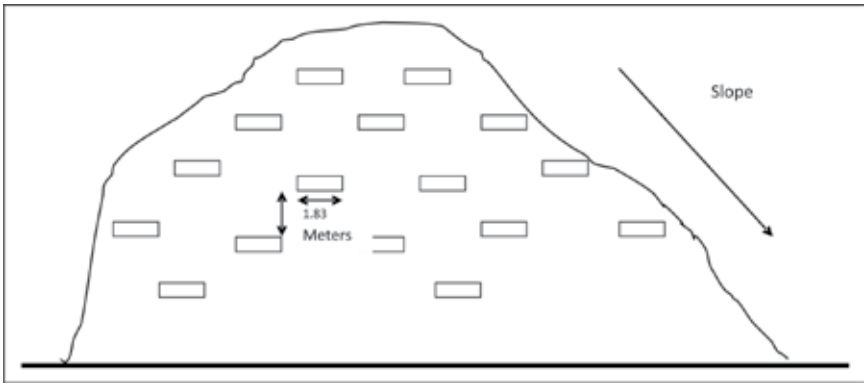


Figure 2.4: Section of the Trench (not to scale)

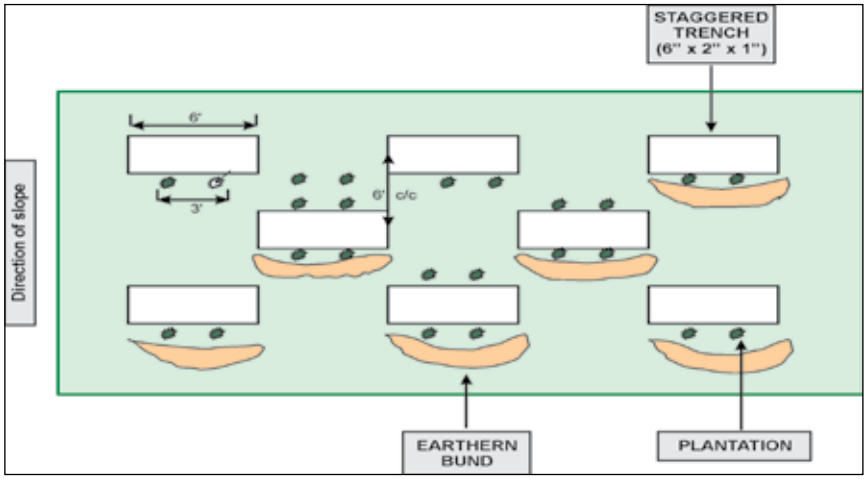


Figure 2.5: Top View of the Trench (Not to Scale)

Time of Construction

It is preferable to begin the construction of the 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. Labour force is thus engaged effectively.

Sample Estimate[5]

For one hectare land

Table 2.5: Calculation of Earth Work

Items	No.	Length (meter)	Width (meter)	Depth (meter)	Quantity (in cum)
Earthwork in cutting and placing soil on the down side of the trench.	1493	1.83	0.62	0.31	525.13

In the eastern plateau and hilly regions, the percentage of un-bunded and un-terraced barren land is quite large. Due to high slopes, both soil and nutrients erode very fast, making agriculture on these lands uneconomical. People, who own this type of land, can adopt this technique to grow species that can meet their fuel, fodder, fiber and timber needs. Of course, the soil quality determines the type of vegetation that it can support. This technique can also be adopted on common or government land, and only on land which has at least 1-foot deep soil, may be containing gravel[6], that can be excavated manually.

The trench is big enough to store the expected runoff volume. The bunds behind the trenches again provide for additional storage in case the runoff exceeds the average.

Case Study: Staggered Trench

This activity was implemented in a patch of 13 ha named Cherrang Tungri in village Nawagarh. The patch is situated at the ridge of the Shaldaha Watershed of Jhalda-1 block of Purulia. Treating the patch to check soil erosion became imperative.

Sabai grass was planted immediately after the excavation of the staggered trenches. In the rainy season it was wonderful to see all the trenches filled with water. The grass grew vigorously. The retention of moisture encouraged other grass species to cover the patch and thus soil erosion was reduced considerably.

Within a year, the total scenario changed. Farmers experienced improved moisture status in the medium upland (around 10 ha) below the treated patch. They could transplant the patch with paddy seedlings and found their crop unaffected by a 35-day-long dry spell. They could even get a pulse crop after harvesting the paddy in the month of January.

[5] When preparing a long-term proposal, due provision should be made to accommodate the revision of unit cost.
[6] Gravels are soil particles with diameter more than 2 mm.

Note:
Land treatment with staggered trenches should start from the ridgeline. A diversion channel has to be constructed if, for some reason, the treatment cannot be started from the ridgeline, to prevent the entry of the runoff from above into the treated patch, and to dispose it off safely.

2.3.2. Contour bunding

Contour Bunding

A contour bund is a simple and low-cost method of checking the velocity of runoff in the *un-bunded* and un-terraced slopes near the ridge area of any watershed. These are suitable for lands with slope in between 3% to 8%. This is a *bund* constructed along the contour lines, an imaginary line that joins points of equal elevation, because it is designed to harvest most of the runoff, it suits an area with permeable soil and below 600 mm annual rainfall.

Design

The rainfall pattern and the vegetative cover of the land should be known. The vertical interval, V.I., between two successive bunds must be designed in such a way that the velocity of the runoff does not exceed the erosive velocity[7] of the soil.

The V.I. between two successive bunds is calculated by applying the following formula.

V.I. = 0.305 (XS+Y),

where.

S = Slope of the land in percentage

[7] The velocity of runoff that removes the soil particles of a given soil is called the erosive velocity of that soil. It depends on the type of soil and the soil cover.

X = Rainfall factor = 0.6 for 625-875 mm rainfall

= 0.8 for < 625 mm rainfall

= 0.4 for > 875 mm rainfall

Y = Soil infiltration and vegetative cover factor = 2 for significant vegetative cover

= 1.5 for average vegetative cover

= 1 for poor vegetative cover

Note: *Vertical spacing can be increased by 10% or by 15 cm to provide better location, alignment or to avoid any obstacle. In case a small strip is left between the last bund and the field boundary, the vertical fall may be distributed in all the bunds rather than in the last bund.*

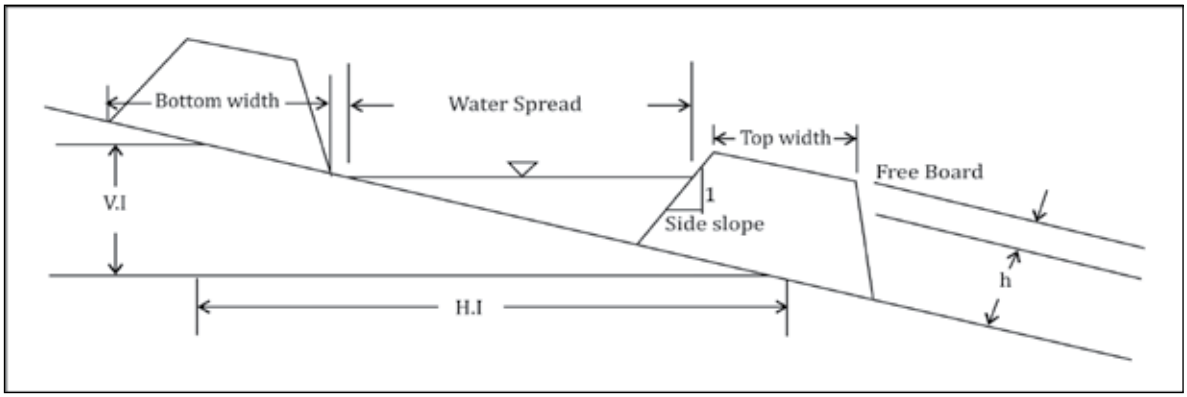


Figure 2.6: Cross Section of Contour bunds

Horizontal Interval (H.I.) between two successive bunds:

H.I. = 100 X V.I./Slope (%)

The bund is designed to hold back the maximum depth of rain occurring in a single rainfall. So the height of the bund = (2 X HI X depth of rain/[side slope + (100/S)])^0.5

In practice, 25% more is added to the bund height as free board and the bund is designed to harvest 2" of rainfall in the area above it.

Table 2.6: Side Slopes Recommended for Different Soil Types

Side slope	1.5:1	2:1	2.5:1
Soil type	Red gravel	Light sandy loam	Sand
	Light red loam	Black cotton soil	
	Black loam	Clay	
	White gravel	Soft decomposed rock	

Area occupied by bunds per ha *(in sq m/ha)* = 10,000 X (Top width + 2 X side slope X bund height)/H.I.

The top width is normally kept 0.3 m

So the earthwork in *bunding* per ha = (top width + side slope X bund height) X bund height X 10,000/HI

Process of Construction

1. Measure the slope in different parts of the ridge area.
2. Mark out areas with slope less than 8%, for laying out contour *bunds.*
3. Begin with the longest section in the area. Now, draw a straight line with wet lime from the top of the slope to the bottom of the slope.
4. On this straight line, mark points at the decided interval between the successive contour *bunds.*
5. Starting from each mark, demarcate the contour line as discussed in *Staggered Trench* part.
6. Make *bunds* along these contour lines.
7. Depending on the specific conditions (such as thick vegetation, rocks, etc., along the contour), gaps between the contour *bunds* may be adjusted.
8. Undertake appropriate plantations, in between the contour *bunds.*

Time of Construction

On fallow land, the work can be started in the month of August so that after the rain the soil becomes soft enough to be excavated. If the plots are covered by the kharif crop, the work can be started in October or just after the harvesting of the crop. Work should be completed before the soil gets too hard in the summer season.

Table 2.7: Earth Work calculation of Contour Bund

For one hectare land with 8% slope				
Rainfall >875 mm				
V.I. between bunds (m)		= 0.305(0.4 X 8+1.5) = 1.43		
H.I. between bunds (m)		= 1.43/8 X 100 = 17.88		
Side slope of the bund		1.5:1		
No.	Items	Top Width (m)	Bund Height* (m)	Quantity (in cum)**
1	Earth work in bunding	0.3	0.45	245
* Bund height = (2 X H.I. X depth of rain/(side slope + 100/S))^0.5				
** Quantity = (top width + side slope X bund height) X bund height X 10,000/H.I.				

Advantages

The *bunds* impound water behind them so that all impounded water is absorbed gradually into the soil for crop use. It serves both as soil and water conservation measures. This structure helps in slowing down the velocity of runoff, checking soil erosion and improving local soil moisture profile.

Note: *This structure is preferable in permeable soil. It is not suited for soils having low internal drainage such as clayey soil. Foothills with gentle slopes and hill surfaces with gentle slopes and good soil depth are treated with this structure.*

2.3.3. 30 x 40 model

30 x 40 model

This is an alternative to contour *bunding* found suitable in high rainfall areas and easier for villagers to construct

What is 30 x 40 model?

The 30 x 40 model is a method of in-situ soil and water conservation, which involves dividing the *un-bunded* and un-terraced uplands with a 3-8% slope into small plots of 30 x 40' (30 ft along the slope and 40 ft across the slope). A pit is dug at the lowest point of each such plot and the excavated earth from the pit is used to make two of its *bunds.*

Design

Length of the plot = 40 ft= 12.195 m

Width of the plot = 30 ft = 9.146 m

Pit

Length of the pit at top = 7ft=2.13 m

Width of the pit at top = 7ft=2.13 m

Depth of the pit = 3 ft =0.9146 m

Length of the pit at bottom = 5 ft = 1.524 m

Width of the pit at bottom = 5 ft = 1.524 m

- Divide and mark the selected area into 30 x 40 ft, starting from the ridge line, with the help of a measuring tape, a rope and lime. The size of the plots may be altered up to +10% to fit to the boundary and ownership.
- Identify the lowest point in each plot.
- Dig a 3 ft deep pit that is 7 ft x 7 ft at the top. The pit should have a sloping wall such that the bottom of the pit is 5 ft 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 1 ft and bottom width of 2 ft.
- Use the rest of the excavated earth to construct the field bund on the side, along the slope.

Time of Construction

If the land is fallow, this work can be started in the month of August so that after the rain the soil becomes soft enough to be excavated. If the plot is under 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.

Table 2.8: Earth Work Estimate of 30 x 40 Model for one Hectare of Land

Number of 30 ft x 40 ft plots =107,584/1200 = 90 (approx.)					
Pit size in each plot = 7 ft x 7 ft (3 ft deep)					
Items	**No.**	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity (in cu m)**
Earth work in cutting and making bunds from the excavated soil					
For the 1st one foot depth	90	2.13	2.13	0.31	126.58
For the 2nd one foot depth	90	1.83	1.83	0.31	93.43
For the 3rd one foot depth	90	1.524	1.524	0.31	64.80

Advantages

Following this treatment, people can use the patch of land to grow their preferred species of plants. The bunds may be planted with grass. This treatment too starts from the ridgeline.

This treatment mainly

- Breaks the velocity of runoff to stop soil erosion (as the water gets arrested before reaching the eroding velocity)
- Harvests the runoff to percolate through the soil slowly, thus improving the soil moisture condition that hastens the growth of vegetation.

Note: *In case it is not possible to treat the area from the ridge, a diversion channel should be constructed above the patch to be treated to safely dispose the runoff to a natural drainage line that otherwise would have entered the patch.*

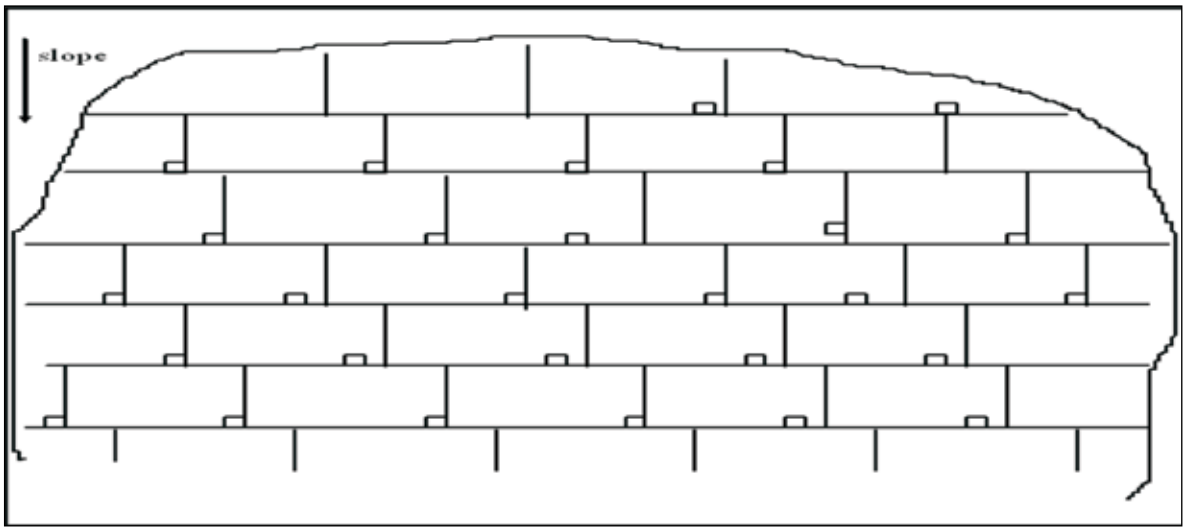


Figure 2.7: Division of uplands into 30 x 40 ft plots

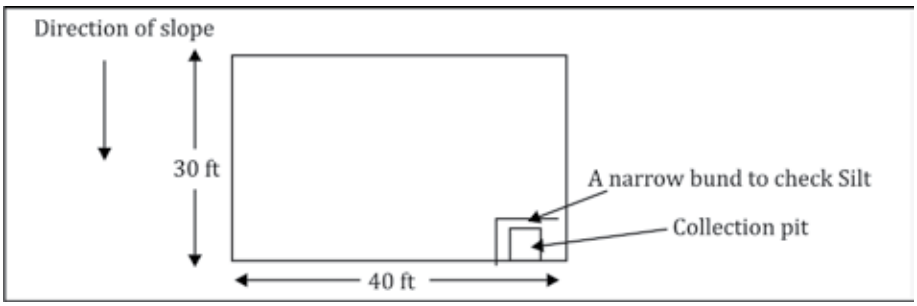


Figure 2.8: Demarcation of pit in 30 x 40 model

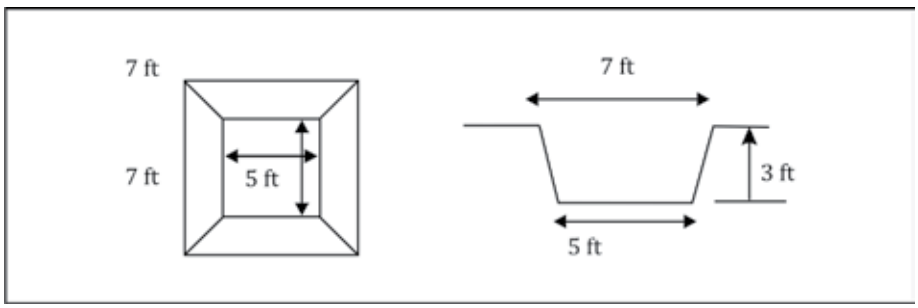


Figure 2.9: A standard pit design

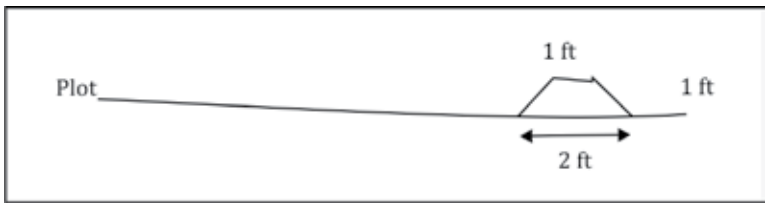


Figure 2.10: Design of the bunds

Case Study: 30 x 40 Model

In the Amagara watershed zone in Barabazar block of Purulia district, a patch of the upland with 10% slope strewn with stones and very little topsoil, was treated with 30 x 40 model. The total land measured 3 ha, owned by seven beneficiaries. After treating the land with the 30 x 40 model, Arjuna (Terminalia arjuna) was planted at a spacing of 7 ft x 7 ft for rearing tasar silkworms as an income generation activity. Arhar (pigeon pea) was also cultivated as an inter-crop in the first two years. Within two years, the piece of fallow land, unfit even for grazing, looked visibly different. Erosion was totally checked, there was grass cover and even the growth of the Arjuna plants was stunning—the plants grew up to 10 ft in two years. From third year onwards, the beneficiaries were able to start tasar rearing, which was completely a new activity. The activity appealed to them because most of the rearing work took place during September and October when there is very little work in agriculture in this paddy-dependent area. In the third year, they earned Rs 12,000 and in the fourth year, even though there was shortage of leaves, they earned Rs 13,000. In the fourth year, when some of the beneficiaries were not willing to rear tasar, four landless families joined the rearing activity.

2.3.4. Field Levelling and Bunding

Field Levelling and Bunding

What is Field Levelling and Bunding ?

Sloping fields are levelled and *bunded* by using either earth or rocks. A *bund* is an earthen or rock embankment made around an agriculture plot to conserve soil and moisture. Rocks are used when easily available and there is a thin layer of top soil. *Bunds* are employed on gentle slopes for the purpose of

preparing level fields. Where the soil is clayey and the rainfall high, the fields are provided with a grade across the slope to drain away the excess runoff. The purpose is to break long slopes into a series of level fields for cultivation, reduce runoff and soil erosion and increase infiltration. People who own undulating land could adopt this technique because it brings about efficient water application to the crops. Irregular, uneven lands do not hold soil moisture and land levelling is necessary to level sloping lands. This helps in increasing soil moisture as well as the uniform distribution of water across the plot.

Design

Spacing: The horizontal spacing of the *bunds* should be such that these are not so close that agricultural operations become difficult. At the same time, the *bunds* should not be so far away as to make leveling difficult. The spacing of *bunds* varies according to the slope. For instance, steeper slopes will result in narrower strips for cultivation.

The following formula is used for determining spacing:

H.I. = 100 x V.I./S

Thus, on a 4% slope, the horizontal distance is determined as follows:

H.I. = V.I./4 x 100= 25 m, assuming a V.I. of 1 m on all slopes up to 12%.

Cross-sections: Height is 65 cm (half of the V.I. + 30% for settlement); top width: 50 cm; side slopes: for earth material, 0.75:1 to 1:1; for rocks: 0.5:1. The cross-section of a *bund* can be calculated roughly as below.

Cross sectional area = ½ X (base width + top width) X Height = ½ X (1.8+0.5) X 0.65 = 0.75m2

Now the *bund* area per ha of land = 10000 X Base width of the *bund*/H.I. = 10000 X 1.8/25 = 720 m2

So the *bund* length per ha = *Bund* area per ha/base width = 720/1.8 = 400 m

Volume of *bund* per ha = Length x C/s area = 400 x 0.75 = 300 m3

In addition, *bunds* are also constructed along the slope with suggestions and preference taken from the land owners. Its volume has to be calculated after determining its dimensions.

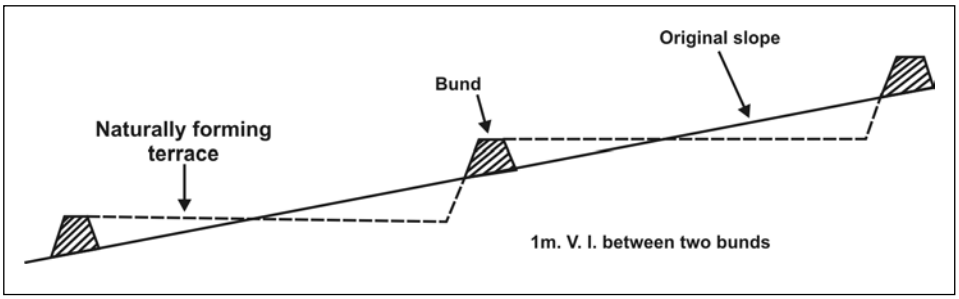


Figure 2.11: Cross Section of Field Bunds

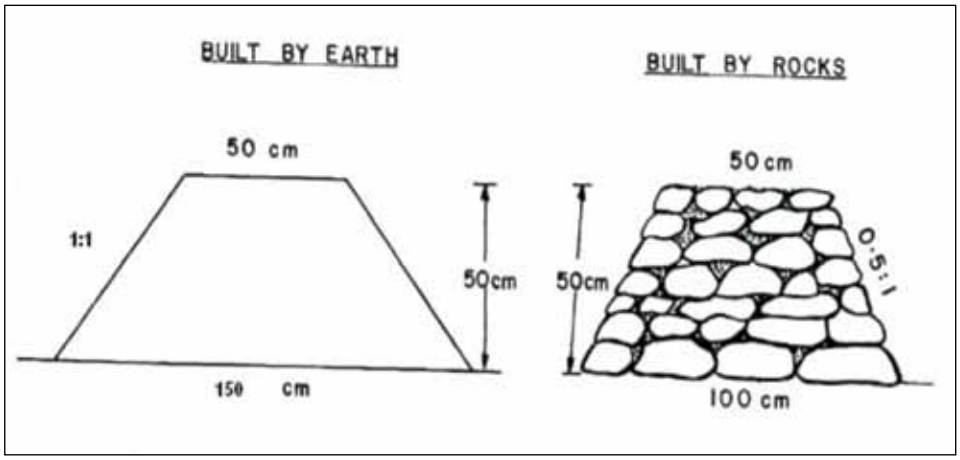


Figure 2.12: Design of a Field Bund

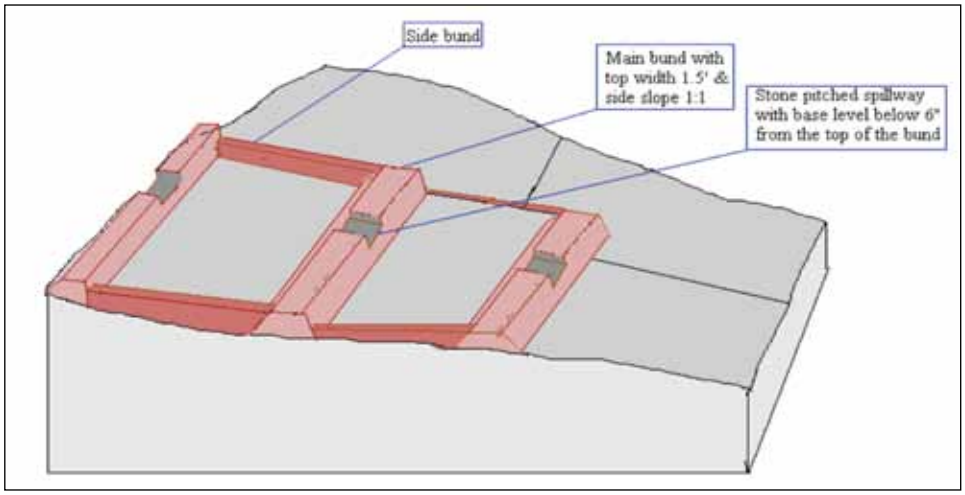


Figure 2.13: Design of a Field Bund

Process of Construction

1. Select a patch for leveling and bunding; plan the boundaries of the plot and the drainage system, considering the ownership and depth of the top soil. The topsoil depth has to be kept in mind when 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" topsoil has to be ensured for crop cultivation. In case of thin topsoil, plots will be of smaller width.

2. Mark the boundaries on the ground along which the bunds have to be laid, with a rope and lime powder. Make the bunds 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 top soil may be kept separately and replaced once the final level of the plot is attained.

3. Construct the bund as follows: The top width of the bund ranges from 0.5-1.5 ft, depending on its height. The side slope is 1:1. The height of the bund will be such that the plot holds enough runoff to maximize moisture conservation without causing inundation. It should at least be of 1' height. Ideally, the bund should be made 30% higher than the design height to provide for settlement.

4. To drain the excess runoff from the field, construct a small surplus escape on the lower field bund with local stones. The top of the spillway should be at least 6" 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.

Refer to the following table to know the width of the spillway (in) for a given area of plot size (in sq mt).

Table 2.9: Width of the Spillway

Plot Area (sq mt)	Spillway Width (mt)
450	0.24
550	0.29
650	0.33
740	0.38
830	0.43
930	0.48

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 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.

Table 2.10: Earth Work Estimate of field Bund

Vertical Interval (VI) between bunds (m)				=	**1**
Horizontal Interval (HI) between bunds (m)				= (1/4) X 100	**25**
Side Slope of the Bund					1:1
No.	**Items**	**Top Width (m)**	**Bund Height* (m)**	**Base Width (m)****	**Quantity (in cum)*****
1	Earth work in bunding across the slope	0.5	0.65	1.8	300
2	Earthwork in bunding along the slope	0.5	0.65	1.8	75
* Bund height = 0.5 *V.I.					
**Base width in 1:1 side slope = 2 *bund height + top width					
*** Quantity = 0.5 *(top width + base width) * bund height *10000/HI					

Advantages

Field leveling and bunding make a plot suitable for agriculture by the

- Uniform distribution of soil moisture
- Retention of soil and manure
- Better drainage and use of irrigation water where available

Note: *Field bunding is generally done in uplands with less than 3% slope, which is to be used for intensive agriculture. The upstream side and mounds of the plot are cut to fill its downstream side, depressions and bunds to almost make a level field. Normally bunds are constructed as per design; the depressions are filled and the plot is left to be leveled through repeated ploughing.*

Case Study: Field Bunding

Lob Singh Sardar of Vikhari Cheliamma village of Barabazar block in Purulia district was a very poor farmer, with food security for only six months in a year. He owned just one acre of land, a portion of which was un-bunded and un-terraced. When the Barabazar Panchayat Samiti was implementing the watershed development programme in the village, Lob Singh was present in the planning meeting. During the options generation exercise, he suggested land leveling of 0.3 acres of his land. In 2000, his land was leveled, costing Rs 2,000. In the same year, Lob Singh harvested 5 quintals of paddy from the piece of leveled land that was earlier unproductive. To Lob Singh, this was a huge benefit because it increased food sufficiency for another four months.

2.3.5. Dug Well


Dug Well

What is a Dug Well?

A dug well is a 30 to 50 ft deep and 10 to 20 ft diameter water source that captures the subsurface flow to irrigate crops. Its depth varies depending on the location. In fact, it is dug beyond the water table in the dry season for year round water supply.

Design

For drinking water purposes, a dug well is located near the habitation. For irrigation, it is located near the fields to be irrigated. A well in the homestead serves both the purpose.

Process of Construction

Dug wells are constructed on uplands, especially homestead lands where agro-horticulture or vegetable cultivation is planned. These wells are circular in shape to provide stability against caving. The wells are dug manually and are lined with stone masonry. It is raised by 3 to 4 ft above the ground.

Time of Construction

It is constructed before the monsoons, in the months of April and May, so as to cut the water table in the dry weather.

Table 2.11: Earth Work Estimate of a Dug Well (15' x 35', 32' below GL, 3' above Ground Level)

No.	Items	Dimension (in Ft)	Quantity (in cubic ft)	Quantity (in cubic meters)
1	Earthwork in excavation			
	a) Up to 5' in ordinary soil	(3.14/4) x 17 x 17 x 5	1135.01	32.14
	b) From 5-10' in hard soil	(3.14/4) x 17 x 17 x 5	1135.01	32.14
	c) From 10-13' in hard soil	(3.14/4) x 17 x 17 x 3	680.69	19.28
	d) From 13-17' hard soil	(3.14/4) x 17 x 17 x 3	680.69	19.28
	e) From 17-20' hard soil	(3.14/4) x 17 x 17 x 3	680.69	19.28
	f) From 20-23' hard soil with blasting	(3.14/4) x 17 x 17 x 3	680.69	19.28
	g) From 23-26' hard soil with blasting	(3.14/4) x 17 x 17 x 3	680.69	19.28
	h) From 26-29' hard soil with blasting	(3.14/4) x 17 x 17 x 3	680.69	19.28
	i) From 29-32' hard soil with blasting	(3.14/4) x 17 x 17 x 3	680.69	19.28
2	Rough dressed random rubble			
	Stone masonry 1:6 cm below GL	3.14 x 16 x 32 x 1	1608.94	45.56

No.	Items	Dimension (in Ft)	Quantity (in cubic ft)	Quantity (in cubic meters)
3	Rough dressed random rubble			
	Stone masonry 1:6 cm above GL	3.14 x 16 x 3 x 1	150.79	4.27
4	Providing cement flush pointing			
	complete job with 1:3 cm			
	I) Inside	3.14 x 15 x 35	1649.37 sq ft	153.23
	ii) Outside	3.14 x 17 x 3	160.28 sq ft	114.89
	iii) Top	3.14 x 16 x 1	50.27 sq ft	4.67

Advantages

Farmer who has the only option to cultivate vegetables in the uplands, the construction of a dug well provides a remedy to the omnipresent demand of irrigation. Experience shows that such a well can irrigate about 0.40 ha of uplands in winter if its upper catchment area is treated to enhance infiltration. Water in the dug wells is used for domestic purposes as well.

Note: *Being costlier than the other structures discussed earlier, precautions have to be taken to select the beneficiary and site. Before digging the well, one should ascertain that there is less chance of a hard rock strata beneath the well construction zone by looking at the adjacent areas. Large diameter (at least 20') community wells are made in the lowlands as well to utilize the higher subsurface flow to irrigate more areas.*

Case Study: Dug Well in the Uplands

Rajesh Mahato of Kenduadih villge of Jhalda I block, Purulia district, was a poor farmer, with food security of nine months. In 2001, he constructed a well on his homestead land with the help of a government subsidy. His homestead land measured 33 decimals. The construction cost was Rs 30,000. Following the construction, he started cultivating potato, sunflower and brinjal on the land. Brinjal has been the most lucrative. In 2005, he sold brinjals worth Rs 12,000 in Jhalda market. In winter, he got another Rs 12,000 by selling cucumber from the same field. Now Rajesh Mahato is considered to be a well-to-do farmer in his village.

2.4. Treatment for Land Capability Class III

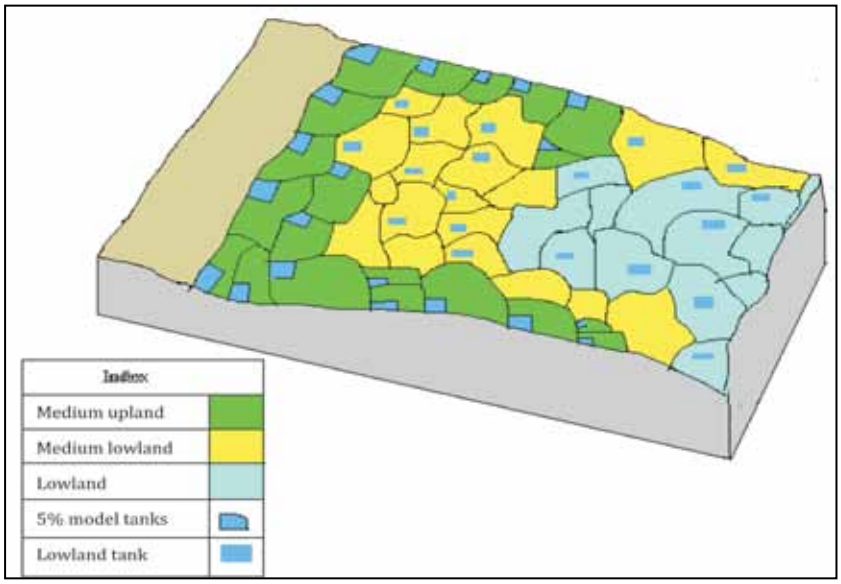


Figure 2.14: Treatments in Medium Upland, Medium Lowland and Lowland

The purpose of treating medium upland is to:

- Save the paddy crop from dry spells by providing life-saving irrigation.
- Increase the soil moisture regime.

2.4.1. 5% Model


Figure of 5% Model

What is 5% Model ?

The 5% model is a model of in-situ rainwater harvesting, suitable for medium uplands. Every plot has its own water body, the area of which equals 5% of the total area of the plot. It is able to hold the rainwater that otherwise flows out of the plot as runoff. The water held in the pit irrigates the plots during water scarcity.

Design

The length is one-fifth of the length of the plot and the width is one-fourth of the width of the plot.

Process of Construction

Measure the length and width of each individual plot.

- Demarcate 5% area of the plot in the following manner. Mark an area one-fifth of the length and one-fourth of the width at the upper right corner of the plot, to dig a pit. For example, suppose, a plot is 150 m long and 100 m wide. So the pit area needs to be 30 m x 25 m or 750 sq m.
- A pit is dug to the following dimensions-Depth: 8-10 ft depending upon the type of the soil; Wall slope: 1:1.
- Use the excavated earth to fill the depressions and strengthen the field bunds.
- Make a small 4" high bund around the pit to keep some standing water in the field.

Time of Construction

The best time to construct this is between December and June.

For a plot size of 0.15 ha

Size of 5% pit = 30 x 27'

(Size of the pit may vary as per the size of plot)

Table 2.12: Earth Work estimate of 5% model (Cutting slope 1:1)

Items	Length (mt)	Width (mt)	Depth (mt)	Quantity (in cum)
Earth work in excavation				
0-2 ft in ordinary soil	9.14	8.23	.6	45.13
2-4 ft in ordinary soil	7.92	7.01	.6	33.31
4-6 ft in ordinary soil	6.71	5.79	.6	23.31
6-8 ft in hard soil	5.49	4.57	.6	15.05
8-10 ft in hard and wet soil	4.27	3.35	.6	8.58

Advantages

This model not only saves the crop in the plot but also increases percolation, to augment water availability downstream. Additionally, this treatment increases a farmer's access to water because there is a storage structure in each of his plots. The farmer can, thus exercise individual choice on how best to utilize it.

The 5% model has been successfully experimented in this agro-climatic zone for these two purposes. The core idea of the 5% model of in-situ rain water harvesting is that every plot should have its own water body to hold runoff that otherwise was flowing out of the plot.

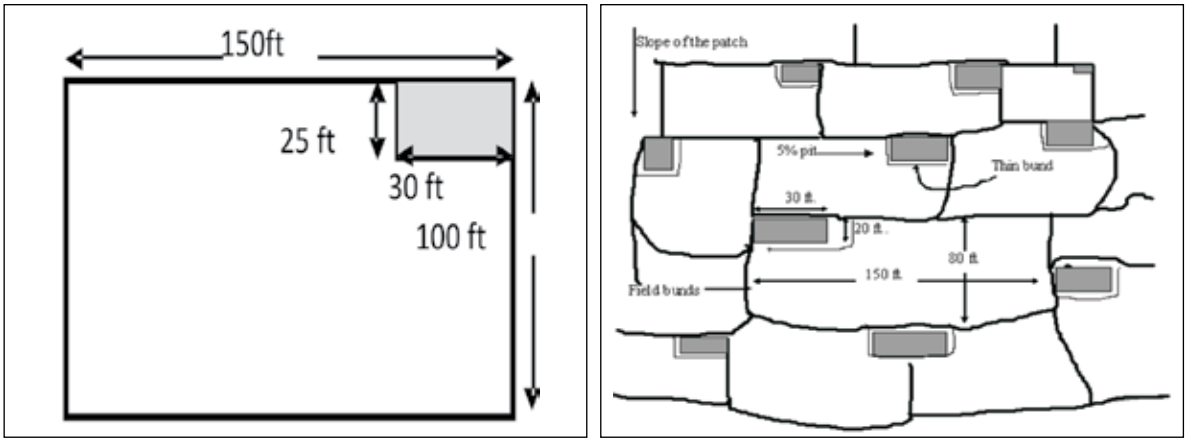


Figure 2.15: Demarcation of the 5% Area and the Location of the Pit

***Note**: This treatment is suitable for a patch of minimum 4 ha with unidirectional slope, where the crop usually fails due to regular water stress. The patch should have good soil cover with moderate porosity.*
The norm for allocating 5% area is not sacrosanct. One needs to consider the land quality and farmers' preferences and other crop plans. A bigger pit is required to store more water. While laying out the pits in successive plots along the slope, one needs to make sure that the pits are not in a straight line but are staggered.

Case Study: The 5% Model

Nepal Chandra Baskey and his brother of Bagmundi block of Purulia district own 167 decimals of land. Their house occupies 23 decimals and the rest is medium upland. Before treatment, they used to grow upland paddy on a 25-decimal plot, reaping a harvest of 2.1 quintals if the rains were good; otherwise they used to get about 1 quintal of paddy. On 40 decimals, they used to grow maize from which they harvested 1 quintal of corn. The remaining 79 decimals were lying fallow; they grew tomatoes, which often failed.

Under the Sir Ratan Tata Trust (SRTT) funded project, Nepal Chandra's lands were treated with 5% model by spending approximately Rs 15,000. A lemon orchard with 275 plants was planted on 70 decimals of his land. In that year, with the water from the tank, he grew tomatoes in 20 decimals, to earn a profit of Rs 6,500; potatoes in 21 decimals, which yielded 6.5 quintals and earned him approximately Rs 2,600); Sem in 5 decimals that earned Rs him Rs 350; and paddy in 18 decimals of land that yielded 1 quintals of paddy. Additionally, he earned Rs 1,000 from lemon. The potential was much higher but he could not find the market for selling it. Although they lost 7 decimals of land to the tank, the earning from the rest was much more than what he was getting from the whole plot. This is remarkable considering that this year there was a drought-like situation in the area.

2.4.2. Lowland Tank

Lowland Tank

What is Lowland Tank?

A lowland tank is a small structure (on an average 1,000 to 1,500 sq ft) with an average depth of 6 to 10 ft cut out in a corner of an individual field on medium lowland and lowland. It captures and recycles the sub-surface flow to irrigate crops. These are made in a series to recycle maximum possible sub-surface flow for enhancing agricultural production.

Design

The average dimensions are 50 ft in length, 30 ft width and about 10 ft depth.

Process of Construction

The design and steps of excavating a farm pond is same as the construction of a 5% pit.

Time of Construction

This work can be started after harvesting paddy and completed before the monsoon. So the best time to construct these ponds is between December and May.

Table 2.13: Earth Work Estimate of Lowland Tank

Items	Length (mt)	Width (mt)	Depth (mt)	Quantity (in cum)
Earth work in excavation				
0-2 ft in ordinary soil	15.24	9.14	.61	83.57
2-4 ft in ordinary soil	14.02	7.92	.61	67.73
4-6 ft in ordinary soil	12.8	6.71	.61	52.37
6-8 ft in hard soil	11.58	5.49	.61	38.77
8-10 ft in hard & wet soil	10.36	4.27	.61	26.98

Advantages

A lowland tank provides water security to the kharif crops thus increasing the yield by at least 1.5 times. In addition, farmers can grow winter and summer vegetables in the land alongside the tanks.

2.4.3. Gully or Drainage Line Treatment

Generally, gullies are formed at an advanced stage of erosion. Therefore, reduction of runoff velocity and bank protection is essential in gully control. In gully control, the following three methods are applied in the order given:

1 Vegetation of gully catchments to reduce and regulate the runoff rates (peak flows)

2 Diversion of surface water above the gully area

3 Stabilization of gullies by structural measures

Table 2.14: Gully Classes Based on Size

Gully Classes	Gully Depth (m)	Gully Drainage Area (ha)
(a) Small gully	Less than 1	Less than 2
(b) Medium gully	1 to 5	2 to 20
(c) Large gully	More than 5	More than 20

For a continuous gully, the main criteria for selecting structural control measures are based on the size of the gully catchment area, the gradient and the length of the gully channel. The various portions of the main gully channel and branch gullies are stabilized by brush fills, earth plugs brushwood, log and loose stone check dams. The lower parts are treated with loose stone or boulder check dams. At a stable point in the lowest section of the main gully channel, for example, on a rock outcrop, a gabion check dam or cement masonry check dam should be constructed. The points where the check dams are to be constructed are determined according to the permissible gradient of the gully channel and the effective height of the check dams. The general standards for selecting control measures for each portion of a continuous gully are given in **Table 2.15.**

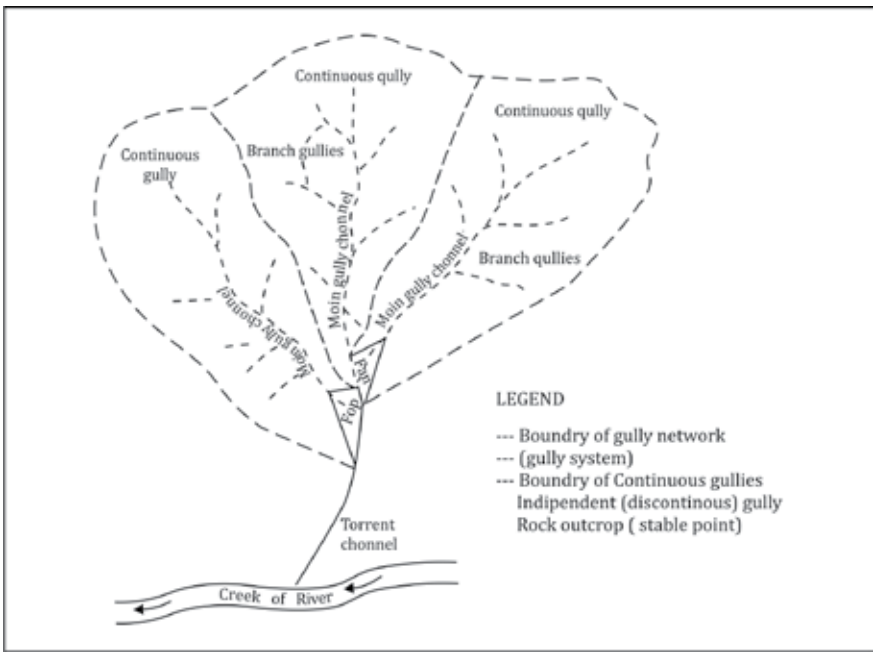


Figure 2.16: A gully network (gully system)

Table 2.15: Criteria for Selection of Control Measures of a Continuous Gully

S. No.	Length of Main Gully Channel Portion	Gradient of Main Gully Channel Portion	Catchment Area of Gully Portions	Required Structural Measures for each Portion of Main Gully Channel
1.	M	%	Ha	
2.	-	-	2 or less	**Above gully head:** Diversion ditches or channels
3.	100 or less (from gully head)	various	2 or less	**Maximum 100 metre from gully head:** Brush 9fills), earth plugs, woven wire, brushwood, log and loose stone check dams. These measures can also be constructed in branch gullies
4.	900	70 or less	2 to 20	**Between 100th - 1000th metres:** Boulder check dams, retaining walls between check dams, if necessary one gabion or cement masonry check dam is usually constructed as a first check dam, instead of a boulder one.

Note : *All structural measures must be accompanied with vegetative measures (plant log) of tree seedlings, shrub and grass cuttings, and sowing of trees, shrub and grass seeds.*

Table 2.16: Context and Purpose of some of the Gully Control Structures

No.	Name of the Structures	Context	Purpose
1	Brushwood checks	Where the local bed slopes are above 20% and adequate raw materials available	Reducing soil erosion, trapping silt, enhancing ground water recharge
2	Loose boulder checks	Where local bed slopes are 5-20% and if boulders are freely available	Same as above
3	Boulder-cum-earth checks	Where local bed slopes are 5-20% and if boulders are not freely available	Same as above
4	Earthen dams	Where local bed slopes are less than 5%	Irrigation
5	Sand-filled bag structure	Where local bed slopes are less than 5% and sand is locally available	Check the velocity of the stream flow

No.	Name of the Structures	Context	Purpose
6	Gabion structure	Where local bed slopes are less than 5% and the velocity and the peak runoff are too high for a loose boulder structure	Reducing soil erosion, trapping silt, enhancing ground water recharge
7	Nalla training	Where the stream embankments have been severely eroded (during peak floods the stream flows over its embankments and damages the fields alongside)	To prevent damage of the fields alongside
8	Underground dykes	Where the impermeable strata are overlain by thin layer of permeable deposits	Harvesting subsurface runoff for irrigation

All structural measures used in gully control must be accompanied with vegetative measures to obtain a sound result. The general principles are:

- After completing the structural measures in the dry season, the accompanying vegetative measures are undertaken during the following rainy season.
- Suitable tree seedlings and cuttings must be planted just behind the structural measures by depositing the excavated earth.
- Tree and grass seeds should be sown between the structural measures, and on gentle, bare slopes that have sufficient soil.

For designing any structure on the drainage line, an estimation of the runoff is required.

Runoff and Its Estimation

Runoff may be defined as the portion of the precipitation that makes its way towards streams, channels, lakes or ocean as surface or sub-surface flow. The estimation of runoff is defined as the process of determining the volume or peak rate of runoff from a given catchment area (watershed). This is required for the design of soil and water conservation structures.

Estimation of Runoff by *Rational Formula*

(used for watersheds less than 1300 ha)

Q = C.I.A/360, where

Q = Peak rate of runoff in m^3/sec for the given frequency of rainfall

C = Rational runoff coefficient

I = Intensity in mm per hour for design frequency and for a duration equal to the time of concentration (Tc)

A = Area of the catchment in hectares

Estimation of 'C'

Table 2.17: Values of 'C'

Vegetative Cover and Slope	Soil Texture		
	Sandy Loam	Clayey and Silt Loam	Stiff Clay
Cultivated land			
0-5%	0.30	0.50	0.60
5-10%	0.40	0.60	0.70
10-30%	0.52	0.72	0.82
Pasture land			
0-5%	0.10	0.30	0.40
5-10%	0.16	0.36	0.55
10-30%	0.22	0.42	0.60
Forest land			
0-5%	0.10	0.30	0.40
5-10%	0.25	0.35	0.50
10-30%	0.30	0.50	0.60

In case the catchment comprises more than one land use and soil types, the average value of 'C' for the catchment is computed as follows:

$$C = \frac{A_1C_1 + A_2C_2 + A_3C_3 + \ldots\ldots\ldots\ldots + A_nC_n}{A_1 + A_2 + A_3 + \ldots\ldots\ldots + A_n}$$

Time of concentration (T_c)

The storm duration, which will correspond with the maximum rate of runoff, is known as the time of concentration. It is defined as the time taken for water to travel as surface flow from the most remote point in the catchment to the outlet.

$Tc = 0.000325(L^3/H)^{0.385}$,

where

T_c = The time of concentration in an hour.

L = The maximum length of flow in meters, that is, from the most remote point to the outlet.

H = The difference in the elevation between the highest point and the outlet in 'm'.

Note: *For a catchment with undulating topography, the ratio (L^3/H) should be calculated at different points, those seem different and remote seem to be equally remote. The highest ratio should be chosen for calculation of T_c*

Estimation of I:

$$I = \frac{10\ K\ T_r^{a}}{(T_c+b)^{n}}$$ where,

T_r = Return Period

Peak discharge is estimated for the maximum storm size in the life of the structure. Return period is the periodicity of occurrence of that storm. For all practical purposes, this can be taken to be 10-25 years.

T_c = Time of concentration in an hour
k, a, b and n are constants.

In Jharkhand, Orissa and the western plateau of West Bengal, the values of k, a, b and n can be taken as follows:,

k = 6.930, a = 0.1307, b = 0.50, n = 0.9284

Hence I (for the duration equal to the time of concentration, and return period of 10 years)

$$= \frac{10 \times 6.930 \times 10^{0.1307}}{(Tc + 0.50)^{0.8737}}$$

For Raipur, k = 4.683, a = 0.1389, b = 0.15, n = 0.9284

For the eastern zone, the representative value is:

k = 6.933, a = 0.1353, b = 0.5, n = 0.8801

For Madhya Pradesh the representative value is:

k = 6.9296, a = 0.1892, b = 0.5, n = 0.8767

The following formulae may also be used to calculate peak runoff.

a) Main Kresnik formula

$$Q\ max = \frac{a\ 32\ A}{0.5 + A^{1/2}}$$

b) Simple Kresnik formula

$$Q\ max = 25\ A^{1/2}$$

Where

A = Catchment area of the gully above the proposed check dam, expressed in square kilometres
Q max = Maximum discharge of the gully catchment at the proposed check dam site, expressed in cubic / second
a = Coefficient (0.6 - 2.0 depending on the land use type)

The simple Kresnik formula gives more suitable results for gullies with catchment areas of less than 20 ha. It can also be used in gully control with maximum 300 ha catchment. The main Kresnik formula gives better results for gullies with catchment areas greater than 300 ha.

2.4.4. Loose Boulder Check Dam

Loose Boulder Check Dam

What is a Loose Boulder Check Dam?

A loose boulder check dam is one of the temporary structural measures for gully control adopted where plenty of loose boulders are available locally. This is constructed in series across the gully bed to stop channel erosion. By reducing the original gradient of the gully channel, it diminishes the velocity of water flow and the erosive power of runoff. It conveys the peak runoff safely. It has a life-span of three to eight years and collects and holds soil and moisture in the bottom of the gully. Tree seedlings, as well as shrubs and grass cuttings can be planted in the gullies without being washed away by flowing water. Thus, it facilitates the establishment of a permanent vegetative cover afterwards.

It is used in 100-1,000 mtrs long gullies with a catchment area of 20 ha or less. In anticipation of the perceived threats of falling and damage to the likely vegetation, the height of the dams is kept low. Check dams are not needed on gully portions that are not affected by channel and lateral erosion due to continuous rock outcrops along their gully beds. These may also be combined with retaining walls parallel to the gully axis in order to prevent the scouring and undermining of the gully banks. Check dams continue functioning if the gully catchment is well vegetated.

Design

Check dams are best placed along the gully in such a way that the top level of the lower one is nearly at par with the bottom level of the upper check dam. However, check dams can be placed along the gully at a gradient of up to 3% called the compensation gradient. The lowest check dam in a gully is at the junction point of the gully and the main stream or river, lake or reservoir. It should preferably be constructed on a stable point such as a rock outcrop. If there is no such stable point, enough precaution has to be taken to make it stronger. The points where the other check dams are to be built are determined according to the compensation gradient and the effective height of the check dams. The height of these check dams above the gully bed is normally kept within 1 m and its foundation depth at least 0.5 m. This means that the top of the check dam, in the middle of the stream, is 1 m above the bed level. Figure. 2.16 shows the placement of check dams in a gully bed.

They are preferably placed on the narrowest parts of the gully in order to reduce construction costs. The thickness of the dam at spillway level is 0.5 metres. As the material used in the check dam has a high angle of repose, the upstream slope of the check dam should be fixed at 1:1 in general, to be varied only in exceptional cases where the structure has to handle very high volume of runoff of high velocity. The downstream slope of the boulder check can vary from 2:1 to 4:1, depending on the volume and velocity of runoff. The higher the volume and velocity of runoff, the flatter is the slope. The downstream slope is given for two reasons:

- To absorb the impact of water that enters the structure at a high velocity
- To drain water from the structure and make it trickle through at a non-scouring velocity

The thickness of the base is computed accordingly. If the above-mentioned dimensions are used, it is not necessary to test the stability of the dam against overturning, collapsing and sliding.

The foundation of the dam is dug so that the length of the foundation will be more than the length of the spillway to enter at least 50 cm into each side of the gully to prevent erosion of the embankment. If the bed of the drainage line has hard rock, the boulder check dam can be constructed without any foundation except for the removal of weathered rock at the top. If there is mud or sand in the bed, this must be excavated up to a maximum depth of 0.6 m to secure an adequate foundation for the check dam. On the downstream side, sufficient (at least 1.5 times the height of fall) length and width of stone apron (floor) needs to be provided to prevent scour. The thickness of the apron may be 0.45 m. The gully sides on both upstream and downstream are protected with stone pitching to a height of at least 0.3 m above the anticipated maximum water level, to prevent damage by flowing water.

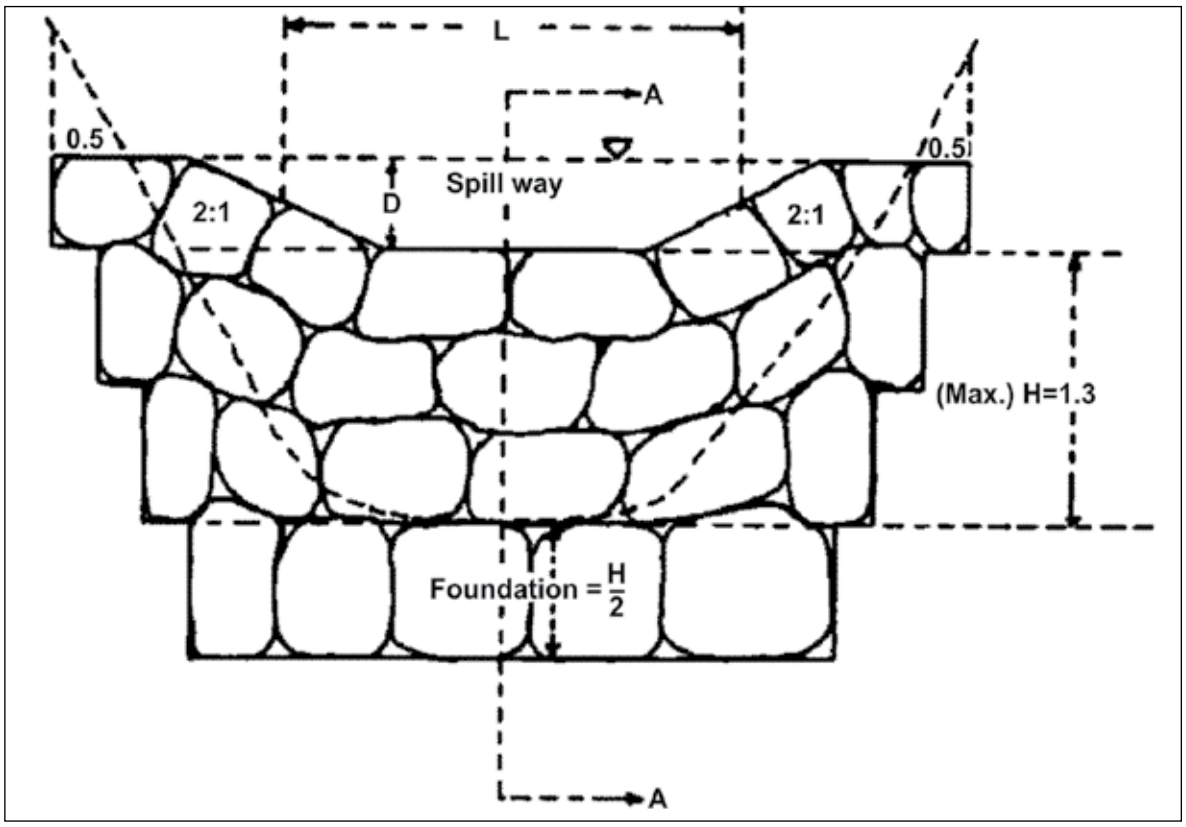


Figure 2.17 Design of Loose Boulder Check Dam

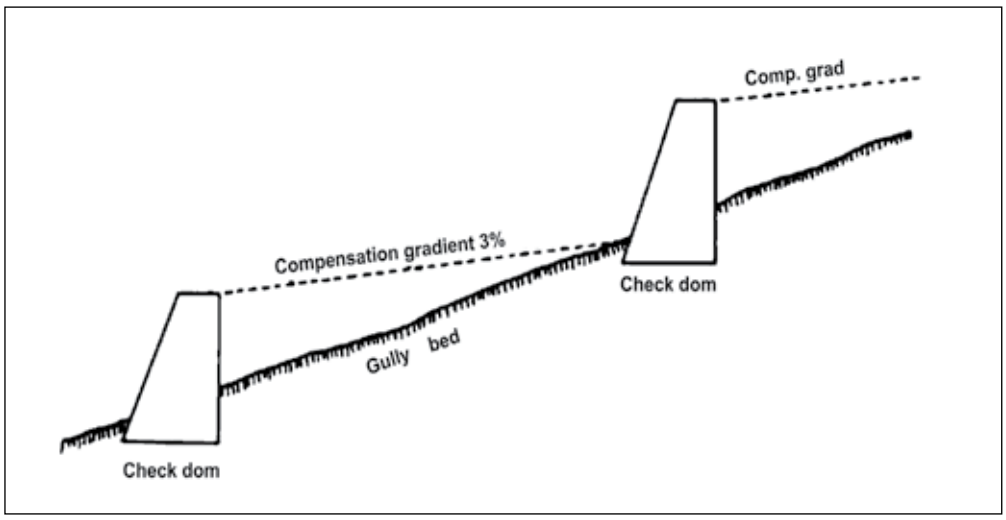


Figure 2.18: Placement of Check Dams along the Gully

The cross-section of the dip (space for passing the runoff) depends on peak channel flow: the higher the flow, the more is the cross-sectional area. The peak channel flow is estimated by using the rational formula. The cross-section of the dip is calculated by using the formula:

$Q_p = CLD^{3/2}$

C = Coefficient, which is 3.0 for loose rock, boulder log and brushwood check dams; 1.8 for gabion and cement masonry check dams

L = Length of spillway in

D = Depth of spillway in, varies from 0.5 to 1.5 m in general

Q_p = Maximum discharge of the gully catchment at the proposed check dam point, in cubic /second.

The spillway form of check dams may be concave, rectangular or trapezoidal (Figure. 2.20). The length of the foundation must always be longer than the length of the spillway to prevent scouring and undermining by falling water. The crest of rectangular and trapezoidal spillways should be level.

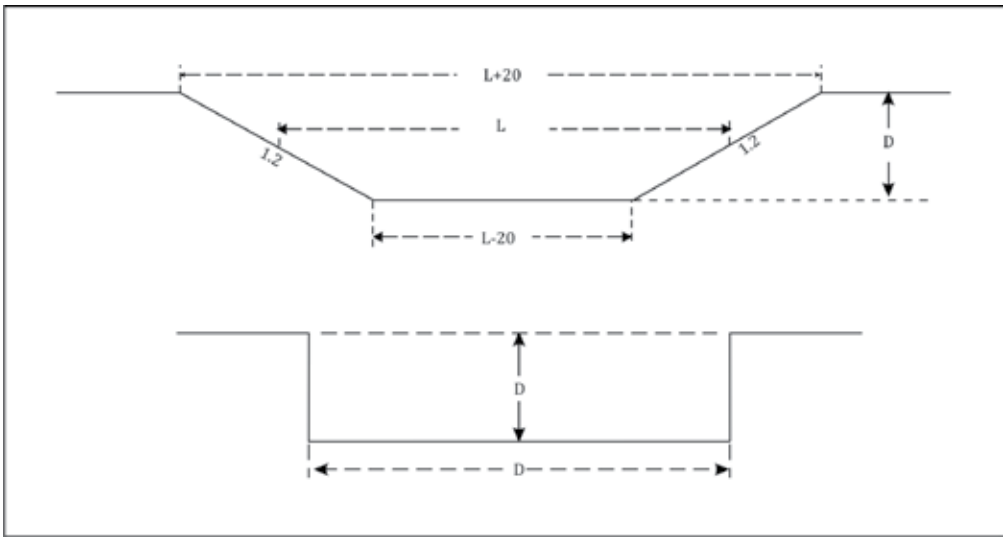


Figure 2.19: Common Spillway Forms of Check Dams-Concave, Rectangular and Trapezoidal

Trapezoidal spillway for loose stone, boulder, gabion and cement masonry check dams. Rectangular spillway for brushwood, log (pole), gabion and cement masonry check dams. Concave spillway for brushwood and loose stone check dams.

General Construction Procedures

The construction of check dams generally proceeds from the bottom to the top of the gully. Gully heads are usually stabilized by building suitable check dams in front of them. The gully's longitudinal profile is an open traverse between the proposed first and last check dams. Proceeding from the bottom to the top of the gully channel, the survey is carried out with the pipe level and a tape to note the slopes and distances. When surveying, materials available at the site should be noted because this will play a part in determining what kind of check dams to build.

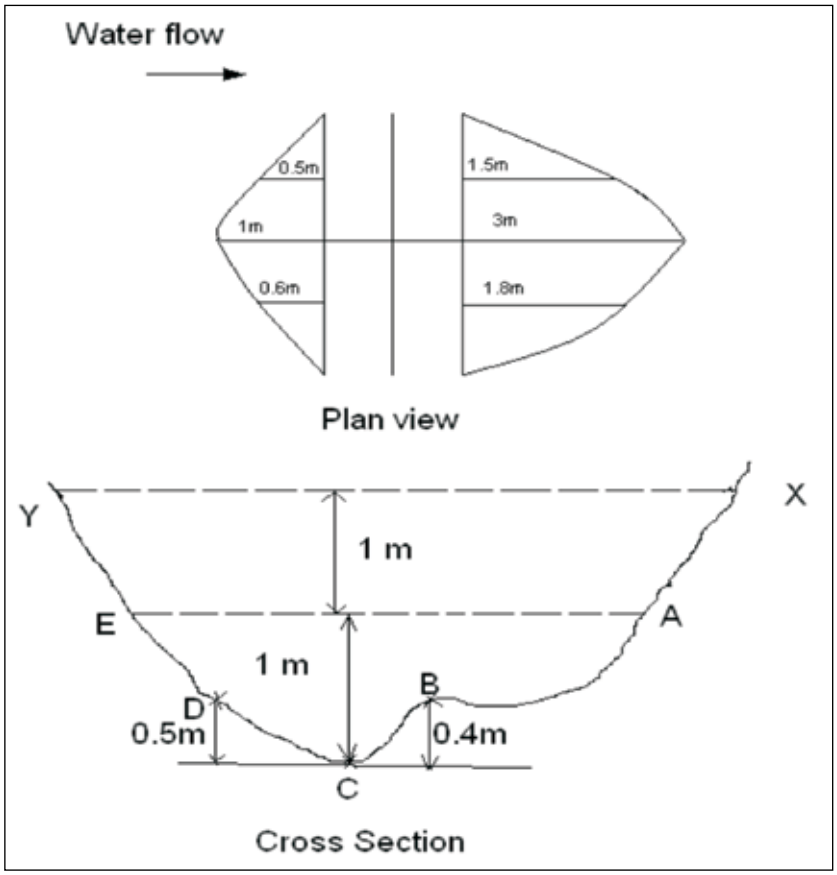


Figure 2.20: Cross–section of a stream at a particular point

Let us now understand how to determine the exact height of a boulder check dam here at each point across the stream.

1. First, place one scale of the pipe level at the lowest point C on the bed of the stream. Slowly, lift the other scale of the pipe level along the embankment.
2. When there is a difference of 1 m (V.I.) between the readings on the two scales, mark this point as A. Similarly, mark point E on the other side of the gully.
3. Take another reading at a point B and D in between A and C, and C and E.

4. All these readings give us the level of these points.
5. Measure the H.I. between these points with a measuring tape.
6. Similarly, fix the top level of the sides of the check dam on both sides by keeping one scale at C and the other at point X first and then at Y so that the difference in readings in both the scales is 2 m.
7. Find the exact design height of the boulder check dam.

In order to find out the exact design height of the boulder check dam from the bed of the stream at any point, one has to subtract the reading of the scale at the point from the reading of the scale at the point C. Table 2.18 plots these heights.

Table 2.18: Height Design of the Loose Boulder Check Dam

Point	Reading of the Scale at the Point (m)	Reading of the Scale at Point C (m)	Height of the Point above C
E	0.5	1.5	1
C	1	1.0	0
D	0.75	1.25	0.5
Y	0	2	2
A	0.5	1.5	1
B	0.8	1.2	0.4
X	0	2	2

Draw a line running through the centre of the proposed site for the boulder check dam till it reaches the points on either side, which are 2 m above the bed of the stream. Naturally, if the embankments are less than 2 m high, this line will only reach till the top of the embankment. From this central line, mark 25 cm on the upstream and downstream sides and draw parallel lines from embankment to embankment. These lines mark the boundaries of the crest. Suppose the slope is 1:1 on the upstream and 3:1 on the downstream. From the centre of the crest line, mark a point on the upstream at a distance of 1 m, along the perpendicular to this line. From the centre of the crest line, mark a point on the downstream at a distance of 3 m, again along the perpendicular to this line.

These points mark the upstream and downstream ends of the boulder check dam, respectively. Draw lines connecting each of these points to the end of the crest lines on both sides. Depending on the streambed conditions, dig the foundation trench to the required depth and the largest boulders available must be placed at the lowermost edge of the check dam on the check dam into the embankment. Along the centre line, after it enters the embankments, dig a trench, which is half a meter wide and half a meter deep.

The trench must extend half a meter beyond the point where the crest of the check dam meets the embankment on both sides. Now the filling begins. The check dam should be raised in horizontal layers. The largest of the boulders must be placed on the outer sides especially on the downstream face. The trenches cut into the embankments on either side of the check dam must also be filled with boulders.

As successive layers are laid out, care must be taken that the downstream and upstream slopes are maintained as per design. Smaller stones are used to fill up the interiors of the check dam. The use of boulders with a diameter of less than 15 cm (or weight less than 1 kg) is avoided. The use of angular stones gives greater stability to the check dam than the use of rounded boulders. Shale, limestone, mud, stone or any loosely cemented rock must not be used because these disintegrate in water. When one reaches the crest of the check dam, one must ensure that the required cross-section of LH is provided for the safe exit of excess runoff.

Time of Construction

Field activities must be planned so that all the construction work is completed before the rainy season. Otherwise, vegetative control measures cannot be undertaken, and the incomplete structures may be washed away.

Advantages

A check dam collects soil and water for the proper growth of the vegetative cover. Loose boulder check dams reduces the velocity of water flowing through the drainage line. By reducing the velocity of runoff, boulder check dams help in:

1. Controlling channel erosion along the gully bed and waterfall erosion by stabilizing gully heads;
2. Trapping the silt carried by the stream to reduce the siltation of the water harvesting structures in the lower reaches.
3. Percolation of surface runoff into the groundwater system
4. Increasing the duration of flow in the drainage line. Therefore, the capacity of the water harvesting structures created downstream on the drainage line is utilized better because they get many more refills.
5. Boulder check dams should not be made at a point where the bed slope of the drainage line is above 20%. This reduces its capacity to hold water and trap silt. The flatter the bed slope, the more will be the storage per unit height of the structure.
6. A boulder check dam should be made where the embankments are strong and stable, and high enough to accommodate the peak flow.
7. No check dams should be constructed where boulders are not adequately available within a radius of 50 m.
8. Maintenance of these must be continued for at least two years after the treatment year. Treated areas must be inspected at least once a year.
9. The trees and grass established in gully catchment areas must be protected against fire, illegal wood cutting, grazing and encroachment. If the re-vegetated areas are properly managed for several years after the treatment, some fuel wood and fodder can be obtained from the plantations.

Note: *Boulder check dams are made in a series along the drainage line, with each structure dividing the total catchment of the drainage line into smaller sections.*

2.4.5. Diversion Channel or Grassed Waterway

What is a Diversion Channel or Grassed Waterway ?

Waterways are constructed to carry runoff from the upper catchments at a safe velocity to a natural drainage line without forming a gully. Waterways are vulnerable to erosion caused by water flow. Many farmers make the waterways too narrow to avoid wasting land; this leads to erosion within them. So waterways should be carefully designed, constructed and maintained to reduce its risk of failure by erosion.

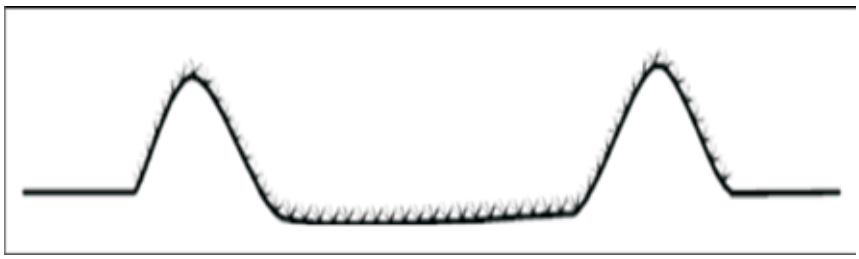


Figure 2.21: A Trapezoidal Waterway

When waterways are constructed to intercept and divert runoff away from agricultural land or habitations into natural drainage or water storages, they are called diversion channels.

Typical uses for diversion channels are as follows:

- Above the patches treated with 30-40 or contour/graded bunding systems to intercept runoff from areas above cropping land and direct it to a waterway
- In strategic locations within cultivated patches, where it is required to divert runoff from entering the low lands and take it through uplands and medium lands before joining a waterway
- To collect runoff from cross road drainage points and direct it to a waterway

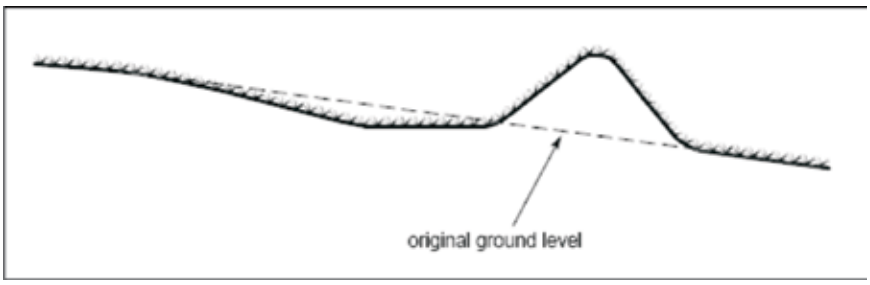


Figure 2.22: Diversion Channel Cross-Section

Design

Waterways are designed by taking into account the size of the catchment area, soil type, land slope and land use. Permissible velocity in a waterway varies for different types of channel bank conditions. A guide to permissible velocities for use in design is provided in the following table.

Table 2.19: Permissible Velocities for Use in Design

Sl. No	Type of Material	Velocity (cm/sec)
1	Soft earth and very fine clay	8 to 9
2	Soft clay or fine clay	15 to 23
3	Very fine or very light pure sand	23 to 30
4	Very light loose sand or silt	30 to 45
5	Coarse sand or very light sandy soil	40 to 60
6	Average sandy soil or good loam	60 to 75
7	Sandy Loam	75 to 85
8	Light ordinary earth or sandy bed	75 to 90
9	Average loam or alluvial soil	85 to 90
10	Firm loam, clay loam	90 to 115
11	Firm gravel or clay	110
12	Stiff clay soil, ordinary gravel soil or clay and gravel	120 to 150
13	Broken stone and clay	150
14	Grass (depending on quality)	90 to 150
15	Course gravel, cobbles, shale	150 to 180
16	Conglomerate cemented gravel, tough "hardpan" or "ouklip". Soft sedimentary rock	180 to 245
17	Soft rock	135 to 245
18	Hard Rock	305 to 460
19	Very hard rock or cement concrete	460 to 760
For lined channels		
1	Boulder lining	150
2	Burnt clay tile lining	180
3	Cement concrete lining	200

Steps Followed in Designing a Waterway

a. Determine the Required Cross-Sectional Area of the Waterway

Calculate the peak discharge, Q, to be carried by the waterway, by using the rational formula. Estimate a safe design velocity (V) from the above table that is appropriate to the channel conditions. Calculate the required cross-sectional area (A = Q/V).

b. Determine the Required Hydraulic Radius of the Waterway

Decide the slope (S) of the waterway. Normally, the prevailing land slope is considered for a waterway, to avoid increasing the cost of construction by providing earth fills and drops.
However, diversion channels are provided with gentle gradients of around 0.5%, to avoid turfing or lining. When grassed, gradients higher than 0.5% can be used. By using the Manning formula, calculate the hydraulic radius for the designed velocity and slope.

$V = 1/n\ R^{2/3}\ S^{1/2}$

where R is the hydraulic radius and

n, the Manning's roughness coefficient, is found from the following table

Table 2.20: Materials to be used

Sl. No	Materials	"n"
Open Channel		
1	With brick side and concrete bottom	0.015
2	Brick lined channels	0.017
3	Rubble masonary, coarse brickwork, earth in good order, very fine gravel, rough concrete, smooth rubble surface	0.02
4	Grassed waterways	0.03
5	Freshly constructed earthen channel	0.035

$V = 1/n\ R^{2/3}\ S^{1/2}$

$V \times A = A/n\ R^{2/3}\ S^{1/2}$

(A= cross sectional area of the channel)

$Q^p = A/n\ R^{2/3}\ S^{1/2}$

(Q^p = Peak discharge)

c. Select a cross-sectional shape and determine the dimensions for the waterway

Normal waterway shapes are trapezoidal. Its cross-sectional area and hydraulic radius are calculated by

A = h X (b+zh) and

$R = A/P = (h \times (b+zh))/(b+2 \times h \times ((1+z2)^{0.5}))$, P is the perimeter of the channel that gets wet due to the flow in it.

where, h = depth of flow in channel

b = base width of the channel

z:1 = side slope (z horizontal and 1 vertical), its value for different kind of soils is given in the table below

Table 2:21 Depth of Soil Layers

No.	Type of the Bank	Up to 2.5 m depth	Between 2.5 and 4.5 m depth
1	Firm rock	01:08	1:8 to 1:4
2	Soft or disintegrated rock	01:04	1:4 to 1:2
3	Alluvial soil, firm gravel, hard compacted earth	01:02	1:2 to 1:1.33
4	Tough hard pan	01:02	01:01.3
5	Ordinary gravel	1.25:1	1.5:1
6	Ordinary earth, soft clay, dry sand, sandy loam	1.5:1	02:01
7	Loose earth, loose sandy loam	02:01	03:01
8	Wet sand	2.5:1	04:01
9	Light sand, wet clay	03:01	3:1 to 4:1

By solving the above two equations, dimensions b and h can be decided.

d. Calculate the constructed bank height

Add 0.15 m to the depth of flow to allow for free board.

e. Calculate the Froude number to ensure that the value is less than unity.

The Froude number can be calculated to check the susceptibility of a waterway to erosion. For safe design, the Froude Number of the design flow should be between 0.8 and 1. Where values exceed 1, it would be necessary to go for channel lining with very high degree of erosion resistance.

Process of Construction

The demarcation for excavating the waterways to the designed dimension and slope are given on the land by lime. First, the centre line of the channel is demarcated on the ground at a slope of S and then the two parallel lines are marked on the ground on either side of the centre line at **(0.5 X b + zh)** distance. Then the channel is excavated to the designed shape and depth.

These are constructed manually or with bulldozers/graders/scrapers. Most often, waterways are located in natural drainage lines to reduce the cost of construction; these are normally constructed in a trapezoidal (as shown in the figure 2.20) or parabolic shape. Suitable grasses are often established on its soil surface to check erosion and are then called grassed waterways. A uniform sod-forming grass having a relatively dense and deep root system offers the best protection against erosion. Villagers' advice should be taken to determine the species. Bends in waterways should be as gradual as possible and, as a general guide, the outside bank on the curve should be given an additional height of 0.2 to 0.3 m.

Whenever possible, topsoil should be spread over excavated channels as part of the construction process, to easily establish grasses. In situations with highly erodible subsoils, it is desirable to avoid disturbing the existing channel. In such cases, the extra flow area is provided by constructing embankments on either side with the soil excavated from the outside.

Time of Construction

Such channels are constructed after the harvest of the kharif crop and before the soil gets too hard in summer.

Earthwork Estimation

Let us estimate the cost of a trapezoidal waterway with side slope of 1.5:1 to carry a discharge of $3m^3/s$ by providing a safe channel slope. Assume that the soil surface has an average grass cover (n = 0.03) and the design velocity is 1.2 m/s.

$A = Q/V = 3/1.2 = 2.5\ m^2$

Now for $2.5\ m^2$ of A, if the bottom width is fixed at 2.25 m and the bank slope is fixed at 1.5:1, the depth of the channel will be 0.75 m.

Now, for this channel, the cross-section will be,

$A = h \times (b + zh) = 0.75 \times (2.25 + 1.5 \times 0.75) = 2.531\ m^2$

The wetted perimeter will be

$P = b + (2 \times h \times (1 + z^2)^{0.5}) = 2.25 + (2 \times 0.75 \times (1+1.5^2)^{0.5}) = 5\ m$

Hydraulic radius will be,

$R = A/P = 2.531/5 = 0.5\ m$

Now, $Q^p = A/n\ R^{2/3}\ S^{1/2}$

So, $S = (Q^p \times n/A \times R^{3/2})^2 = (3 \times 0.03/2.531 \times 0.5^{3/2})^2 = 0.003$

In this case, the channel has to be constructed on a land slope of 3 in 1,000.

Adding a free board of 0.15 m to the depth of flow, the depth of channel comes to 0.9 m.

Top width = $b + 2 \times zh = 2.25 + 2 \times 1.5 \times 0.9 = 4.95$ m

So, the earthwork involved in a kilometre-long waterway is equal to

= {(4.95+2.25)/2}X0.75X1000 = 2,700 m3 **= 95,283 cft**

Advantages

In high rainfall region, some portion of the runoff needs to be safely drained out without causing any gully formation. Diversion channels or grassed waterways are constructed for this purpose. These are even used to carry the surplus runoff from the hills to the storage structures or up lands or medium lands for crop protection.

2.4.6. Small Earthen Dam

What is Small Earthen Dam ?

These are earthen structures constructed mostly across the drainage lines to store water for irrigation, fishery, domestic use or livestock. Their size is usually dictated by the availability of adequate land. In rare cases, one gets to design and build a tank of a desired size to meet the water requirements of the community.

Design

The first step is to work out the water requirement for various needs. The next step is to determine the catchment area above the tank site, from where the runoff will be collected to fill the pond. Thereafter, the location, alignment and height of the earthen bund are decided, as also the location and size of the spillway to evacuate the surplus monsoon discharge.

Unless prescribed for an area, the following general guidelines may be used to determine the water requirements of a village community and the gross storage capacity of the tank.

a. Irrigation: Provide about 0.67 ha meter of capacity for a hectare of irrigation.

b. Animal needs: Provide at the following rates:
   Cattle: 54-68 liters/day
   Dairy cows (drinking + barn needs): 158 liters/day
   Pigs: 18 liters/day
   Sheep: 9 liters/day

c. Domestic water needs: 40 liters per head per day

d. Fish culture: Ensure about 1.85 m depth to provide proper temperature environments.

The storage capacity should be at least double the total water requirement to take care of evaporation and seepage losses. As a rough guide, 10 per cent extra storage may be provided for sediment deposition. For example, if the total annual water requirement is 10,000 cusecs and pond will have only one filling, its gross capacity should be 22,000 cusecs (2 x 10,000 + 10%).

A detailed survey is usually required to estimate the size of the catchment area and the reservoir storage for different water levels. Where the surveys are likely to be expensive or otherwise not feasible, the catchment area can be roughly computed from Survey of India toposheets to the scale of 1:25,000 or

1:50,000. However, for computing approximate reservoir storage volumes, certain rudimentary field surveys have to be carried out, using inexpensive equipment and ordinary local skills.

The para required for computing approximate storage volumes, for different pond levels are:

Channel width B (meters) at the *bund site*

Bank slopes of the channel - n:1 (Fall of 1 m in a length of n meters)

Bed slope of the channel - S:1 (Fall of 1 m in a length of S m along the channel bed)

Depth of water above the channel bed at the bund site - D m

Storage volume is approximately computed by using the formula

$V = (B + nD) \times SD^2/2$

Qualities of a good tank site:

(i) It should be a narrow gorge with a fan-shaped valley above so that a small embankment stores a large volume of water.

(ii) The tank capacity to the catchment area ratio should be such that the pond is filled up in about 2-3 heavy rains. The capacity should not be too small to be choked up with sediments very soon.

(iii) The tank should be located well, to best serve its purpose; for example, for irrigation, it should be above the fields to be irrigated.

(iv) A junction of two tributaries and depressions with sufficient fill material and favorable geology should be preferred. The following soils are unsuitable for construction of tanks:

Saline, alkaline, any soil with abnormal chemistry.

Peat or other soils rich in organic matter.

Heavy clay soil subject to swelling, shrinking and cracking

Very light soils such as sand or loamy sand.

Soil containing a high proportion of fine silt.

(v) It is possible to construct a stable and economical earthen bund on any foundation. However, sites with foundation conditions requiring relatively expensive construction measures should be avoided. A thick layer of relatively impervious material, at surface or at shallow depth, suits the most. They do not need any special measures whereas, in sandy soil, a compacted clay cut-off or key trench is constructed from the surface of the ground into the impervious layer below to prevent failure by excessive seepage.

(vii) The catchment area should be under vegetation or any other conservation practices.

Spillway

The spillway is the structure to pass the surplus runoff or floodwater after the tank is filled. The cost of small earth dams is greatly increased if the spillways have to be constructed with concrete or similar materials. So it is located in a way that the surplus water can be safely discharged over grass-covered spillways. These spillways are placed on one side of the tank, where the bund height is low, provided the surplus can safely be carried to a drainage channel. Alternatively, a pipe spillway can be designed to dispose the surplus runoff.

Spill Way

Peak runoff (Qp) from the catchment above the tank is calculated as explained in the section on gully control structures. The spillway dimensions are worked out by using the formula:

$Qp = 1.7LH^{3/2}$,

where L = Length of the spillway in m and H = Height of water flow above the spillway crest in m.

The ratio of the height of flow above the spillway to the height of spillway should lie between 0.50 to 0.75 for economical spillways, and the ratio of L to H should always be equal to or greater than 2 for a rectangular spillway.

Design of an Earthen Bund

The various components of an earthen bund include (a) foundation, including key trench or cut-off, (b) height of *bund*, (c) side slopes, (d) top width, (e) free board and (f) settlement allowance.

Height of a Bund

The height of a bund depends upon the volume of runoff to be stored and the topography of the reservoir area. The height of the bund should also be selected in such a way that its cost per unit of storage is minimum. While calculating the cost corresponding to any height, allowance for settlement, free board and temporary flood storage during the maximum flow over the spillway need to be made to get the actual bund height.

Free board is the added height of the bund provided as a safety against overtopping of the embankment by waves and flood. It is

(i) 0.5 m for length of backwater[8] up to 400 m

(ii) 0.75 m for length of backwater up to 800 m

(iii) 1 m for more than 800 m long backwater

[8] The longest distance from the dam to the remotest point of submergence, perpendicular to the face of the dam.

Settlement Allowance

This includes the consolidation of the earth in the body of the embankment due to the weight of the *bund* and increased moisture caused by the storage of water. Normally, an allowance of 10% of

Design height is provided for this in a hand-compacted fill. It may be reduced to 5% in the case of a machine-compacted one.

Top Width of Embankment

Adequate top width is provided to the *bund* so that it provides safety against seepage failure and can be used for commuting as well.

Up to 10 m height, Top width = Height/5+2

For 10 to 15 m height, Top width = Height/5+3

Side Slope of the Bund

Adequate upstream and downstream side slopes of the embankment must be provided to satisfy the stability requirements of a reservoir filled with water. The top seepage line that demarcates the saturated and unsaturated zone in an embankment should pass through the base of the embankment. The slope of this line can be taken as 4:1 for all practical purposes. The maximum side slopes recommended in case of small earth dams are given in the following table.

Table 2.22: Maximum Side Slopes Recommended in Case of Small Earth Dams

Depth of Fill (Height)	Side Slopes	
	Upstream	Downstream
Up to 5 m	2:1	2:1
5 to 10 m	(i) 2.5:1 (ii) 3.0:1	2:1 or 2.5:1 2.5:1
10 to 15 m	3:1	3:1

When the fill material comprises more clay and silt, flatter slopes of 3:1 on the upstream is always recommended.

Maintenance

A properly designed and constructed bund is well protected by sod (a type of turf grass)and requires the least maintenance. Particular attention should be given to surface erosion, the development of seepage areas on the downstream face of below the top of the dam, evidence of piping, wave action and damage by cattle and human beings. Corrective steps should be taken in time.

Process of Construction

The following general guidelines are kept in view for the construction of the tank.

i. Mark the layout of the tank with lime on the ground as per the designed base width.

ii. Scrape the upper 30 cm of the soil at the portion of the site where the tank bund has to be constructed, to remove all vegetation, roots and organic matter.

iii. Provide a 1.5 m wide clay-filled bottom key trench with 2:1 side slopes, to give a good bondage with the impervious layer below.

iv. Cut all excavations to 2:1 or at least 1:1 side slopes on the upstream side of the tank to provide for more storage. These should at least be 1 m away from the tank embankment.

v. Lay the excavated soil in horizontal layers of not more than 8 cm at a time to construct the embankment. Sprinkle water over it and compact it.

vi. Install the irrigation outlet (pipes) at the proper level to use maximum possible storage.

vii. Trim slopes to correct angles and use the topsoil and fertilizers to establish a grass cover on the bund quickly. Do not let the trees or bushes come up on the embankment.

viii. The top of the crest should be packed with gravel and provided with a slope on either side, to properly drain out the rains. It may otherwise cause erosion of the embankment.

Time of Construction

The construction should start immediately after the monsoon, when the site is relatively dry. Subsequently, after March, the soils become hard and make it difficult to excavate. Again, it has to be completed before the next monsoon, otherwise it may get washed away.

2.5. Vegetative Measures

Nature has a mechanism to rejuvenate itself. However, new advents and discoveries and headways in science and technology have major impact on biological processes. The destruction of forests and the burning of fossil fuels are the most important factors that have contributed to climatic imbalances. With the advent of medical science, life expectancy went up with a resultant increase in the rate of population growth. To keep pace with the growing demand for food, more forest was cleared to bring land under cultivation. Once the forest cover was removed, it induced loss of the top soil, which in turn reduced the water holding capacity of soil. Once the water-holding capacity was reduced, it affected microbial activities in soil, reducing soil rejuvenation processes. Deforestation also reduced the availability of humus in the soil and created dependency on external inputs.

All this has created a situation where we need to look back into natural processes and see what we can do to reinforce the processes that can sustain growth for millions of years. For ages, no human effort has been invested to increase the carrying capacity of Earth. Human efforts have been limited to exploitation of the carrying capacity built in by nature.

The soil-plant-water relationship needs to be understood in order to work on reinforcing the process for sustained growth.

Water and its importance

- Plants take nutrients in soluble form.
- Water is required for plants for processes such as respiration, translocation of solutes and photosynthesis.
- The availability of water influences all the biochemical and physiological processes in plants, which in turn affects the growth of plants.
- All crops require an optimal moisture regime and any deviation in it results in adverse effects, leading to poor yield and quality of produce.
- Water forms over 90% of the plant body weight.

Soil water or soil moisture is the quantity of water contained in the soil. It is expressed as a ratio, which can range from 0 (completely dry) to the value of the materials' porosity at saturation.

An ideal soil moisture level has to be maintained for better growth, yield and quality of the crops. The manner in which moisture is held in the soil and to what extent it goes into plant system makes a basis of soil water classification.

2.5.1. Physical Classification of Soil-Water

Hygroscopic Water: This is found mostly in a layer around the soil particles in a non-liquid state and as such is immobile in nature. It is present in a 4-5 milli-micron thickness and is held with a tension of **31 atmospheres** or higher. For all practical purposes, it is assumed to be non-available water to the plants.

Capillary Water: This is the available form of water, present in a fluid state, which is held between field capacity (**0.33 atmospheres**) and hygroscopic coefficient (**31 atmosphere**). But when the tension reaches **15 atmospheres** and above, the water movement becomes very sluggish and plants are deprived of their water intake from the soil. The availability of capillary water depends upon the texture and humus content of the soil. The finer the texture of the soil with granular structures and rich in humus content, the greater is the availability of water from capillaries.

Gravitational Water: This water remains only temporarily in the soil till it drains away. It is present in the macro pores and held at a tension of **0.33 atmosphere** or less. Gravitational water results in a loss of plant nutrients from the soil.

Soil Moisture Constants: The following constants are very important in soil-water and plant relationship.

Maximum Water Holding Capacity: This is the moisture saturation stage of the soil when all the pores and capillaries are filled with water. Practically speaking, it is unwise to allow a cropped soil to remain at this level for a very long period because such a saturated condition allows practically no aeration and is consequently harmful to most of the crops.

Field Capacity: This is the soil moisture condition when free water is subjected to move downward because of gravitational pull from a saturated soil and the remaining soil is held at **0.33 atmosphere** or less. Thus, field capacity is the percentage of water (based on dry matter) that soil can retain against gravity when adequate drainage is provided.

Wilting Point: The moisture of the soil is gradually reduced by surface evaporation and plant absorption. The remaining water is held with ever increasing tension and absorption by plants; it becomes more and more difficult against ever increasing tension. The plants try to adjust with the diminished intake of water but, soon after, this absorbed water meets the transpiration loss of water and plants start wilting. The percentage of moisture in the root zone at the permanent wilting of the plants is called the wilting coefficient or critical moisture point. At this stage, the supply of water is essential for the plants to survive.

Available Moisture: Water that is found between the permanent wilting point and field capacity or between a tension of 15 and **0.33 atmosphere** is known as available moisture. The availability of water increases as the tension reduces from and becomes less available with increase of tension.

Irrigation at Critical Growth Stages: The water requirement of a crop varies with the stage of growth. Under limited water supply, the critical growth stages are to be taken into account for scheduling irrigation.

The critical growth stages are most sensitive to shortage of water and the yield of the crop is reduced drastically if there is any moisture stress at these stages even for a short period.

The critical growth stages are different for different crops.

Table 2.23: Critical Growth Stages of Crops

Crops	Critical Growth Stages
Rice	1. Seedling stage 2. Maximum tillering stage 3. Panicle initiation stage 4. Flowering stage 5. Soft dough or milky stage
Wheat	1. Crown root initiation (20 days after germination) 2. Tillering stage 3. Jointing stage 4. Boot leaf stage 5. Flowering stage 6. Milky and dough stage
Maize	1. Seedling stage 2. Tasselling stage 3. Silking stage 4. Dough stage
Pulses	1. Early growth stage 2. Post-flowering stage or pod filling stage
Mustard and Rapeseed	1. Pre-flowering stage 2. Pod filling stage
Sugar cane	Moisture content of 60% during summer and 50% during winter should be maintained throughout the growing season.
Vegetables	Moisture content of 60% during summer and 50% during winter should be maintained throughout the growing season.

Depth of Irrigation

The quantity of water to be applied or depth of irrigation depends on three factors:

1. Depth of root zone
2. Water holding capacity of the soil
3. Degree of dryness in the soil

The quantity of water should be enough to wet the root zone of the crop; moisture below root zone is just a waste.

Table 2.24: Effective Root Zone of Some Common Crops Grown on Very Deep Well-drained Soil

Rooting Characteristics			
Shallow Rooted (60 cm)	**Moderately Deep Rooted (90 cm)**	**Deep Rooted (120 cm)**	**Very Deep Rooted (180 cm)**
Rice Potato Cauliflower Cabbage Lettuce Onion	Wheat Tobacco Castor Groundnut Muskmelon Carrot Pea Beans Chilli	Maize Cotton Sorghum Pearl millet Soybean Sugar beet *Tomato*	Sugar cane Citrus Coffee Apple Grapevine Safflower Lucerne

The approximate amount of irrigation water to be added over the soil during each irrigation (cm)

Table 2.25: Amount of Irrigation required

Root zone	Sandy Soil	Loamy Soil	Clayey Soil
Shallow, up to 60 cm	2.5-5.0	5.0-7.5	7.5-10
Medium, between 60 and 90 cm	5.0-7.5	10.0-15.0	15.0-20.0
Deep, more than 90 cm	10.0-15.0	20.0-25.0	25.0-35.0

Michael A.M. 1981. *Irrigation-Theory and Practice*

Water Management: Keeping in mind all the factors mentioned, one should go for managing water, for example, drainage of water (during rainy season), the ridges, furrows or beds are prepared along the slope of the land and, for irrigating, these are made against the slope. Availability of water must be ensured during critical growth stages. According to the availability of water, the crops and land can be selected and managed. The depth of irrigation should also be monitored to reduce wastage.

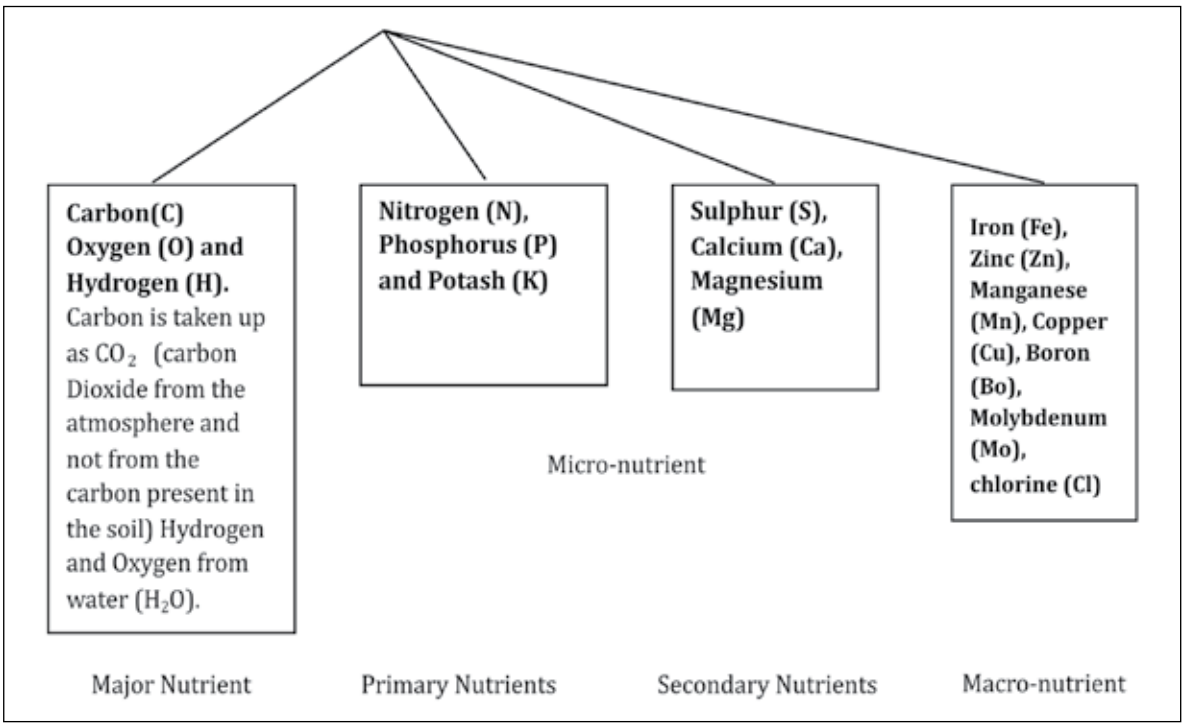


Figure 2.23: Plants Require 16 Elements to Survive

These nutrients are absorbed from the soil by the crops as shown in the Figure No. 2.22 It is necessary to replenish these nutrients to keep the soil fertile for crops by the application of manure and fertilizers.

The presence of soil nutrients can actually suggest how much extra nutrients are needed for soil for a particular crop. Soil testing is needed for this.

Table 2.26: Nutrients removed (kg/ha) from the soil

Crop	Yield	Ton/Ha	Nitrogen (N)	Phosphorous (P)	Potassium (K)
Paddy	Grain	2.8			
	Straw	5.6			
	Total	**8.4**	**82**	**23**	**123**
Wheat (tall)	Grain	2.2			
	Straw	4.4			
	Total	**6.6**	**59**	**29**	**67**
Wheat (dwarf)	Grain	5.0			
	Straw	7.5			
	Total	**12.5**	**120**	**64**	**220**

Maize	Grain	2.7			
	Straw	9.0			
	Total	**11.7**	**110**	**45**	**105**
Potato	Tuber	**17.5**	**95**	**30**	**130**
Sugar cane	Canes	**90**	**120**	**50**	**290**

Uses of Manure and Fertilizer

The nutrients in the chemical fertilizers have first to be converted into naturally available forms before being absorbed by the plants. The nutrients are in a readily available form in case of the chemical fertilisers, meaning plants respond faster which is converted by the microbes living in the soil.

For example, when nitrogen is applied in the amide form, using urea, first it is converted into the ammoniac form by bacteria through a process called **mineralization;** next, the ammoniac form is converted into the nitrate form by bacteria through a process called nitrification. Plants use this nitrate as a source of nitrogen. If the adequate number of bacteria is not present in the soil, the application of chemical nitrogen does not ensure that enough nitrogen available to the plants.

Simultaneously, the bacteria *Pseudonymsriata, Bacillus polymyxa* and fungi such as *Aspergillus awamori* have a great role to play in making available the phosphate to the plants. These bacteria are called phosphate-solublizing bacteria (PSB).

For the survival and multiplication of these microbes, plenty of organic carbon is required. This organic carbon is present in the soil or supplied through composts or FYM. The microbes use this organic carbon, multiply and convert the applied nutrients to a plant-available form. **That is why applying chemical fertilizers without any compost or FYM is not beneficial to the plants; rather it harms the soil by the accumulation and the killing of microbes.** Some specie (such as Azotobactor) help in fixing the free nitrogen from the air and make it available to the plants.

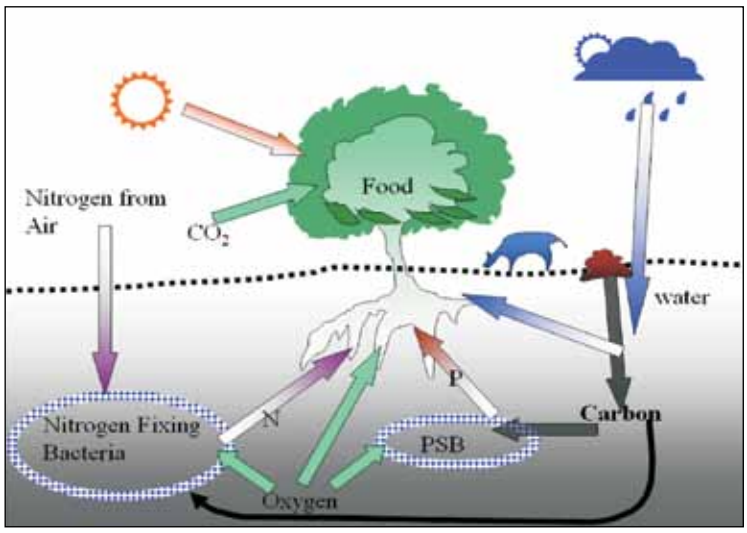


Figure 2.24: Soil and Plant Relationship

Other than this, organic manure helps in changing the texture of the soil. It helps in increasing water and the air holding capacity of the soil.

Vegetative measures, in this chapter, have been proposed to enhance the condition of soil health in a sustainable manner.

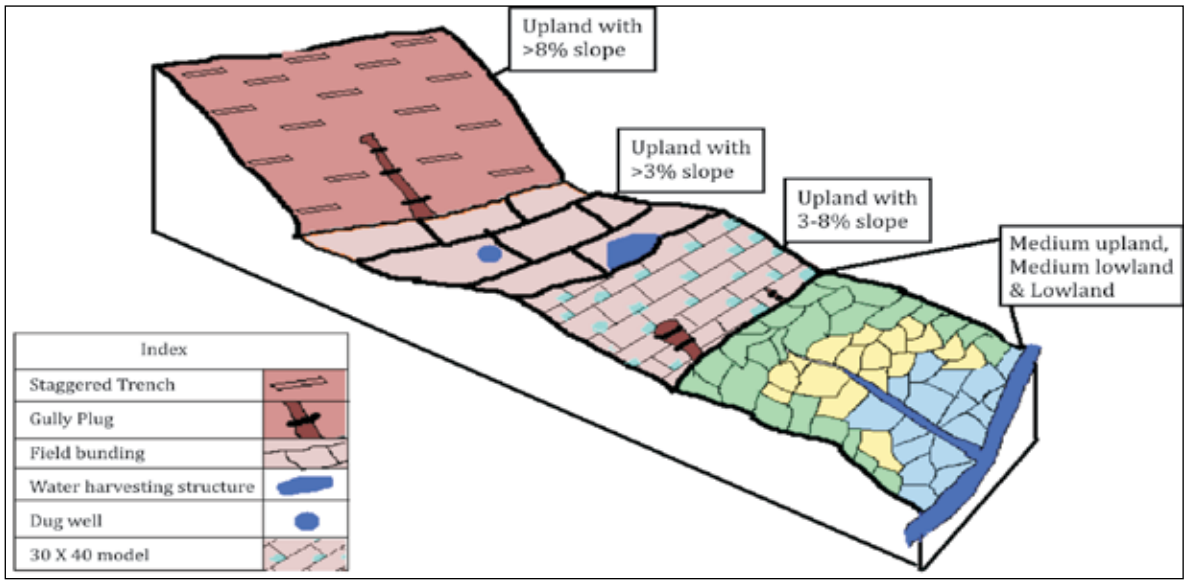


Figure 2.25: Land Use (Vegetative Measures) in Treated Uplands

Table 2.27: Land use as per the Land Slope

Slope	Land Use Plan (Vegetative Measures)	Conditions to be Considered
>8%	Timber plantation, sabai grass	Selection of timber species will depend on the topsoil depth too. If the topsoil depth is <6", plant accassia species. Otherwise, gamhar, sisum, etc., may be planted.
3-8%	Timber plantation, horticulture plantation such as mango, cashew, inter-crop with vegetables, pigeon pea/black gram	
<3%	Horticulture plantation such as cashew, mango, vegetable cultivation, pulses	Selection of patch for the horticulture will also depend on its distance from the habitation because it requires intensive and regular care.

2.5.2. Uplands with >8% Slope

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

Pits for the plantation must be dug at 6" x 6"' intervals. The pit-size must be 1' x 1' x 1'.

Timber species are to be selected based on the type of soil and the depth of top soil. The local need of the villagers is also to be considered. Gamhar *(Gmelina arborea)*, Sisam *(Dalbergia sissoo)* and Acacia *(Acacia spp.)* species have been successfully experimented in this zone; these along with supplying fuel wood have good timber value. Grass species are also to be selected carefully so that it gives some economic return to the landholders. Sabai grass *(Eulaliopsis binata)* has yielded better results in this zone. Besides checking soil erosion, it is useful for making ropes.

Execution Season

Pit digging should be completed during April so that the pits get adequate summer heat, which kills the eggs of insects and other pathogens that may cause harm to the plants. Plantation work must be done in July after the onset of the monsoon.

For one hectare land
Spacing (10 ft x10 ft)
Number of plants = 950

Table 2.28: Work Estimate

No.	Item	Unit	Unit Size	No of Unit	Quantity
1	Fence	Feet	1	1,320	1320
2	Pit digging (1' x 1' x 1')	Cum	0.03	950	28.5
3	Pit filling, and plantation				0
	Vermi-compost	kg	0.5	950	475
	DAP	kg	0.03	950	28.5
	Insecticide	ml	0.3	950	285
	Saplings	Numbers	1	950	950
	Pit filling	Labour days	0.01	950	9.5
	Planting	Labour days	0.02	950	19
4	1st Interculture Operation				0
	Fertilizer	kg	0.1	950	95
	Labour	Labour days	0.02	950	19
5	2nd Interculture Operation				0
	Fertilizer	kg	0.1	950	95
	Labour	Labour days	0.02	950	19
6	3rd Interculture Operation				0
	Fertilizer	kg	0.1	950	95
	Labour	Labour days	0.02	950	19

No.	Item	Unit	Unit Size	No of Unit	Quantity
7	Fodder on bund	ha	NA	0.1	0.1
8	Pigeon pea	ha	NA	0.8	0.8

Estimated Returns

After 15 years, from one ha of land under timber plantation, the return will be around Rs 1.5 lakhs. Sabai cultivation will give a return of Rs 10,000 per year up to the 4th year when replanting is required.

Material Cost and Labour Component

If seedlings are purchased and considered as material cost, the labour component will be 66% of the total cost for timber plantation.

For sabai plantations too, 66% of the costs will be the labour component if the seedlings are purchased and considered as material cost.

Upland with less than 8% slope

Experimentation has been done by PRADAN where timber and horticulture plantations were raised successfully in the uplands with slopes less than 8%. The patch needs to be near the human habitation as horticulture plantation needs intensive and regular care.

For timber species, the spacing must be 6' x 6'. The species should be selected following the process discussed earlier. It is better to go for a mixed plantation with different gestation periods, to get returns in different years.

Mango Orchards in Upland

Sabai Grass in Upland

Grass can be grown on the field bunds to maximize income and stabilize the bunds. The grass species should be selected according to the need of the villagers. Fodder grasses such as *Dinanath (Pennisetum pedicellatum)* and Stylo *(Stylosanthes hamata)* can also be grown here.

Horticulture species can be selected based on the market, distance of the patch from the homestead, the investment capacity (labour and capital) of the farmer and the availability of irrigation facilities. Finalize the decision on the species after holding thorough discussions with the community.

In irrigated uplands, mango and lemon plantations have shown potential whereas cashew may be an option for unirrigated uplands

Mango Plantation

The spacing of the plantations will vary according to species selected. A horticulture patch should be interspersed with some straight growing timber species such as gamhar and teak, to increase the return as well as to create a wind barrier for the fruit crops. Inter-cropping with pulses and other vegetables optimizes returns from the land. Inter-cropping with pulse crops also increases soil fertility, which further enhances the growth of the fruit plants.

Timber Plantation in 30 * 40 model

For one hectare land

Spacing: (20' x 20') for block plantation

Number of plants = 240

Table 2.29: Model Work Estimate of Mango (Mangifera Indica) Plantation

No	Item	Unit	Unit Size	No of Unit	Quantity
1	Fencing	Running feet	1	1320	1320
2	Pit digging (3' x 3' x 3')	Cum	0.77	240	184.8
3	Pit filling, and plantation				
	Vermi-compost	Kg	10	240	2400
	NPK	Kg	0.15	240	36
	SSP	Kg	0.1	240	24
	Durmet/Dursban (chlorpyrifos)	ml	2	240	480
	Neem cake	Kg	1	240	240
	Saplings	Numbers	1	240	240
	Labour for pit filling	Labour days	0.03	240	7.2
	Planting of saplings	Labour days	0.03	240	7.2
	Earthen pitcher	Pitchers	2	240	480

No	Item	Unit	Unit Size	No of Unit	Quantity
4	1st Interculture Operation				
	Suphala (10:26:26)	Kg	0.15	240	36
	Labour	Labour days	0.05	240	12
	Watering	Labour days	0.03	240	7.2
	Growth hormone	Ml	1	240	240
5	2nd Interculture Operation				
	Vermi-compost	Kg	5	240	1200
	DAP	Kg	0.15	240	36
	Labour	Labour days	0.05	240	12
	Watering	Labour days	0.03	240	7.2
	Growth hormone	Ml	1	240	240
6	3rd Interculture Operation				
	Suphala (10:26:26)	Kg	0.15	240	36
	Labour	Labour days	0.05	240	12
	Watering	Labour days	0.03	240	7.2
	Growth hormone	Ml	1	240	240
7	4th Interculture Operation				
	Suphala (10:26:26)	Kg	0.15	240	36
	Labour	Labour days	0.05	240	12
	Watering	Labour days	0.03	240	7.2
	Growth hormone	Ml	1	240	240
8	Pigeon pea inter-cropping	Ha	0.8		0.8

Return

After the fifth year, the return from a mango orchard will be around 13,000/ha. The return will reach Rs. 1,00,000/ha after the 10th year.

Execution Season

In case of plantations, the pit digging is to be completed during April, to expose the pit to the summer heat for the next 1.5 months so that the insect eggs and pathogens are destroyed. The planting of saplings should be done after onset of monsoon, that is, in the middle of July.

Material cost and labour component

The labour component for a mango plantation is 63% of the total cost, provided the saplings are purchased and considered as material cost.

Person-days generated

In mango plantation work, 221 person-days will be generated for one hectare of land.

2.5.3. Potential Land Use of Treated Medium Land

The 5% model pits constructed in medium uplands provide irrigation during dry spells. This helps to stabilize paddy production in paddy growing areas. Paddy production can be further increased if the System for Rice Intensification (SRI) method is adopted. In SRI, the alternative drying and wetting of the paddy field is required, for which the 5% pits will be of immense use. In non-paddy growing areas, maize and soybean can be grown in the kharif season. In the rabi season, farmers can grow pulse and oil seeds. Plants such as *dhaincha* can be grown in summer season on these lands. This could be used as green manure.

2.5.4. Potential Land Use of Treated Lowland

In the kharif season, paddy cultivation using the SRI method will increase the paddy yield at least 1.5 times. Seeds of crops such as *dhaincha* can be sown in June and those plants can be used as green manure. The farmer can grow summer vegetables, pulses and oilseeds in these lands. In the rabi season, farmers can grow wheat.

Case Study: Transforming Lives through INRM

Dinabandhu Majhi, a resident of Ponra village, heads a family of seven including his wife Saraswati and five children. He owns 4 acres of land, of which 0.5 acre is upland paddy land and the rest is sloping upland.

Earlier, the 3.5 acres of unterraced upland was extremely unproductive. Only 66 decimals could be used for short duration paddy. The yield was miserable, only 3.5 quintals during good rains. An occasional crop of tomato and maize during kharif fetched him an additional Rs 3,600. For his sustenance, Dinabandhu depended on petty trade in goats, catching fish from the adjacent river, on wage labour and lac cultivation. Despite his multiple efforts, he was barely able to make two ends meet for his family.

During an INRM intervention in his village, Dinabandhu and his family decided to use 3.5 acres of his sloping upland for grafted mango plantation (400 saplings of regular bearing Amrapalli variety). The intervention provided for a well, to support the entire plantation. Dinabandhu also constructed two 5% pits in his upland paddy land of 0.5 acres. The assured irrigation helped him cultivate a crop of pumpkin and arhar in the horticulture patch and rear fish in the 5% pits.

Following this intervention, Dinabandhu's family economics dramatically transformed. His low productive asset became his most prized assets. He earned Rs 4,120 from his crop of pumpkin and arhar in the very first year. Well irrigation, in addition to protection of fruit trees, helped him cultivate vegetables such as bottle gourd and tomato in 66 decimals of upland, earlier used for paddy. The 5% pits assured and doubled paddy production in the uplands. Wages earned during the project period helped him take another 1 acre of land on lease. Dinabandhu plans to purchase this land in the near future.

Three years after planting the mango saplings, he has already sold 3.5 quintals of mango for Rs 3,360. Another consignment of 1 quintal has been sent to Singapore, the expected earning from which is at least another Rs 6,000. This yield from the mango plants will keep on increasing every year. In the 10th year, the expected yield is a minimum of 40 kg per plant.

In their own words, both Dinabandhu and Saraswati say that their lives have been transformed and their standard of living has improved. They have improved their house and have purchased assets such as TV, cycle, etc. They say that now they even have leisure time, which previously was simply unthinkable.

Steps in INRM Planning

Steps of INRM intervention and their purposes:

(Check sheet for each component is in the annexe)

Steps	Component	Purpose
Community organization	Village selection	To choose the target villages, based on the poverty status
	Concept seeding	To help the villagers understand the importance and potential of the natural resources
	VLA formation	To form a village-level programme management and implementation unit, which provides a platform to share, discuss, plan and implement
	Programme Execution Committee (PEC) formation[9]	To form a village-level planning and implementing unit
Participatory planning at village level and resource management plan	Baseline data collection	To get an idea about the village profile, which helps in planning and in impact assessment
	Resource mapping	To get an overview of the available resources
	Ownership mapping	To get an understanding of the land ownership in the village
	Problem identification	To define and analyse the problems of each patch of land
	Options generation	To generate a number of alternatives for each patch of land, according to its problems
	Activity plan and proposed land use map	To scrutinize options that are economically viable and socially acceptable
	Budget preparation	To prepare the overall budget by consolidating all the plans
Phasing of activities and the implementation plan	Approval from the VLA	To get a formal approval of the plan and budget
	Sanction from the donor/ government	To get the plan and budget sanctioned

[9]The name can be any, for example, PEC, VCC, WSC, etc. It refers to a small group of project implementation teams.

3.1. Village selection

The following criteria may be used to identify and short-list a group of villages inhabited largely by the poor and marginalized sections of society.

Table 3.1: Table Showing Criteria and Sources of Information for Village Selection

No.	Indicators	Criteria	Source of information
1	Target population[10]	60 - 70%	Census book, BPL list from block office
2	Remoteness	Poor connectivity, not accessible in all seasons	Block revenue map, block office
3	Work-force participation (in agriculture)	High wage labour/ agriculture labour	Census book
4	List of backward villages	Identify at least 10-12 villages in a contiguous area	Concerned block officer
5	Land use data	Dependency on agriculture	Census book, District Information Centre

Finalize the selection of the village only after a field visit and informal interaction with the key decision-makers of the village such as the village headman, *munda, manki, majhi, pradhan, panchayat* leaders, etc., in case prior social mobilization is not done. This will help to verify and correct the initial selection decision.

3.1.1. Expected Output

1. *A cluster of villages with substantial population of poor and marginalized section and having the potential for land- and water- based activities will be selected.*

Time Involved

One Person days for selecting a cluster of 5-6 villages.

3.1.2. Concept seeding

This step involves intensive interaction with the villagers, to help them understand the following:

- The importance and potential of the natural resources
- The impact of natural resources on the lives and livelihoods of people

[10] Scheduled Castes, Scheduled Tribes and BPL people in the area.

Concept seeding involves:

i. Interaction prior to the village-level meeting, to finalize the details

ii. Village-level meeting to introduce the integrated ways of managing the natural resources and develop clarity on the integrated approach

3.1.3. Pre-meeting Interaction with Villagers

Fix a date and time for the village-level meeting with the village head/leader, according to his/her convenience; alternatively, if SHGs exist, this consultation may begin in the cluster meeting and the members can take the initiative to involve all concerned. Share the broad objectives of the meeting (as mentioned earlier) and the role of the villagers in INRM approaches. If necessary, use some photographs of land and water interventions.

Ensure that s/he facilitates the presence of at least 4-5 representatives from each hamlet (preferably SHG representatives) in the meeting. Representatives should be able to influence the men and the women in their respective hamlets after the meeting.

Tips for Entry-level Visit

1. Interact respectfully with the village headman and the villagers.
2. Avoid raising villagers' expectations. Do not make promises.
3. Say, "I have come here to learn about the living conditions of the people, the existing resources, their uses, etc., in this village."
4. Following are some of the leading questions that can be explored are.
   i. Tell me something about your village.
   ii. Capture the key points/components, that is, resources, utilization of resources, livelihoods of people (primary and supportive), major crops and seasonality, migration, workforce availability, etc.
   iii. Dependency on farms and farming system to capture the potential of land and water based

3.2. First Village Meeting

3.2.1. Objectives

- Representatives attending the meeting will develop a common understanding of the problems and the prospects of their natural resources and the impact of these on their lives and livelihood
- Villagers or SHG members share the responsibility of organizing subsequent village meetings (date, time and venue).

Request the village headman to initiate the meeting. Begin by greeting the villagers and introducing yourself (name, background, purpose of participating in the meeting, etc.). Share the importance and the impact of INRM on the lives and livelihood of villagers, and their involvement in the overall INRM approach. Obtain the villagers' views on this.

At Village Meetings

- Be on time.
- Sit in a circle and explain the rationale (that everyone is important).
- Welcome villagers with a formal greeting.
- Be patient and LISTEN.
- Move at the pace of the villagers. Never try to supersede them.
- Pay equal attention to all the villagers, not only to the ones who are 'vocal'.

Finalize the date and time of a village-level meeting with the representatives. Request the representatives to ensure full participation of all family members, especially the women and the marginalized sections. Give them the responsibility of arranging a meeting place. The meeting place should be centrally located and away from disturbances.

Time involved: 1 Person day

Note: *If 20-30 persons from a cluster of villages (2-3 key persons, women included, from each village) visited an area where the intervention has been made, it will help them develop their perspective and understanding about the INRM approach. These people can play an important role in disseminating information to the rest of the villagers and facilitating the next meeting. The 'exposure' visit can be organized as per the module in the following page.*

3.3. Second Village Meeting

3.3.1. Objective

To develop the villagers' clarity, about the INRM approach.

Request the head of the village to initiate the meeting. The SHG members/representatives can also start the meeting by greeting the village leader and the others. Greet the people and introduce yourself. Share the purpose of the meeting. Request the people to share about their village, resources, existing livelihood options, land use, productivity, etc. Allow the villagers to express their views and relate it with the overall INRM perspective. Focused group discussions with women and marginalized sections such as the landless may be carried out to get their views on the importance and implication of the natural resources on their lives and livelihoods.

To have an understanding of the INRM perspective, some of the leading questions could be:

- How is your life? How happy are you with your life?
- What is source of your livelihood?
- What are the vulnerabilities?
- Summarize the responses. Then say, "I would like to understand the existing status and use of natural resources {the 5 *"Ja"s: Jal* (Water), *Jungle* (Forest), *Jamin* (Land, *Jan* (People) and *Janwar* (Livestock)}.

- What are the implications of these/what does it mean to you (both short-term and long-term implication)?
- What changes do you think are required to address the present scenario?
- What are the supports available to bring about the changes at your level? (If required, discuss some positive experiences on the potential of each category of natural resources).
- What are the other supports required to bring about the expected change in your village?
- What role do you expect the different actors (villagers, panchayat, block, intervening agency, government, etc.) to play?

Note: *The presence and the sharing of experiences of one or two people from villages (of similar terrain, agro-climate, socio-economic strata, etc.) where INRM interventions are already in place would be helpful.*

– Show some photographs/audio-visual materials on INRM interventions.

When an overall broad understanding of the INRM perspective has been developed in all sections, propose the idea of arranging an exposure visit (to demonstrate INRM and its impact). If they show interest, ask them to choose a delegation of 30-40 people (at least 30% of the household in the village, including some spokespersons, who can articulate the experiences in the subsequent meetings), representing all hamlets in their village. Women and landless/marginal farmers must be a part of the delegation. Members should be able to grasp the subject and explain it to others.

Note: *In case the size of the village is more than 100 households, one can conduct a similar exercise in each hamlet.*

Exposure Visit

Guided exposure visits to areas of good practices are an effective method of changing people's misconceptions, beliefs and attitudes. Changes in belief systems are crucial for other inputs to become effective. Thus, care should be taken to plan and organize exposure visits so that they do not end up as sight-seeing tours. The timing of the exposure visit is crucial so that people can interact freely and see changes in farming practices because of the INRM approach and its impact in the lives and livelihoods of the people.

Process

Organizing an exposure visit involves a set of pre-visit steps, steps to be followed during the actual visit and post visit steps.

Pre-Exposure Visit Steps

Once the villagers are ready to send their delegates for an exposure visit, choose a village where INRM has been successfully carried out, preferably close to this cluster and in similar terrain with similar socio-economic conditions. Keep the visitors' needs in mind and choose a site where they can maximize their learning.

Get the consent of the villagers of the village to be visited about hosting the exposure programme. Finalize dates and logistics with the villagers. Also brief the hosts about the visitors and guide them about the INRM interventions, impact, overall management, etc., that they should emphasize in their interactions.

Inform those going on the visit about the date of the visit, the location of the host village, directions to reach it and the logistics. Influence the villagers to share a considerable part of the expenses (in terms of cash or kind) required for conducting the exposure visit so that the visit becomes their need.

The Visit

The programme of the visit needs to be closely facilitated by a professional of the intervening agency. Reach the village with the visitors at the scheduled time and date. Assemble at a common/community place in the village along with delegates and members of the host village. Sit in a circle.

The meeting should start with a welcome address accompanied by an honourable person from the host village community. The villagers should be motivated to describe the INRM practices adopted in their village, challenges faced in the process, impact of the intervention and overall management in the host village.

Divide the visitors into small groups, with one or two members of the host village in each group. Send them to visit the village and fields, to interact, observe and understand the following:

- What was the situation before the intervention?
- Why was such an intervention required? What were the costs incurred and the benefits that accrued?
- What were the hurdles in adopting the new idea?
- How were these hurdles sorted?
- What support was available from within the community and from outside?
- What role did the different actors (villagers, Panchayat, block, intervening agency, etc.) play?
- How did the lives of individuals change due to the intervention?

Note: *Interact with families who have experienced transformation through INRM interventions.*

Reassemble at the same place and invite each of the sub-groups to share their observations with the large group. Encourage other participants to add and clarify issues wherever required.

Provide the visitors an opportunity to interact informally with host villagers to get further clarity on the intervention.

Before the delegates depart for their homes, fix a date for a follow-up meeting (the representatives will be facilitated to take up the additional responsibility of inviting all villagers from their respective hamlets).

Time Required: 1 person-day

(The time required may vary depending upon the distance of the host village,)

3.4. Third Village Meeting

3.4.1 Post-Exposure Visit Steps

Reach the village for the follow-up meeting at the scheduled time and date, as suggested by the delegates. Ask them to share their experiences of the exposure visit with rest of the villagers.

Ask others to share their thoughts and feelings after listening to the delegates. The potential of such interventions in their own village needs to be explored through the visioning exercise.

Once a broad understanding on resource management in an integrated way is realized and villagers articulate that they need some forums to deliberate and intervene, the follow-up plan for promoting a village-level association (VLA) can be shared.

3.5. Village-Level Association (VLA) Formation

3.5.1. Objective

Operational unit of the village having a platform to share, discuss, plan and implement Natural Resource Management structures.

3.5.2. Roles and Responsibilities

1. Providing a platform for collective decision-making
2. Planning of village-level activities
3. Reviewing the detailed patch-wise plan and giving approval
4. Implementing the activities as per the plan
5. Reviewing the performances against the plan
6. Resolving inter-hamlet conflicts
7. Information dissemination to the hamlets through hamlet representatives

3.5.3. Membership

All male and female members (above 18 years) of the village are members of this forum. The decision in the VLA can only be taken if at least 60% of the eligible members attend the meeting.

3.5.4. Frequency of Meetings

- At least once in two months (however, for the smooth functioning of the VLA and to maintain regularity, effective sharing and review of all activities, monthly meetings are preferred)

3.5.5. Records to be Maintained

- Meeting Register (all proceedings, details of plan, budget, etc.)

3.5.6. Requirements

Stamp pad, pen, register, cover file (to keep documents such as activity plans, sanctioned budget, and copies of the muster roll, maps and stock details)

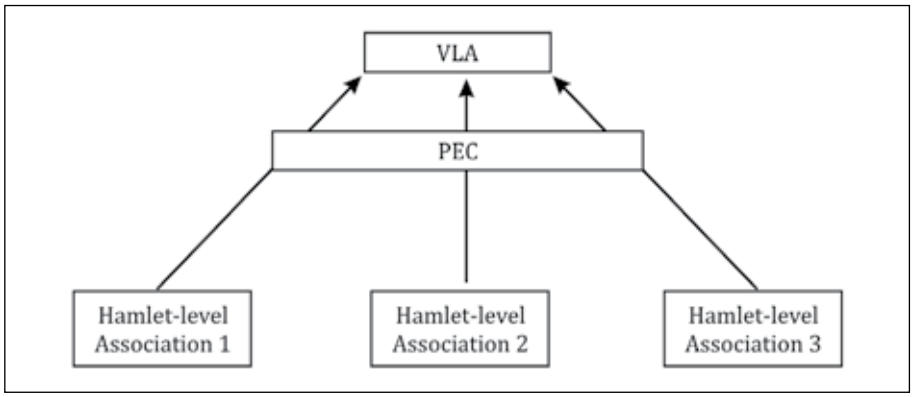
3.5.7. Process of Formation

1. The village head will chair the meeting or the SHG-cluster members can propose someone from among themselves.
2. Share the objectives, membership, norms of the VLA.
3. Share the roles of the VLA and work out minimum norms such as the meeting frequency, who will maintain the records, chairperson of the VLA, etc.
4. After getting everyone's consent, formalize the VLA by writing all the names of the members in the register.
5. Fix the next VLA meeting (date and time) identify hamlet-wise volunteers to ensure the participation of all families in the meeting.
6. Close the meeting with a vote of thanks by the chairperson after writing the proceedings and taking the signatures of all.

- If the attendance is less than 60% of the eligible members, repeat the process in the next meeting.
- The VLA may assign the roles and responsibilities amongst members.

Time: 4-5 Hours

In case the size of the village is more than 100 households and the households are distributed in more than one hamlet, separate hamlet-level associations, HLAs (considering the physical proximity and operations) have to be formed, using a similar process. These HLAs can then be integrated at the VLA level.



Note: *The women's SHGs that PRADAN promotes should be integrated with the HLAs and VLAs. For example, in Purulia district of West Bengal, women SHG members form the PEC and implement and monitor programmes.*

3.6. Fourth Village Meeting

3.6.1. Objective

To form a village-level programme management and implementation unit, for example, Project Execution Committee (PEC)/Village Development Committee (VDC)/Watershed Development Committee (WDC)/ Village Core Committee (VCC), etc.

3.6.2. Roles and Responsibilities

1. Reviewing the resource management plan (RMP)
2. Getting the plans approved from the Gram Sabha (GS)
3. Managing finance
4. Programme execution
5. Programme monitoring
6. Resolving conflict
7. Information dissemination
8. Maintaining links with various stakeholders such as community based organizations (SHGs, clusters, co-operatives, federations, etc.), government departments, panchayat functionaries, facilitating agency, banks, etc.

3.6.3. Membership

The PEC comprises two or three representatives from all hamlets. The VLA should select women representatives to the PEC. The minimum strength of the PEC is 10 and the maximum is 20 (so that they can deliberate effectively as a group). Decisions in the PEC can only be taken if at least 70% of the members attend the meeting.

3.6.4. Frequency of Meetings

At least twice a month (weekly meetings are preferred to monitor the plan and its execution closely)

3.6.5. Records to be Maintained

- Meeting register
- Muster roll
- Utilization certificates
- Cash book
- Ledger
- Vouchers
- Stock register
- Cheque register

3.6.6. Requirements

Measuring tapes (equal to that of the number of hamlets), one stamp pad, cash box, pen, formats of utilization certificate, calculator, etc.

3.6.7. Process of Formation

- The village head or one of the cluster leaders will initiate the meeting.
- Read the minutes of the last VLA meeting. This helps the participant families to initiate a discussion on resource management and utilization planning.
- Explain the need and importance of a PEC for the proper implementation and management of INRM activities in the village. Obtain the consensus of the VLA to form a PEC.
- Ask each individual hamlet to select their representative for the PEC by considering their roles and responsibilities, (hamlet-wise group discussions are preferred to identify representatives from each hamlet and to have detailed deliberations in smaller group; care needs to be taken to select representatives from all sections, that is, class, caste and gender, etc.).
- One member from each hamlet will introduce the nominated persons from their hamlet to the larger group.
- Obtain the consent of the VLA and all hamlet representatives for the formation of the PEC. Formalize the body by writing the names of PEC members in the meeting register.
- Work out the roles and responsibilities of the PEC members. Decide on minimum norms such as frequency and the appointment of an accountant, to maintain the accounts and records.
- Close the meeting with a vote of thanks by the village head after recording the proceedings and taking the signatures of all present.

Time Required: 4–5 hours

3.7. Process of Planning

3.7.1. Introduction

This section describes the steps involved in developing a village-level resource management plan. It spells out the purpose of different planning exercises, the processes involved and the formats used. The entire process of planning is participatory and can only be carried out with the active involvement of the villagers themselves.

3.7.2. 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 natural resources and help villagers utilize these resources optimally to get maximum incremental benefit from them.

3.7.3. Processes Involved

- Baseline data collection: people, infrastructure and facilities, physical and natural resources
- Resource mapping

- Ownership mapping
- Problem identification
- Option generation and finalization of options
- Activity planning and scheduling
- Budget preparation and obtaining approval from the VLA

Baseline data collection[11]

The purpose of this exercise is to get an idea of the village profile before initiating the project. A comparison with the data collected after intervention helps to evaluate the overall impact of the intervention on the village in terms of:

1. Enhanced production of cereals, oilseeds, pulses, vegetables, horticulture, fisheries and fodder
2. Qualitative and quantitative changes in the livestock
3. Increase in the irrigated area
4. Increase in the harvesting of run-off
5. Change in the groundwater table
6. Change in income and expenditure pattern of families

Baseline data collection involves the collection of data on people, infrastructure and facilities and natural resources. It includes a combination of *village level data and data from individual households* and is collected with the help of hamlet representatives.

3.7.4. Process Involved

- The members of the PEC organize hamlet-level meetings before undertaking the processes of data collection. They explain the need and importance of such data collection in the meeting and clarify doubts and issues (such as, "Nobody will take your assets, it is your own;" "This is not for short-listing BPL families;" "Baseline data collection is undertaken only to map what is existing").
- The PEC then selects 2-3 volunteers from each hamlet and trains them to collect data. The help of the SHG members is sought in the cluster meetings to collect data that are more authentic.
- The members find out when villagers will be able to give time for group discussions and individual interactions, required for such data collection.
- The members collect data at the convenience of the villagers.
- They triangulate/cross-check the data gathered.
- During the planning process the community has to identify a place for storing the data generated during the planning and implementation process. This could be stored safely in a large tin box. This would aid in the data being available in the village itself for verification and other purposes like reference etc.

[11]All the sample formats are given in the annexure.

3.7.5. Types of Data and Mapping Exercises

Demography

This table provides information on the distribution of male and female population, according to age and caste, and about the available workforce in the village.

Sample Format No.	Hamlet	Name of the Family Head	Caste	1-5 years		5-18 years		18-50 years		>50 years	
				Boys	Girls	Boys	Girls	Men	Women	Men	Women

Food Security

This helps in understanding the availability of food from all assured sources of income for a particular family. This also helps in triangulating the findings for the wealth ranking exercise.

No.	Hamlet	Name of the Family Head	Food Sufficiency (in Months)

Labour Availability

This helps to assess the availability of labour in the area during different months. The data is used to plan and to implement various activities. For example, if one hamlet has planned to excavate 50 small water harvesting structures (40' x 40' x 8') within three months, they need 72 workers approximately every day (considering one person will cut 100 cft earth in eight hours) for three months. If the hamlet knows about labour availability in the area, it can plan accordingly.

Name of Hamlet				
Month	Labour Availability			Nature of Activities in which the Household is Engaged
	Male	*Female*	*Total*	
January				
February				
March				
April				
May				
June				
July				
August				
September				

October				
November				
December				

3.7.6. Natural Resources

Livestock

This provides information on the number of livestock and the data about them/in the village. The data forms a baseline for evaluating the impact of the programme at the end of the project period.

No.	Hamlet	Cross bred Cow	Local Cow	Bullock	Buffalo	Sheep	Goat	Total

Major Livestock Diseases

Data on this helps to assess the major diseases that the livestock are prone to and their severity in a particular month. Livestock is an important resource for the families and is very closely integrated with the farming system (for example, in tillage operations, fodder development and organic manure). Such information is important for planning and implementing preventive measures such as vaccination camps for livestock.

Month	Symptoms as Reported by Villagers	Major Livestock Diseases
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

Crop Production Data

This is important for understanding the existing land-use pattern, major crops and their productivity. The data can be analysed to understand the gaps in the potential and the actual productivity, and different crop combinations.

Name of the Hamlet					
No.	**Crop**	**Type of Land**	**Area in Hectares**	**Production in Quintals**	**Average Productivity (Qn/Ha)**
1	Cereal	Medium Upland (Paddy Lowland Paddy)			
2	Vegetables	Upland			
3	Horticulture	Upland			
4	Pulse	Upland			
5	Oil seeds	Upland			
6	Forestry/trees	Nil Upland			
7	Fodder	Nil			

Note: *Local units (for example, in case of area: katha, bigha, etc.) can also be used; the conversion factors can be followed to calculate the respective units.*

Irrigated area in hectares

- *The amount of run-off water arrested through existing water bodies in hectare-metres. This will help to plan the availability of water for irrigation in different seasons. The volume of water bodies will vary in different seasons, for example, in the kharif season, the volume of water bodies will be more than in the rabi and summer seasons. For example.*

Name of the Water Body	Length (ft.)	Breadth (ft.)	Average Depth of Water (ft.)	Volume of Water Bodies	
				In cft	In Ha-m
Water harvesting tank in Upar Tola	100	100	7	70000	0.198

Water body Volume calculation tips

Volume of water bodies (in cft): Length (ft) x Breadth (ft) x Average depth (ft)

1 acre = 43,560 sq ft and 1 ha = 10,000 sq m and 1 m = 3.28 ft.

So, volume of water bodies (in acre ft) = (Length (ft) x Breadth (ft) x average depth (ft/43,560)

Assume n acre ft,

Which means if one crop needs 6 irrigations and the depth of irrigation is 2", the above n acre ft of water can only irrigate n acre land in the respective season.

Similarly, the volume of water bodies (in ha-m) = Length (ft) x Breadth (ft) x Average depth (ft/35.28x 10,000).

- The depth of the groundwater table in summer (through some sample survey of the existing dug wells) in feet, the sample can be taken from different wells situated in different category of land.
- Area under plantation in hectares: These will help to understand the availability of fuel wood, fodder and timber.

Sample Format

Hamlet	Tree Species	Area (in Ha)/ Number	Present Use

3.7.7. Time Involved

About 7-8 days of the volunteers and 2-3 days of the facilitators (for a village of around 100 households). Time may vary as per the number of households. The information gathered will be consolidated at the village level by the PEC members; this is then to be documented for further planning and impact analysis.

3.7.8. Household Survey

Conduct a household survey through a random sampling of 20% of total families from each category of families—better off, poor and poorest—to understand the income expenditure pattern. Analysing the data will help to understand the distribution of income from different sources. The whole village can then be categorized as deficit/surplus areas by extrapolation of the data, etc.

Sample Format

Name of the Family: Devendra Hasda

Income items(s)	Amount (in Rs)	Expenditure Item(s)	Amount (in Rs)
Total (A)		Total (B)	
Surplus/Deficit (A-B):			

3.8. Resource Mapping

This involves the plotting of different land types, water bodies, ridgelines, drainage line and direction of water flow on a revenue map of the village.

3.8.1. Materials Required

Colour sketch pen, plain paper, scissors, brown tape, three copies of the village revenue/cadastral map, topo-sheet, pencil, eraser, inch graph paper, plastic wax crayons, stamp pad

3.8.2. Process Involved

Arrangements for the resource mapping exercise

(Resource mapping to be done at village level)

1. The date and time for the resource mapping exercise is fixed by the PEC members. Get revenue maps of the target villages from the village head. (The maps may also be collected from the District Treasury Office, block/district land revenue office, panchayat, forest office, etc.)
2. Photocopy of sheets of the village revenue map maintaining the same scale maintained in the original ones.
3. Join the different sheets to prepare a village map.
4. The dates and places of meeting are shared with different HLAs (Hamlet Level Associations) in the villages.
5. HLA selects 2-3 persons from their hamlets who have knowledge and understanding about revenue map and land.
6. The selected persons gather at a pre-decided place.

3.8.3. Resource Mapping

1. Share the purpose of this mapping exercise.
2. Delineate the village boundary, drainage line and ridgeline on the village map, with the help of the villagers.
3. Denote different types of lands (lowland, medium lowland, medium upland, upland, forest, common grazing land) in different colours. For example, use green colour for lowlands. An index for the different colours used may be provided on the lower right hand corner of the map itself.

4. Identify the local patches in the map. Circle these clusters of plots with a colour sketch pen. Write the code numbers of the farmers who have lands in that cluster in the encircled portion. At the same time, note the patch name and numbers on a piece of paper.
5. Calculate the area of each patch of land and the total area of the village on the revenue map, using a transparent inch graph sheet/transparent sheet and graph paper.

Cadastral/Revenue Maps

The term 'cadastral' is derived from the French word cadastre, meaning register of territorial property. These maps are made by governments to collect land revenue. In addition to direction and scale, these maps also have detailed descriptions of the boundaries of each plot, drainage lines, type of land use, etc. These are usually drawn to a very large scale such as 1:3960 (can be used as 1: 4000) or 16 inches = 1 mile, which means 1 cm on the map is equal to 4,000 cm or 40 m on the ground or 1 inch on the map is 100 m on the ground; or I sq inch on the map is equivalent to 1 ha on ground.

Topo-sheets/Topographical Maps

Topographical maps provide information about the lay of the land. The special feature of topographical map (or topo-sheets) is that along with direction, scale and legend, they also provide information about the relief of the land, using contour lines (contour lines are imaginary lines joining points on the same elevation). Hence, these maps are of extreme value in planning and executing INRM works. A topo-sheet gives detailed information on the contour lines, drainage, water harvesting structures, land use, villages and urban settlements, roads, railway lines, electricity and telephone lines, etc. The vertical interval in a topographical map remains constant throughout. Using the information in a topo-sheet, we can find out the elevation of any spot. We can also find out which areas are parts of the ridge and which are in the valley.

Topo-sheets are available mainly in 3 scales: 1:1,000,000; 1:2,50,000 and 1:50,000.

In case of a 1:50000 scale, 1 cm on the map is equal to 50,000 cm or 500 m on the ground, or 1 sq cm on the map is equivalent to 25 ha on the ground.

Demarcating Watersheds

1. For demarcating a watershed, we have to first identify the point with respect to which the watershed is to be marked (the exit point/common outlet/drainage point)
2. We then mark out drainage lines of various orders and types, which drain into this common point. This must be done very carefully because the topo-sheet has many other lines indicating contours and roads, which appear similar to drainage lines. The simplest way to do this is to begin from the common water discharge point and move along the drainage to its origin. To make things clearer, we can also mark the nearby drainage lines that do not drain off into this common point.
3. Beginning from the exit point, draw a line around the drainage system, enclosing all drainage lines, which drain into the exit point. This boundary line will terminate at the exit point. This line, demarcating the watershed boundary, is called a ridge line. In other words, a ridge line is an imaginary line joining all points of higher elevation in a selected watershed and separating the watershed from other watersheds. It never cuts across a drainage line and, therefore, the defining feature of the ridge line is that water does not flow over it. Ensure that the watershed boundary (the ridge line) never crosses any drainage line inside the watershed.

Calculation of Area of a Watershed

Using a transparent graph paper, we can calculate the area of the watershed quickly and simply. Here is how:

1. Trace the boundary of the demarcated watershed on to a transparent graph paper. This graph paper is divided into 1 cm x 1 cm squares, which are again divided into 100 smaller, 1 mm x 1 mm squares. The watershed boundary is traced on a graph paper.
2. Count the number of whole 1 cm x 1 cm squares in the graph paper falling within the watershed boundary. In the leftover partial 1 cm x 1 cm squares, count the number of whole 1 mm x 1 mm squares.
3. The total number of 1 cm x 1 cm squares inside the watershed boundary:
4. Total no. of 1 cm x 1 cm squares =

$$\frac{\text{No. of complete 1 cm x 1 cm sqr.}}{100} + \text{No. of 1 mm x 1 mm squares}$$

Assume, X squares

So, for example, for the topo-sheet with a 1:50000 scale, because 1 sq cm is equal to 25 ha on the ground, thus, the area of the watershed is 25X ha.

Undertake a field visit along with the villagers for physical verification of the ridge line, the drainage line and various types of land, including patches. Make the necessary corrections in case of inconsistencies in the map. Then plot the respective part of the ridge line and drainage line on the revenue map (take the help of the amin/knowledgeable persons and plot the points on the revenue map and then draw a line by joining the points).

Finalize the resource map in consultation with the hamlet representatives. This map will be used in the later stage of planning; therefore, it is advisable to make four copies of the same.

3.8.4. Expected Output

All the resources (mainly, the type of lands, water bodies, local patches, ridge line, drainage line and area of the patch) will be shown on the revenue map of the village (a sample map is shown here).

Table 3.2: Land Category

Land Category	*Area (Ha)*
Upland (Hillock)	39
Upland	14.5
Medium Upland	13
Medium Lowland	7
Lowland	0.5
Water bodies	1
Roads, Habitation, etc.	2
Total	77

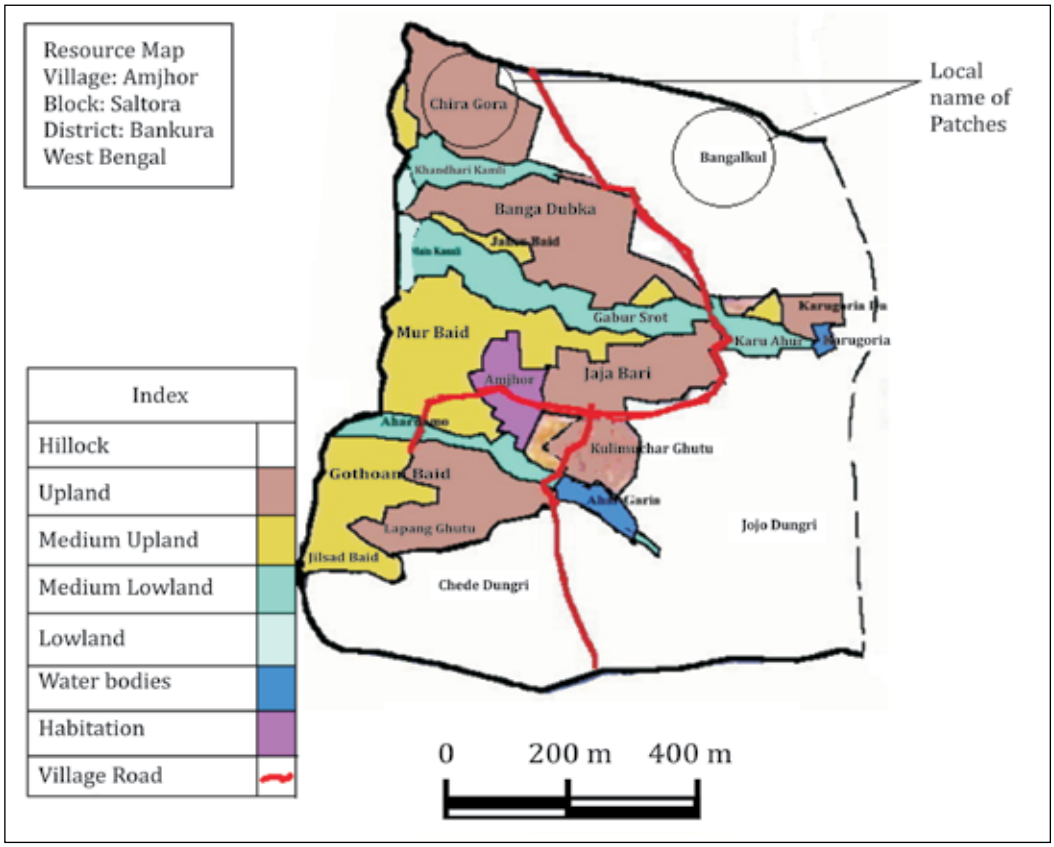


Figure 3.1: Resource Map of Amjhor village, Bankura district

Time: 3 person-days

3.9. Land Ownership and Users' Mapping

3.9.1. Ownership mapping

This is a process of recording the pattern of land ownership and its users in the hamlets. It is undertaken after completing the resource map and helps to identify the patches, which are mostly owned by poor families. This mapping involves two steps:

1. Wealth ranking exercise
2. Collection of ownership data and present land use

The prerequisites for this exercise are that the decision-maker(s) of the family should participate.

3.9.2. Wealth Ranking Exercise

Wealth ranking is a process used for generating information on different classes of people in the village. It is especially used to identify poor families in the village and helps in giving priority to the poorest families during planning and implementation.

3.9.3. Process Involved

- Draw three circles of different sizes on three chart papers. Each of these denotes the economic strata in the village. For example, the biggest circle denotes the better off (C); the smallest denotes the poorest families (A); and the intermediate circle denotes the poor (B).
- Ask each individual family to grade themselves on the basis of their own criterion. (At first, the villagers may hesitate to do it. Strong facilitation by the resource person is required.)
- Ask the participant families to put their own name slips (which are numbered) in their chosen circles on their own.
- At the end of the exercise, take each name and cross-check it with the rest of the participant families and put it in the appropriate circle.
- Write the slip numbers on the chart paper, and document the same in the meeting register of the VLA.

Time: 3-4 hours (for approximately 100 families)

3.9.4. Expected Output

All families will be mapped to understand the economic strata of individual family as well as that of the village.

Table 3.3: Sample Format

Hamlet	Name of Head of Family	Category (A/B/C)
Ramsai	Debendra Hansda	B
	Nilmuni Hansda	C
Sosopi	Armia Hansda	C
	Elisaba Soren	A

Collection of Ownership and users' Data and Present Land Use

Ownership/users' and present land use data are collected, using the format (as mentioned in the option generation part).

Time: 1 person-day

3.9.5. Expected Output

Patch-wise ownership map and the use of land on the resource map would be prepared.

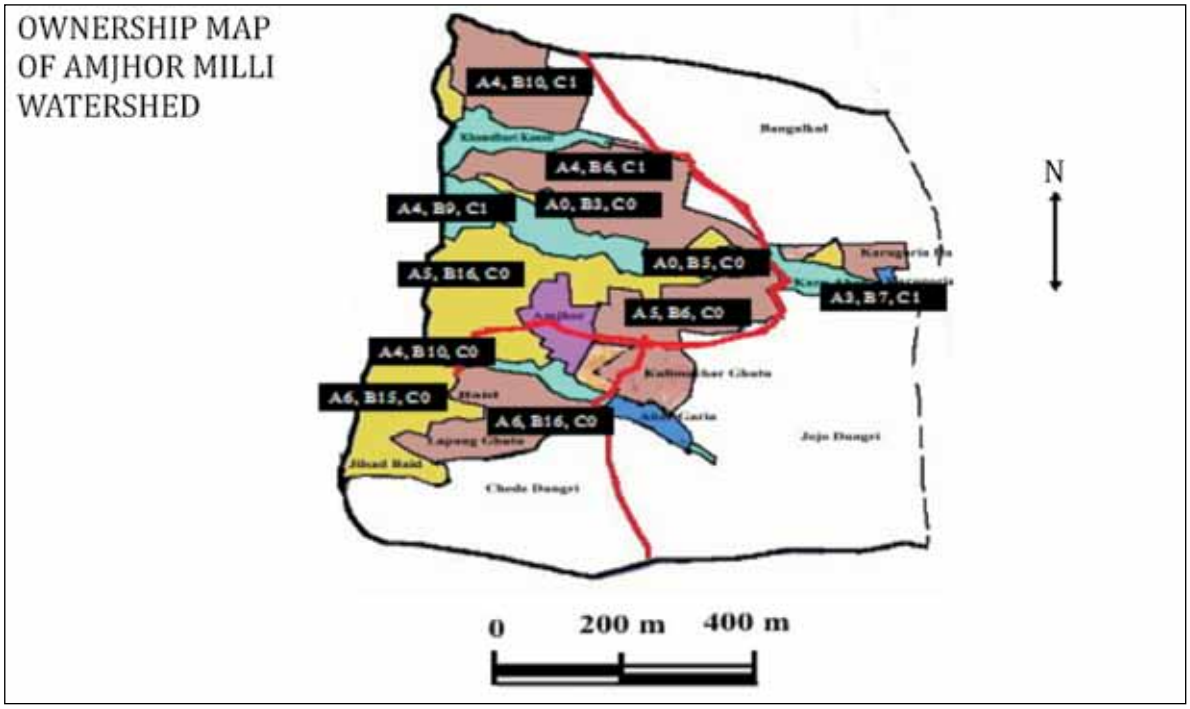


Figure 3.2: Process of Coding and Recording Data on Ownership Map and Land Use

Ownership Mapping

1. A patch with 3 owners from the A category, 4 from the B category and 2 from the C category can be coded as 3A, 4B, 2C (A,B and C are the code used in the wealth ranking exercise). This coding is done to identify which patch of land is owned by poor families, so as to prioritize the interventions.

2. Cropping seasons are coded as:

   K: Kharif

   R: Rabi

   S: Summer

3. Crops are coded as follows:

   C: Cereals

   O: Oilseeds

   P: Pulses

   V: Vegetables

   H: Horticulture

   F: Fisheries

   FO: Fodder

   FS: Forest trees

   FA: Fallow

Use of Codes: An Example

In `X' patch, someone has 200 decimals of land of which 100 is used for kharif vegetables, 20 for oilseeds in kharif, 10 for summer vegetables and the remaining 80 decimals remain fallow. This data will be recorded in the following manner:

100 KV + 20 KO + 10 SV + 80 FA

3.9.6. Process Involved

I. Let PEC members invite the family for the meeting.

II. Write the patch-wise names, as mentioned in the resource map, on the chart papers; have on PEC member display these. Record the names of the landowners and their spouses against each patch.

III. In case of share cropping/barga, for each plot number the names of the present users, relationship with the plot owner along with approximate area is discussed.

IV. Form sub-groups of respective patches, comprising landowners, land users and their spouses and PEC members in each sub-group.

V. Record the data of the landholdings, the present use (in Kharif, rabi and summer seasons) and the irrigation coverage on a chart paper, after consultations with the landowners/family members.

VI. Display all the data (describing all the patches) consolidated by the PEC.

VII. Enter the data on the resource map, after confirmation by the villagers, mentioning the codes (wealth ranking, season and crops.) this is an in-house exercise; however, the data need to be verified during the field visit, as detailed in the problem identification and options generations steps. This will also help to include the families not participating in the exercise.

3.10. Problem Identification

The process of analyzing and delineating the problems for each patch of land and other natural resources is called problem identification. This is required for generating alternative options, to overcome these problems.

3.10.1. Process Involved

- Ask the PEC members to arrange a date and time for the interaction. Ask them to inform the owners of each patch and their spouses about the place where the planning will be done). The presence of the women is compulsory because they see the problems from a different perspective.
- Ask the PEC members present at the planning process to share about the resource and ownership maps that they had prepared earlier.
- Visit each patch of land in the presence of the owner's family, to identify/verify the existing problems in each patch.
- Note the typical features of each patch such as the type of soil, depth of soil, water holding capacity, slope, erosion, vegetation, irrigation, crop productivity, etc.
- Note also the constraining factors at the family level related to the workforce, draft animals, remoteness, cash flow, etc.
- Ask the PEC members to triangulate these data in the village meeting.
- Document all the data collected in the formats mentioned in the option generation part.

Note: *Record all the responses from the landowners without any judgement; also try not to impose your own biases/opinion.*

3.10.2. Expected Output

Area of a patch, its current land use and problems are identified and documented; the maps are also prepared, to overcome the problems.

3.10.3. Process Involved

- Visit each patch with all the owners and their spouses (a must). After Identifying its problems and understanding the present land use, help the owner's families to brainstorm possible alternatives to deal with the problems in a better way. (Refer to INRM technologies for information on the type of options available for each patch of land).
- For each alternative, have the owners' families calculate the costs and benefits involved during the visit itself. It helps to select the best option available in consultation with the families.
- Expected Outcome
- Multiple options for treating problems in each land type will be generated.

- Time Involved
- Problem identification and options generation take around 2 days for a village of around 100 households, with 100-120 ha of land.

Note:

- *The patch-wise problem identification and options generated are done simultaneously. This is because landowners are available during the field visit and it is easier to relate the problem/s with the option/s generated. It also saves time.*
- *Carrying a measuring tape, water level marker and calculator during the field visit saves time.*

Table 3.4: Patch-wise Data collection Format for options in the field visit

Sl No	Name of the owner	Category (A/B/C)	Land Holding (ha)	Crops grown with respective areas			Irrigation in Ha			Problems	Options Gene-rated	Re-marks (Present returns etc.)
				kharif	Rabi	Summer	kharif	Rabi	Summer			

3.11. Activity Plan and Scheduling

Different options are scrutinized with the villagers; options that are most cost effective and acceptable to the comm unity are selected. These selected options form the basis of the final action plan. The preparation of an activity involves the following:

1. Preparation of a general plan
2. Preparation of a plan addressing the concerns of women and the landless
3. Preparation of a projected land use map

3.11.1. Process Involved for Preparing a General Plan

- Ask the PEC members to organize a village meeting after the patch-wise problem identification and option generation are over.
- Have the members initiate the meeting by sharing the maps (resource and ownership, land use).
- Have the members mention that the purpose of the meeting is to prioritize the options generated in all patches.
- Ask the women members to articulate the process undertaken so far and describe the maps in their local language. Special emphasis is given to the concerns raised by women members.
- Have the members discuss the options generated and select the best option for each patch of land. (Before initiating this exercise, one should go through the technology chapter to give an overview of the projected cost, benefits accrued from the proposed intervention.)

- Generate the Action plan, comprising the best options. The members prioritize and sequence the proposed activities (from upland to lowland) and form a timeline.
- Have the PEC record the Action Plan and the time-line in the minutes book of the VLA. Ensure at least 80% attendance in this meeting.

Table 3.5: The following format can be used for noting down the Activity Plan.

No	Name of the Patch	Name of the Landowner	Area in Ha	Options Generated	Type of Intervention	Year of Implementation
1	Pokhribera	Lakhan Hasda	1	Lowland tanks, well	Lowland tank (40' x 40' x 8'), bund plantation	2nd year
		Sitaram Hasda	0.5	Lowland well, small tank	Dug Well (20' x 15')	1st Year

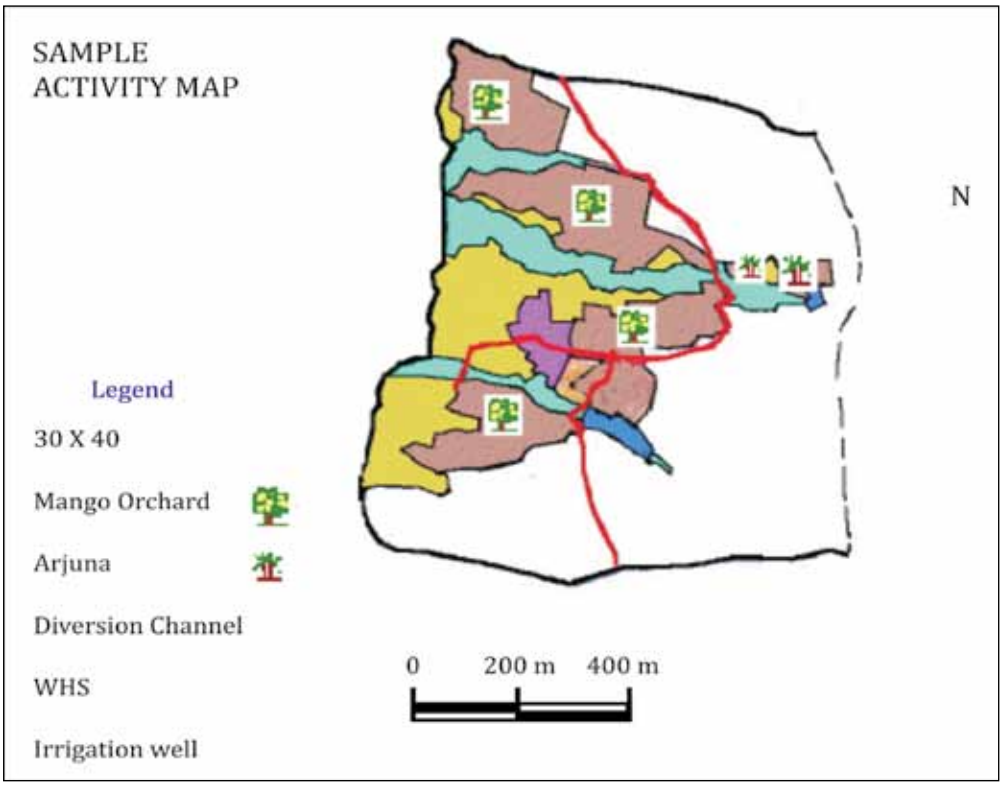


Figure 3.3: Sample Activity Map

Case Study: Transforming Lives through INRM

Dinabandhu Manjhi, a resident of Ponra village, heads a family of seven, which includes his wife sarswati and five children. He owns 4 acres of upland of which only 0.66 acres was paddy and the rest was mostly unproductive.

The Paddy yield was miserable – only 3.5 quintals in a year with sufficient rains. An occasional crop of tomato and maize during the Kharif season fetched him an additional Rs 3,600. For sustenance, Dinabandhu depended on goat trading; fishing from the adjacent river, wage labour and lac cultivation. Despite all his efforts, he was barely able to make both ends meet.

During an INRM intervention in his village, Dinabandhu together with his family decided to use 3 acres of his unused upland for grafted Mango plantation (400 saplings of the Amrapalli variety). The intervention provided for a well to support the entire plantation of 15 acres. Dinabandhu also constructed two 5% pits in his upland paddy land. The assured irrigation helped him cultivation pumpkin and arhar (Pigeon Pea) in the horticulture patch and rear fish in the 5% pits.

Subsequently, Dinabandhu's earnings changed dramatically. His unproductive asset became the most prized asset. He earned Rs 4,120 from his crop of pumpkin and arhar in the very first year. Water from the 5% pits doubled the paddy production. Well irrigation helped him cultivate vegetables, such as bottle gourd and tomato, in his paddy land. The wages earned during the project period helped him take another 1 acre of land on lease. Dinabandhu plans to purchase this land in near future.

Three years after planting the mango saplings, he has sold 3.5 quintals of mango for Rs 3,360. Another consignment of 1 quintal has been sent to Singapore, the expected earnings from which is at least Rs 6,000. This yield from the mango plants will keep on increasing every year. In the 10th year, the expected income is Rs 75,000 at 40 kg of fruits per plant.

In their own words, both Dinabandhu and Sarswati say, "Our lives have completely changed. Over and above sufficient income there is leisure time, which previously was simply unimaginable. There is no need to go in search of employment."

3.11.2. Plan based on Concerns Raised by the Landless Families and Women

A separate plan is made in order to ensure the inclusion of the most downtrodden section of society in the process of development. This ensures that the pro-poor focus of the programme is retained. This plan is prepared simultaneously and alongside the general plan. The planning process can be initiated where women can voice the problems they face in carrying out the activities exclusive for home management such as fetching drinking water or post-harvest activities that can be addressed in this programme.

3.11.3. Process Involved

1. Conduct meetings with marginal farmers, landless, women or other backward sections of the people.
2. Identify their present skills, resources and problems in these meetings.

3. Help them to brainstorm about possible alternatives to combat their problems, using their present resources and skills (in the context of integrating the same with the INRM approach, for example, vermi-compost production, poly house nursery and seedling preparation, and goat rearing).
4. Prioritize and finalize these options at the village level, options generation meeting. Use this to prepare a separate action plan for the landless and the women. It may include any other need of the villagers to improve their living, for example, roads and electricity.

However, this is an area that requires further exploration, in order to generate various alternatives, beneficial for the landless in the context of the INRM approach.

The women of Barokuli

In the planning meeting with women at Bankura, the women of Barokuli hamlet shared their pain in having to lift water from the dug well – the only drinking water source in the hamlet. The well does not have a pulley. They also spoke about the problems of drying paddy grain and bathing publicly in the village pond. In the planning exercise, a discussion was facilitated to generate options to overcome the problems. The women came up with three options – a pulley for the dug well, a community threshing floor for drying paddy, and a dressing room by the side of the village pond.

3.11.4. Preparation of the Projected Land Use Map

Once the activity plan has been finalized, an expected land use map is prepared based on the proposed activities. The process of preparing this map is similar to the process of resource mapping. Herein, treated patches with proposed land use are shown on a revenue map of the village. At the end of the project period, the projected land use is compared to the existing land use to judge how far the expectation have been met.

3.12. Budget Preparation and Obtaining Approval of the VLA

This involves the preparation of estimates and the consolidation of these, to understand the total plan outlay.

The following format can be used to prepare the budget.

Name of the Patch	Name of the Landowner	Proposed Plan	Unit	Rate (in Rs)	Estimated Cost (in Rs)	Remarks

One can refer to the unit rate of each intervention in the activity chapter. For preparing the estimate, one must refer to the latest Schedule of Rates (SoR). (The SoR is available with the line departments of the districts, private book stall etc.)

3.12.1. Approval of the Plan

This involves obtaining final approval of the resource management plans from the VLA.

3.12.2. Process Involved

- After the activity plans of all the hamlets in a village have been finalized, the PEC members share these plans at the VLA meeting. Patch-wise plans are shared in the HLA before bringing it to the VLA.
- The members discuss the plan, provide necessary clarifications and help sort out disagreements. The PEC members are asked to make the necessary changes in the plan on the basis of the given inputs.
- Finally, the VLA's approval of the plan is formalized by recording the signature or impressions of the left thumb in the meeting register.

3.12.3. Obtaining Sanction

- This involves submission of the approved plan of the village to the government authorities at the district and getting money for implementing the proposed village-level plan.

3.12.4. Process Involved

- After obtaining approval of the VLA, the PEC will integrate all the activity plans into a village-approved plan document.
- The plan will be submitted to the respective donors for approval and sanction.

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Implementation and Financing

PEC (Programme Execution Committee) – PEC is constituted at the village level for the execution of the schematic works in each village.

HLA (Hamlet Level Association) – HLA is constituted at the hamlet (Tola) level in the villages for the execution of the schematic work at the hamlet level. It works as a subsidiary unit of PEC.

CSP (Community Service Providers) – A Community Service Provider (CSP) is a person from the local community who provides services such as knowledge and information around INRM to the community, as and when required

PIA (Project Implementing Agency) – PIA refers to all special staffing and other arrangements made in the agencies to manage and implement projects.

SHG (Self Help Group) – A SHG is a group of micro entrepreneurs having homogenous social and economic backgrounds, voluntarily coming together to save regular small sums of money, mutually agreeing to contribute to a common fund and to meet their emergencies needs on the basis of mutual help.

Gram Sabha – The Gram Sabha is a meeting of all adults who live in the area covered by a Panchayat. Anyone who is 18 years old or more and who has the right to vote is a member of the Gram Sabha.

4.1. The Implementation Mechanisms for Structural Measures

Task	Sub-task
Mechanism of fund flow	• Selection of functionaries • Opening of bank account
Capacity building	• Capacity building of Project Execution Committee (PEC) members • Capacity building of accountants and supervisors of PEC/HLA
Implementation structure	• Preparation of a half-yearly/quarterly indent by the PEC • Generation of a weekly indent by the HLA and submission to the PEC • CSP give layout in the field • Measurement of the earthwork done and preparation of bills • Weekly payment and settlements of bills • Book-keeping
Monitoring mechanism	• Monitoring at the PEC level • Monitoring at the HLA level • Monitoring at the VLA level

4.2. Overview of the Implementation Mechanism and the Fund Flow

The PEC consolidates the HLA plans and presents this to the VLA. As and when the plan is approved by the VLA, the PEC submits it to the government/respective funding agency for necessary sanctioning and fund release.

Once the plan is sanctioned, PEC members select three office bearers to become signatories of the bank account. The PEC then opens a bank account in the nearest bank branch, through which it will channelize the funds for sanctioned activities.

At the village level, the VLA engages in a process of weekly planning (activities, which are a part of the overall plan). The members decide on the work that needs to be undertaken in the following week, the money required for the same, the person(s) to supervise the work, etc. The PEC consolidates the weekly indent of the village and withdraws money from the bank. The community service provider (CSP) appointed by the VLA looks after the work, takes the measurements and prepares the muster rolls/bills.

The PEC meets every week for the purpose of payment for the works done or for advances, reviews the work progress of the previous week, plans for the coming week and estimates the money required. Bills/Muster rolls against the advances and expenditure are collected in the meeting. Labour payment, payment to the CSP and all related payments are made by the PEC. Advance payments should be avoided at all costs.

The PEC accountant maintains the accounts and the records such as the minutes book, cash book, ledger, vouchers, cheque register and stock register. S/he also checks the measurements and bills. The PEC accounts are subject to an annual audit.

A series of training programmes are conducted at various levels (for example, PEC members, supervisors, accountant, landowners and their spouses) for smooth implementation.

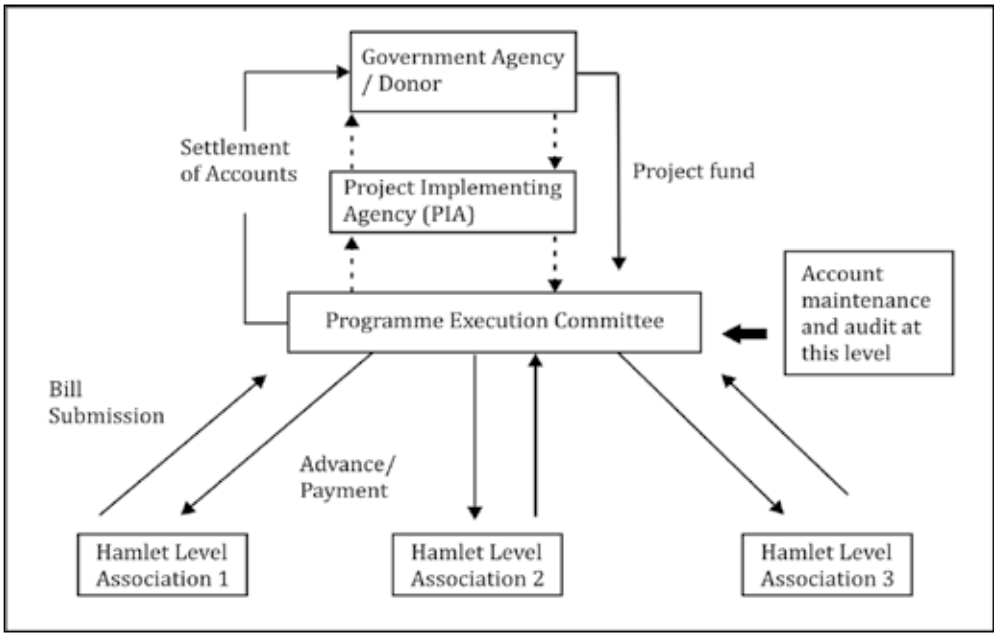


Figure 4.1: Implementation Mechanism and the Fund Flow

4.3. Fund-flow Mechanism

Pre-implementation phase

This phase involves:

1. Selection of functionaries (office bearers, accountant, CSP)
2. Opening of bank account
3. Training of PEC members, accountant and CSP/CRP

4.3.1. Selection of Functionaries

- Selection of office bearers

Roles and responsibilities

- Operate the bank account
- Maintain the books of accounts
- Manage the cash flow and finances
- Coordinate with the respective funding agencies and Project Implementing Agency (PIA)
- Carry out statutory requirements (for example audit, reporting, compliances, etc.)
- Make payments to the persons/parties
- Coordinate with other PEC members and CSP

Membership

- Any three PEC members[12]
- At least two out of three members should be literate[13]
- Representation from different hamlets
- It can be all women or at least one woman PEC member

4.3.2. Process for the selection of office bearers

- The PEC members conduct a meeting at a date convenient to all members. A PEC representative or a cluster leader of SHGs can facilitate the meeting.
- The PEC representative or the cluster leader shares the objective of the meeting, which is to select the office bearers; she/he also shares about the roles and responsibilities of the office bearers.
- Three members are selected consensually (only one member from a family is eligible for selection).
- The decision to open the savings bank account in the nearest bank (mentioning the name of the branch) is taken.

[12] In some cases, one representative from the PIA may be one of the signatories of the bank account as per the requirement of the funding agency.

[13] A minimum understanding of addition, counting, reading and writing is necessary.

- The three office bearers are asked to arrange for passport size photographs (3 copies each) within 7 days so that the bank account may be opened.
- The PEC members decide to collect the required amount to be deposited in the bank account (the minimum is Rs 500), the expenses to purchase a register, stamp pad, box, lock, stamp, etc., from the VLA members. Hamlet representatives take the responsibility of collecting the money from their hamlets and deposit the same at the PEC meeting within a specific period (preferably 7 days). The bank deposit amount may be collected from the SHGs, and gram sabha (GS) members may collect the money to purchase the stationery items.
- A resolution for doing the above mentioned point is recorded by one of the members in the meeting register. This is read by the PEC representative/cluster leader and all attendees sign the resolution.
- The meeting ends with vote of thanks by the PEC representative or cluster leader, whoever is conducting the meeting.

Note: *During the selection of office bearers, the following needs to be kept in mind:*

- *Do the office bearers have two identity cards, mentioning the same name, surname and address proof of each person? For example, a ration card/voter card/certificate from the panchayat pradhan, people's representative/SC/ST certificate, etc.*
- *Does at least one of the identity cards have a photo of the person? For example, voter identity card/pan card/pass book of any individual bank account in the same branch/job card with a photo/any other.*
- *For availing of cheque facility, at least two of the office bearers must be able to sign/write their names.*

Time required: Half a day

- Selection of the PEC accountant

4.3.3. Roles and responsibilities

- Maintains the books of accounts
- Prepares the statement of expenditure
- Prepares the receipt payment statement
- Prepares the audit report and statutory compliances

A suitable PEC accountant

- Is between 18 and 40 years.
- Is preferably from the same village and is accepted by the villagers.
- Is at least a 10th pass.
- Is regarded by villagers as honest, transparent and hardworking.
- Has time available to take on the role.

Preference is given to a person with some basic knowledge of measurement and maintaining books of accounts.

4.4. Selection of a CSP

Roles and responsibility

- Maintain records related to measurement, muster rolls, bills and advances at the village level.
- Prepares the muster rolls.
- Provides technical guidance to the villagers during construction.
- Compiles the bills at the hamlet and the village levels.
- Co-ordinates with the accountant and the PEC.

Characteristics of a good CSP

- Is between 18 and 40 years
- Is preferably from the same hamlet/village and accepted by the villagers.
- Is at least a 10th pass
- Is known to be honest, transparent and hardworking.
- Is familiar with the terrain, land-use maps and farming practices.
- Has the time available to play the role.

Preference is given to a person with some knowledge about the farm-based livelihood activities of the area, and about measurement and basic skills of accounting.

4.1.1. Process of selection of the accountant and the CSP

- The PEC members fix a date for the VLA meeting. A PEC or a cluster representative may facilitate the meeting.
- The representative announces that the objective of the meeting is to select an accountant and a CSP. S/he also shares about the expected roles and responsibilities.
- The members share the criteria for the selection of the accountant and the CSP with all. The villagers may suggest other criteria for inclusion, depending on the local situation.
- The PEC generates a list of probable persons for the post of the accountant and the supervisor.
- After the villagers agree about the nominated persons, the PEC finalizes the selection of the accountant and the CSP.
- A resolution to this effect is recorded by one of the members in the meeting register. This is read out and the members sign the resolution.
- The meeting ends with vote of thanks by the PEC or the cluster leader, whosoever is conducting the meeting.

[14] PEC members, barring the office bearers, can also perform the roles.

Time required: *Half a day*

All the functionaries (office bearers, accountant, CSP and PEC members) selected for different roles and responsibilities can be changed, depending on their performance, which may be reviewed by the VLA at any point of time. The selection process, as mentioned, is to be repeated for the new persons.

4.5. Opening a Bank Account

On a fixed date, the three office bearers go to a nearby bank and open a savings bank account. The following documents are required to open a bank account, in addition to the physical presence of the three members:

- Three passport size photographs of each office bearer.
- A photocopy of the photo-identity proof of each office bearer.
- A photocopy and the original (for verification at by the bank) of the ration card/voter identity card or an address proof certificate by a local leader of each office bearer.
- A copy of the resolution of the PEC meeting and the minutes (the selection process of the office bearers, decision to open a bank account, names of the account holder, for example, PEC, VLA, etc.)
- A copy of the resolution of the VLA meeting (selection of PEC members).
- Money, collected by the VLA members, that is to be deposited (at least Rs 500 is required to open a bank account with cheque facility).
- The name of a person/group that has had an operative account in the same branch for more than six months.

Note: *Depending on the funding agency and project requirement, the VLA may need to open a separate Village Development Fund (VDF)/Watershed Development Fund (WDF) account. The requirement and the process of opening the account are similar to that of a PEC account.*

4.6. Training of PEC Members

The responsibility for the execution of the whole programme lies with the PEC members. Therefore, a series of training programmes for capacity building is conducted.

Training to be conducted:

- INRM approach and structural measures
- Book-keeping

The training on the INRM approach and the structural measures will focus on the following:

- Understanding the INRM approach
- Rationale for each structural intervention
- Technical aspects of each structure
- Role of different stakeholders, for example, donor, facilitating agency, gram panchayat, VLA, accountant, CSP.

The training on book-keeping will focus on the following:

- A basic understanding of the cash book, muster roll, ledger, stock register, asset register, receipt payment voucher, indent, utilization certificate, minutes book, trial balance, etc.
- Fund-flow mechanism
- Rationale of maintaining the books of accounts

4.7. Implementation Phase

This phase involves:

1. Preparation of indent
2. Laying out of structures and measurement of on-going activities
3. Ongoing monitoring of works
4. Payment and bill settlement
5. Book-keeping

4.7.1. Preparation of indent

Half yearly (or as per the requirement of the funding agency) indent by the PEC to the funding agency/ PIA is to be submitted in order to get the required fund in its account.

A funding agency usually requires a half-yearly/periodic indent of the work that will be completed in the following months. The PEC conducts a meeting and collates the activities to be carried out over the next six months from the resource management plan.

The PEC consolidates the same, using the following sample format.

Table 4.1: Sample Half-yearly Plan and Budget

Name of the Village : Talaburu
Name of the PEC : Karyakarini Samiti
Period : 01/04/2008 to 30/09/2008

No.	Month	Work to be Undertaken	Unit	Total Units to be Undertaken	Total Fund Required (Rs)	Total Workdays to be Generated	Materials Required
1	January						
2	February						
3	March						
4	April	Lowland tank	Number	10	150000	1500	Nil
		Timber plantation– pit digging	Acres	10	6800	68	Nil

No.	Month	Work to be Undertaken	Unit	Total Units to be Undertaken	Total Fund Required (Rs)	Total Workdays to be Generated	Materials Required
5	May	Timber plantation– pit filling	Acres	10	13600	68	Manure and fertilizer: Rs 6800
		5% model	Acre	20	220000	68	Nil
6	June	Fencing in plantation area	Acre	10	20000	2200	Fencing Material; Rs 10000
7	July	Plantation	Acre	10	47000	100	Saplings: Rs 17000
8	August	Inter-culture in plantation	Acre	10	5000	300	Fertilizer: Rs 1000
9	September	Plantation maintenance	Acre	10	5000	40	Pesticides: Rs 1000
10	October					40	
11	November						
12	December						
			Total		467400	4316	35800
(Signature of the office Bearers of PEC) (Seal of PEC)						Date:	

Weekly Indent by the Hamlet Representative and Submission to PEC

Once the budget is approved and the required money is released to the PEC bank account, the demand for work starts from the hamlet. The representatives generate the weekly demand for work and the amount required for payment. They prepare it in the hamlet-level meeting, taking the consensus of all, and submit it to the PEC for funds.

A sample format for generating an indent is attached.

Table 4.2: Format of Indent from Hamlet Level to PEC

Name of Hamlet : *Kulugutu* Village : *Talaburu*

Name of PEC : *Gram Sabha Karyakarini Samiti*

Period : 08/04/2008 to 14/04/2008

No.	Works to be Undertaken	Labour Requirement	Expected Expenditure (in Rs)
1.	Earth work in the lowland tank (4 units)	150	15,000
2.	Pit digging (4 acres)	24	2,400
	Total	174	17,400

Unsettled advance: Rs 1,000

Amount required: Rs 16,400

(Signature of hamlet representatives) Date:

4.7.2. Laying out of the Structure in the Field by the CSP

Checklist: Landowner, measuring tape, calculator, copy of the resource management plan, materials required for marking, for example, lime, ash, wooden sticks, rope, shovel, spade, etc.

Process

- The CSP, the landowner and spouse, accompanied by the PEC member of that hamlet/village/SHG representative will reach the worksite on the scheduled date and time. They will be accompanied by the labour.
- Depending upon the type of structure to be constructed, the layout of the plot is given (See chapter on technology for details of the each structure)
- The outline of the structure is marked with the lime/ash.
- Depending upon the volume of earthwork to be done, the labour and material budgets are calculated; the landowner is informed of this. A written, schematic diagram, with the budget involved for each activity, is handed over to the beneficiary by the PEC representative. An agreement that the beneficiary wants this activity to be taken up on her/his land will be signed on the spot by both the land owner and spouse.
- Some specific tips such as where to put the excavated soil in case of WHT, horticulture pits, 5% model, etc., are detailed in the field during the layout itself.
- Representatives from the PEC help to facilitate the process.

4.7.3. Ongoing Monitoring of the Work

The core responsibility for implementing the plan lies with the PEC members and the CSP.

Things to be focused on during the monitoring of the work in the field include:

- Work conditions at the site: maintenance of safe and hygienic conditions.
- The timing of arrival, departure and duration of the lunch break of daily wagers.
- Quality of the work.
- On-time completion of the task.
- On-job conflict resolution.
- On time payment to the labour.

The CSP keeps a record of the attendance, volume of earthwork per person, materials purchase, etc.

At every work site, a board displaying the name of work, the implementing agency, the estimated cost, the year of implementation, the wage rate, work days generated, command area, families benefited, etc., is to be put up.

Display board at work site

The sanctioned plan should be painted at a central place (somebody's wall/community hall), mentioning the nature of the activity, the sanctioned budget, the number of families to be benefited, the coverage, the names of the implementing agency and the funding agency, etc., preferably in the local language.

For effective implementation and monitoring, it is advisable that weekly meetings are held at the village, the hamlet and the PEC levels. Some items on the agenda could be as follows:

- Status of the ongoing activity
- Physical and financial achievement against the plan
- Issues and concerns faced
- Strategy to address the issues
- Plans for the coming week
- Detailing of the task, along with time-line

Measurement of the work done

Pre-requisites: The physical presence of the landowner and the labour, register, calculator, measuring tape, pen and muster rolls.

Process

- The CSP and the PEC representatives go to the site with the landowner and the labour.
- The CSP takes the measurement on a day decided earlier by the HLA/VLA (if necessary, this can be done more than once a week).
- Person wise measurements of work are recorded by the CSP.

- Calculate the total volume of work along with the payment amount and share it with the labour, in presence of the landowner.
- Prepare the muster rolls and payment details/bills.[15]

Some regular items on the agenda of the HLA meeting include the following

- *Receiving money from the representatives, who have taken advances from the PEC.*
- *Reviewing the progress of the previous week:*
  - What was planned?
  - What was achieved?
  - Payment on receipt of bills/muster rolls.
  - Which activities could not be initiated or completed as per the plan?
  - What were the reasons for this?
- *Planning for the coming week:*
  - What activities are to be taken up?
  - Whose work?
  - Cost estimate for the planned activities.
  - Distribution of stock items.
  - Discussion/distribution of labour.
- *Authorizing representatives* to bring the required advances.
- Any other issues such as conflicts, community action, etc.

[15] Payment details/bills are used to calculate the actual amount of work done and payments are made to the respective persons. Muster rolls are available in stationary shops/government offices and can be used for this purpose. Muster rolls include the details of the payment along with the attendance of labour.

Table 4.3: Sample form for payment details/bill

No.	Name of the Labour	Name of Father/ Husband/ Wife	Date: From-To	Measurement			Total Volume of Earth-work (cft)	Rate (Rs/100 cft)	Total Amount (Rs)	Actual Payment Amount (Rs)	Signature of Labour[16]
				Length (ft)	Breadth (ft)	Height (ft)					
	TOTAL										----------

Landowner's contribution: Rs 153.75

Prepared by: Verified by: Approved by:

(Signature of CSP) (Signature of PEC Representatives) (Signature of PEC Office Bearer)

Date:

Seal of PEC

[16] Signature of the labour is to be taken only during payment. The rest of the payment details may be filled up before payment.

4.7.4. Payment and Bill Settlement

1. Office bearers of the PEC withdraw the amount as per the indent (from the HLAs).
2. The hamlet representative receives the indented money from the PEC before the payment date.
3. The representative, with the help of the CSP and the landowner, makes the payment as per the payment details/bills to the labour. Contribution from the landowner (as per the decided norm) is collected. Signatures/Thumb impressions of the labour are taken in the respective rows of the payment details/bill.
4. For payment against the procurement of materials, all the related bills from the respective parties are collected and verified by the PEC office bearers; vouchers are prepared, as per the following sample format. Supporting bills are attached with the payment voucher. In case the bills are more than Rs 5,000, the signature of the receiver is taken on a revenue stamp on the payment voucher.

Note: *The payment can also be made directly to the family or the landowner by cheque. The CSP and PEC representative must check if the payment has been made to the labour.*

Payment Voucher

Payment Voucher Name of the PEC: Village: Block: Date: 22/05/2008	
Voucher No. 1111	
Particulars	Amount (in Rs)
Total Payment (Cash/Cheque/Draft)	16,219
Received rupees sixteen thousand two hundred nineteen only from the *Gram Sabha Karyakarini Samiti, Talaburu,* in cash. (Signature with date)	
Address:	
Signature of PEC Accountant	(Approved) PEC Office Bearers

5. The completed bills and vouchers, and the demand for the following week are submitted to the PEC by the HLA representative.

4.7.5. Book-keeping

The following books of accounts are maintained by the accountant of the PEC.

Cash Book:

- This is used to maintain the daily transactions (both receipts and payments).

Ledger:

- This is maintained to capture the activity/head/component-wise income and/or expenditure, for example, 5% model, horticulture, owner's contribution, etc.

Ledger

Page No.:

Activity Head:

Total Sanctioned Amount: Total Area:

Date	Particulars	L/F No.	Dr. / Cr.	Amount (in Rs)	Remarks
22/03/08					
29/03/08					
16/05/08					
17/05/08					
17/05/08					
29/06/08					
07/07/08					
14/07/08					
	Total				

Field Diary

- The CSP maintains the details of the works in a field diary, in order to record the daily progress. A sample format is as follows.

		Date				Dimension (ft)			Earth-work (cft)	Person Days	Unit Rate (Rs)	Total Amount (Rs)
No	Name of Labour					Length	Breadth	Height				
	Total											

Stock Register

- This is used for maintaining the stock at the PEC level.

Name of the Stock Item:										
Receipt					Issued					
Date	Parti-culars	Unit	Quantity	Amount (in Rs)	Date	Partic-ulars	Unit	Quan-tity	Amount (in Rs)	Signature of the Person
	Total					Total				
						Balance Stock				

Asset Register

- An asset register is used to keep track of the assets being created. A sample of it is as follows.

No.	Name of the Patch	Name of the Landowner	Plot No.	Type of Inter-vention	Sanctioned Amount (Rs)	Total Expenditure (Rs)	Total Workdays Generated	Signature of the Landowner
Prepared by: Approved by: (Signature of Accountant) Date:			(Signature of PEC Representatives)				Verified by: (Signature of PEC Office Bearer) Seal of PEC	

Note: *As per the project requirement, a food grain register, a muster roll register, a cheque register, etc., may be maintained.*

4.7.6. Completion of the Activity

The utilization certificate is prepared after the completion of the activity. This is prepared for each sanctioned activity and is certified by the office bearers of PEC. This is submitted to the respective funding agency/PIA.

Utilization certificate

Utilization Certificate	Date:
Name of the landowner: Patch : Plot number:	
PEC:	
Activity:	Sanctioned amount:
Dimension of the WHT: Top width: Bottom width: Depth: Volume of earth-work: Dressing of embankment:	Total expenditure:
This is to certify that the above information is true to best of my knowledge and the structure is physically completed. An amount of Rs 14,006 was spent in constructing the WHT. I will utilize the structure for irrigating my fields. Certified by (Signature of landowner)	Verified by (Signature of PEC office-bearers)

Compilation of the activity undertaken is made and given to the funding agency/PIA at least every quarter (this may vary as per the requirement of the funding agency).

Activity compilation report

No.	Name of Patch	Landowner's Name	Plot Number	Interv-ention	Sanctioned Amount (in Rs)	Expenditure (in Rs)	Status of Work	Remarks
		Total						

Prepared by
Approved By

Verified by

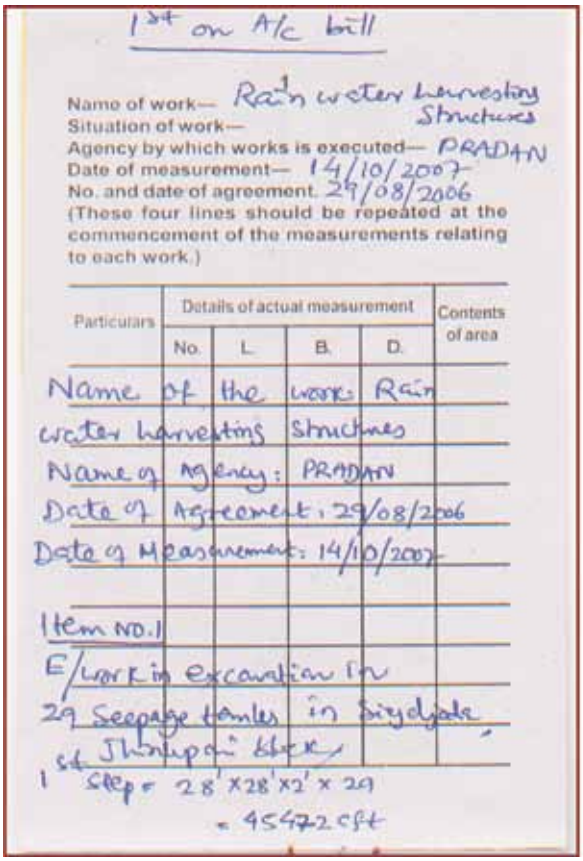
(Signature of Accountant) (Signature of PEC Representatives) (Signature of PEC Office Bearer)

Date:

Seal of PEC

Depending upon the requirement of funding agency, the measurement books (MBs) are prepared and submitted to the agency. MBs are prepared activity-wise; here, the actual dimensions of the structure constructed are mentioned along with the costs incurred.

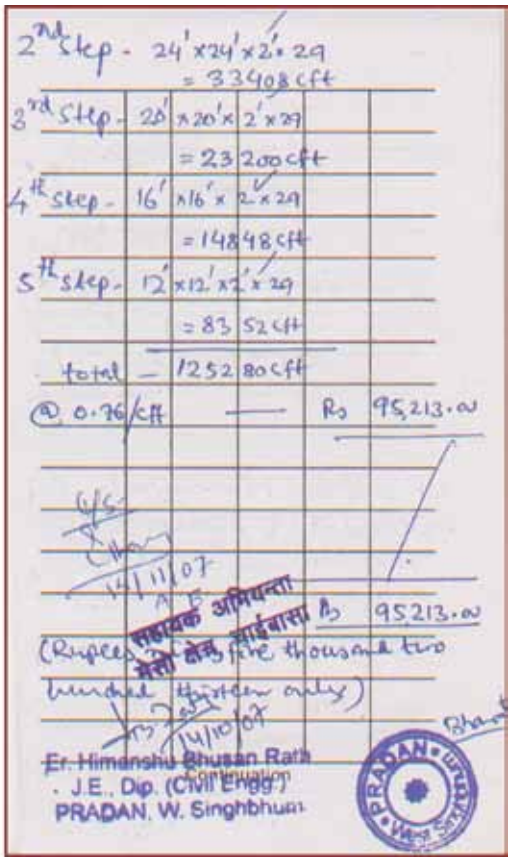
A Measurement Book (MB)



1st on A/c bill

Name of work— Rain water harvesting Structures
Situation of work—
Agency by which works is executed— PRADAN
Date of measurement— 14/10/2007
No. and date of agreement. 29/08/2006
(These four lines should be repeated at the commencement of the measurements relating to each work.)

Particulars	Details of actual measurement				Contents of area
	No.	L.	B.	D.	
Name of the work Rain water harvesting Structures					
Name of Agency: PRADAN					
Date of Agreement: 29/08/2006					
Date of Measurement: 14/10/2007					
Item No. 1					
E/work in excavation in 29 Seepage tanks in Sizdjole at Jhinkpani block,					
1st step = 28'x28'x2'x29 = 45472 cft					



2nd step - 24'x24'x2'x29 = 33408 cft
3rd step - 20'x20'x2'x29 = 23200 cft
4th step - 16'x16'x2'x29 = 14848 cft
5th step - 12'x12'x2'x29 = 8352 cft
total — 125280 cft
@ 0.76/cft — Rs 95,213.00

14/11/07
A.E.
Rs 95213.00
(Rupees ninety five thousand two hundred thirteen only)
14/10/07
Er. Himanshu Bhusan Rath
J.E., Dip. (Civil Engg.)
PRADAN, W. Singhbhum

4.7.7. Annual Audit

In the annual audit of the accounts of the PEC at the village level, all the transactions (receipts and payments, activity-wise expenditure, verification of assets, cash and bank balance) are checked, so as to detect any discrepancies in operations. After the verification of records, a copy of the audited report is submitted to the PIA/Funding agency. The audit may be conducted by the accountant, with the help of the PEC members and the CSP.

The help of the PIA staff may be taken when auditing the accounts if required.

4.7.8. Implementation of Farm-based Livelihoods

For implementing farm-based livelihood activities, the tasks undertaken are as follows:

Tasks	Sub-task
Annual land-based livelihoods plan preparation	• Selection of persons by the villagers to be groomed as CSPs • Consolidation of patch-wise data into a family-wise resource database • Training of CSPs on INRM-based livelihoods planning and implementation • Preparation of the year-round, detailed, land-use plan for every family by the HLA with the help of the CSPs • Preparation of the year-round investment plan, including credit plan by the families with the help of the CSPs
Input procurement	• Funds mobilization • Input arrangement • Distribution process
Maintaining accounts	• Book-keeping at the hamlet level
Implementation	• Hamlet-/village-level implementation plan • Developing a package of practices (PoP) suitable for the area • On-field training to farmers • Delineation of task
Monitoring	• Monitoring by the HLA

Chapter 5

INRM-based Annual Livelihoods Plan Preparation

Objective

1. To prepare year-round livelihoods plan for all the families
2. To prepare detailed action plans for implementation of these plans

5.1. Selection of CSPs[17]

Duration: Half-a-day

Participants: Male and female members of the household at the hamlet-level meeting (on an average 60 villagers)

- Ask the villagers to read aloud the INRM plan for the hamlet.
- Ask questions.
  - Are you able to use the land to its maximum potential, thus increasing the income in the family substantially?
  - What is the deficit figure in your family income and how can it be mitigated?
  - The facilitator should help in making a matrix of the tasks; who will play what role and at which stage is support required?
  - Who will support you in times of need?
  - Is it always possible for external persons to provide timely support?
- Share the need for CSPs. Use a Focused Group Discussion (FGD) to list out the criteria needed for CSPs.
- Generate names.
- Help the group select a CSP, keeping the criteria in view.
- Generate training needs for the CSP.

The villagers will then send the CSPs for training.

[17] These are also called CRPs, village resource persons (VRPs), Vikas Sathi, etc., across the projects.

5.2. Consolidation of the Patch-wise Data into Family-wise Resource Database

The CSP would prepare a household level, resource data base that would be helpful for making family based livelihood plans; it will also work as a baseline data for the families. The patch-wise data, collected during INRM planning process, would be collated to prepare the family-wise resource database.

5.3. Training of CSPs

Details of the training given in the Appendix.

5.4. Preparation of the Year-round, Detailed, Land-use Plan for each Family in the HLAs/SHGs with the Help of the CSPs

Time: 1 day

Participants: Male and female members of each household (on an average, 60 villagers) at the hamlet-level meeting

Facilitator: CSP - S/he attends the meeting with the resource database of all the families in the hamlet.

Training material required: Five chart papers showing the economics of different crops, 15 chart papers, sketch pens, family based planning format on the chart paper, preferably in flex material (for use in other villages also), photographs of different kinds of land use (both traditional and improved)

Ideal time to start this meeting: The planning meeting must be held in the month of February because after the indenting, purchases have to be made. Otherwise, the process gets delayed.

The meeting process is as follows:

- Request all the participants to sit in a circle.
- Share the objectives of the meeting. The CSP shows the members the various uses, both traditional and improved, that can be made of the land that they have; she/he informs them of the economics of the improved and traditional crops, using the chart that was given to her/him during her/his CSP training.
- Ask the group to select one family whose plan has to be formulated first. The family's resource base is discussed in the group and all the participants help the family to make its year-round plan and investment requirement. The family is then assisted in identifying the sources of investment and it makes a credit plan. The CSP facilitates the entire process.
- Divide the participants into sub-groups next. Each sub-group will comprise five families (both the head and the spouse). Within each sub-group, the families help each other to prepare the year-round livelihoods plan, the investment plan and the credit plan. The CSP moves around, providing suggestions and help to all the sub groups, where necessary.
- Have the CSP collect all the plans.

Family-wise Planning Format

Name of the family ..... No. of family member ..... No. of working member .....

Food sufficiency in months .....

Area																		
Atructural measures																		
		Horti Culture					Horti Culture											
Visualised land Use plan																		
Total																		
Annual Plan																		
Total																		

	=		+		+	From external agency

SHG Name ..... Village .....

- Support needed and articulation of constraint
  - Using an FGD (Focused Group Discussion), the CSP will note down the perceived constraints, which would be faced implementing the plan.
  - The HLAs/SHGs plan to address these constraints.
  - Make a note of the supports required from the family and others to realize each plan.

5.5. Credit Plan

- The CSP works out the total investment of each family, with the help of the crop economics chart paper.
- Each family is then asked to plan for the investment (from their own resources, from the bank, from the SHG, from the donor).
- The CSP verifies the possibility of getting the required funds (such as the credibility of a member in the SHG, any loan outstanding in the bank, etc). Based on this, the plan is finalized.
- The CSP helps the families to fill the bank linkage forms.
- After arranging the finance, fix the dates for the final money collection from individual members.

A Community Service Provider (CSP) is a person from the local community who provides services such as knowledge and information around INRM to the community, as and when required. In many locations, knowledge and information on improved farming systems do not reach the community when it needs it. Even if the community does have access to these, traditional farmers need hand-holding support on the field to implement it. There is need, therefore, to see that the latest knowledge and information from the external world reaches the villages on a regular basis. A CSP from the community can play this role, without depending on outsiders.

Criteria for Selection of CSPs

Usually, a woman is preferred to play the role of a CSP. A CSP should:

- Be from the local community (preferably from the same hamlet/village or from a nearby village).
- Be acceptable to the community.
- Have the time to play the role. One CSP works with at least 40–50 families, that is, one hamlet.
- Be able to read, write and do simpler arithmetical calculations.
- Be interested in learning new ideas.

Roles and Responsibilities

A CSP will:

- Help the family prepare a livelihood plan.
- Help institutions (SHGs/HLA/GS) mobilize finances for livelihood activities.
- Train families about improved practices of farming system.
- Provide day-to-day hand-holding support at the field level.

Prerequisites for the Practitioners/ Implementers (Development professional) before the Training and Planning Exercise for the CSPs

- Finalization of the package of practices for the crops (agriculture and horticulture)
- Chart papers showing the economics and the intervention points/stages of major crops
- Photos showing different kinds of land use (both traditional and improved)
- Clarity on crop combination in the context of family, land and climate
- Clarity on the strategy for service delivery (input purchasing and distribution system)
- Clarity on payment systems of CSPs

Note: *The CSPs may assist the families measure the area of their land; this will help in the planning of the input and budgeting.*

Service Delivery Mechanism

Depending on the context, broadly two types of service delivery mechanisms are practised.

1. Promotion of producer entities (centralized system)

Producer entities are promoted when:

- Villagers are not well connected with the market.
- Timely quality inputs are not available in the approachable market.
- Agricultural practices are very traditional and are usually not dependent on outside markets.
- Intensification of one product is required.

2. Linkage with entrepreneurs (decentralized system)

Service delivery is ensured through entrepreneurs when:

- There are some existing, local input shops.
- There are a significant number of families desiring improved agriculture
- There are better approachable roads throughout the year to the villages.

5.6. Input Procurement

Mobilization of funds

For any intervention, the community level institutions (SHG/HLA/GS) ensure the finance required for the member as per the family plan. The inputs like seed, fertilizer, implements etc which, are required for carrying out the interventions need to be ensured at the doorstep, maintaining the quality, quantity and proper time.

There could be different approaches to different situations. Two examples are:

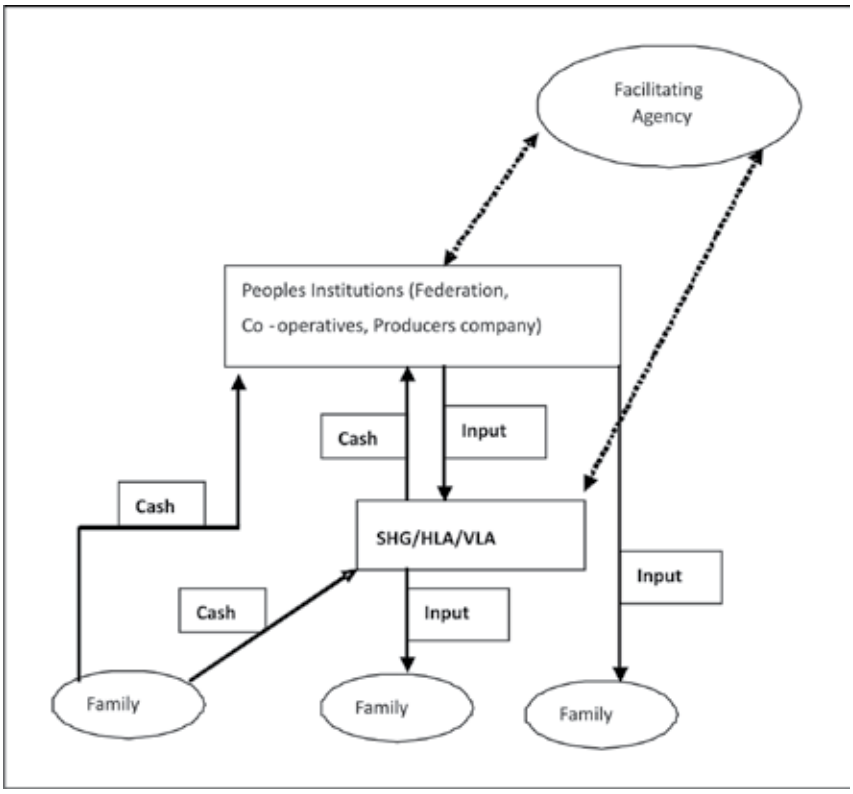


Figure 5.1: Approach 1

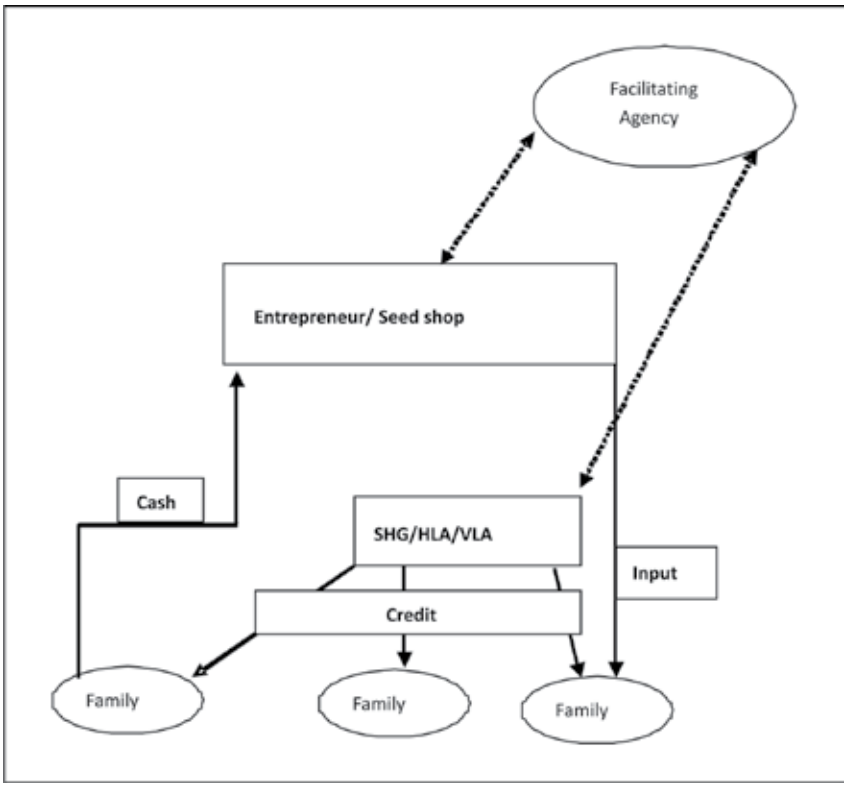


Figure 5.2: Approach 2

Note 1: *Sometimes a plan cannot be implemented because finances are not available on time. The reasons for this may be:*

- The bank did not disburse the amount in time and there are no substitute mechanisms.
- The family was unable to arrange the money that it planned.
- There are loans outstanding against the family because of which it did not receive a loan from its SHG.
- Care should be taken to address these hurdles by preparing the plans detailing of sources of fund and the time when it will be available for each family need to be worked out during planning.

5.7. Input Arrangement

Objective: Getting the quality input on time.

5.7.1. Process

Step 1: The CSP/facilitating agency helps the villagers meet the dealers, distributors and company representatives. This is done to share the year's plans and strategies, and the tentative estimate of the inputs. On the basis of the outcomes of that meeting, a tentative order is placed by the village level institution to the relevant sources. Facilitating agency helps to establish a working agreement between the community and the input suppliers for supply of inputs on credit. This is done for a mutually agreed period with a clause for the community to be able to return unused/surplus inputs within a mutually agreed timeframe.

Step 2: Data compilation

The CSP records SHG/Hamlet/Village data of each family in a register (input delivery register/stock register). A format is prepared to record the quantity of inputs required at different points of time. An estimate of the cash flow is prepared that helps in ensuring timely delivery of inputs.

The following are given preference:

- Bulk purchasing strategy
- Compiling the data of a cluster of contiguous villages (5–10 villages)

Ensure that systems are developed for availability of cash book, ledger, challans and receipt/payment vouchers and stock at the village and central level.

Checklist of purchasing/arranging inputs

- Expiry date of the product, germination percentage, physical impurity, seed treatment status, MRP, company name and logo, sealed or distorted pack, etc.
- Go through the leaflet provided by the company for each product.
- In case of doubt, consult experts.
- Prefer tested and well-accepted inputs. (New inputs must be tested before scaling up. If possible, try to get the free sample from the dealer/distributor.)
- Reputed tested companies should be preferred.

- Physically verify a uniform seed size, any disease or pest infestation, age of seedling for plantation, healthy seedlings, etc.
- Conduct tests such as germination tests for the seed, fertilizer tests, etc.

Even if some seeds are from trustworthy farmers, these need to be checked as per the above.

Germination Test

This is a test to identify effective seeds, which will sprout and produce plants. Before selecting a particular seed, a germination test should be done.

Process of testing:

Take 200 seeds from a packet of paddy seeds on a random basis.

Take two trays each of about 6 x 4 inches, and depth of 1 to 2 inches and make 3 or 4 small holes to drain out the excess water.

Fill the trays with sand and wet it.

Put the seeds in the sand in a line, at a space of 1 x 1 cm

Cover the tray with a piece of newspaper and spray water over it so that it is fully wet.

Water the seeds twice or three times.

Put it in shade at room temperature.

Check if the seeds have sprouted after 2 to 4 days

Count the seeds that have sprouted (S).

Calculate the percentage of germination, using the formula:

$$\text{Germination\%} = \frac{S}{200} \times 100$$

Note: *Germination percentage should be at least more than 60% for any field crop There are other methods to test germination such as wet cloth testing, blotting paper testing, etc.*

Fertilizer Test

For example: potash fertilizer.

Process:
Take a handful of fertilizer in a bowl.

Dilute it with water.
Check whether the water gets coloured (reddish) or not. If it does not get coloured, it is a good quality fertilizer.

5.8. Distribution Process

5.8.1. Objective

Establishing systems and processes to ensure the availability of inputs at the doorstep on time.

The distribution process includes:

- Facilitating the institution (SHG, PI, gram sabha, etc.) to ensure logistics such as identifying stock centres, selecting the stock in-charge, determining distribution mechanisms, etc., through interactions with the villagers. The stock centres should be well ventilated and have dried floors, etc.
- Training the stock in-charge in book-keeping, maintaining stock registers, distribution ledgers, family cards, receipts and payment vouchers, etc.
- Calculating, at the institution level, the input requirements, family-wise as well as month-wise, for each stock centre
- Ensuring availability of all inputs on time at the stock centres.
- Sharing with the villagers by the stock in-charge/CSP about the availability of inputs.
- Preparing a chart in the local language with a list of all items, quantities and the rates, and displaying this on the wall of the stock centre.
- Recording each transaction (giving inputs, receiving money, etc.) in the registers such as the stock register, distribution register, farmer's cards and other relevant challans/bills.
- Sharing the status of the stock centres in the institution (SHG/PEC/GS, etc.) meetings by the stock in-charge or the CSPs.
- Reviewing the condition of the stock centres regularly by the SHG/HLA/GS such as proper storage of inputs, losses, etc..
- Taking special care to purchase pesticides in a sealed packet, to be distributed to the families. Keep the pesticides in a safe place.
- Informing the villagers about the safety measures to be taken when handling pesticides.

Note: *Families purchasing directly from the entrepreneurs/shops must ensure that the input arrangement and distribution process by the SHG/HLA/GS mentioned earlier are adhered to.*

5.9. Maintaining Accounts

5.9.1. Objective

To maintain a transparent and efficient fund management system

5.9.2. Process

- Select an accountant at the institution level, who will be involved at the integration level in the process. (The accountant of the SHG/cluster/PEC/co-operative, etc., can also play this role.)
- Train the accountant to handle the stock register, ledger, challans, receipts and payment vouchers, cashbook, etc.

- Record each transaction immediately in the respective books.
- Consolidate monthly accounts.
- Review the status frequently
- Verify the stock centres physically on a regular basis.

Note: *For institutions, working with a significant number of families (more than 500 families), a user-friendly software for accounting and financial management needs to be developed.*

5.10. Implementation

- Village-level meeting

5.10.1. Objective

- To prepare detailed tasks month-wise for executing the plan
- To finalize important dates for the required events

The men and women of the households attend the event.

Duration: 4 hours

5.10.2. Process

- Sit in a circle.
- Greet everybody.
- The CSP presents the plan briefly, highlighting the important activities. Have an FGD to demonstrate the process of generating tasks to implement one activity, for example SRI, and the time-line for each task.
- Break into activity-wise sub groups (10–15 members in each group) for detailing the tasks and the time-lines: (45 minutes).
- Display the prepared chart and share it and take consent from the villagers.
- Consolidate the tasks **generated** for each month of all activities.
- Fix the tentative dates at least for one crop period or subsequent 3 months for essential events such as nursery raising training and crop practices training.

A sample annual calendar of events and responsibilities for various tasks in a particular year

Tasks	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	*Responsibility
Pest management training for Rabi crop													**PRADAN**
Input availing for summer crop													**Villagers and stock centre**
Summer crop implementation training													**CSP**
Summer crop implementation													
Inter-culture operation and pest management training of summer crop													**CSP**
Inter-culture operation and pest management of summer crop													
Annual vegetative planning event													**PRADAN**
Submitting application for bank linkage													**SHG,CSP**
Bank linkage follow-up													**SHG,CSP**
Money arrangements as per the plan													**SHG, Villagers, GS**
Input arrangements													**Villagers and stock centre**
Stock centre finalization													**Villagers and PRADAN**
Pit digging and layout training													**CSP**

A sample annual calendar of events and responsibilities for various tasks in a particular year

Tasks	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	*Responsibility
Pit digging for plantation work													
Fencing for plantation work													
Land preparation for kharif crop													
Taking the status of input availability													
Input purchasing/availing													**Villagers/Stock centre**
Dhaincha sowing													
Nursery raising training (for HYV paddy and vegetables) in the field													**CSP**
Nursery raising													
Vegetable implementation training													**CSP**
Seed sowing for vegetables													
Pit filling for plantation													
Wet-bed nursery raising of HYV paddy													
SRI nursery raising													
SRI/HYV transplantation training													**CSP**
SRI/HYV transplantation													
Inter-culture and fertilizer application for vegetables													

A sample annual calendar of events and responsibilities for various tasks in a particular year

Tasks	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	*Responsibility
Planting the saplings for plantation crops													
Weeding/hoeing of SRI													
Staking/Machan-making for tomato and creeper													
Pest management training of kharif crop													**PRADAN**
Rabi and summer crop input arrangement													**Villagers and stock centres**
Inter-culture operations for plantation													
Land preparation for rabi crop													
Rabi crop training													**PRADAN**
Rabi crop implementation													
Inter-culture of rabi crop													
Spraying (as per the schedule)													
Yield data collection													

** The blank rows indicate that HLA/villagers are responsible.*

Note: *Prepare the matrix on a chart paper in the meeting.*

- Developing a package of practices (PoP) suitable for the area.

As per the crops finalized in the plan, a detailed PoP for the crop is to be prepared for the season.

5.10.3. Process

The steps to generate a shared PoP is as per the following.

i. Schedule a two-day event for this.

ii. Invite expert farmers (having expertise in the crops that are being planned), expert scientists and general farmers of the local area in the meeting.

iii. Keeping handy PoPs that has been implemented earlier

iv. Share the experience of the farmers around the specific crop.

v. List out major problems because of which crop loss takes place.

vi. Generate options for solving the problem.

vii. Farmers are asked to choose the best suitable options, as per their understanding (facilitate the farmers in taking a decision by looking at all factors)

viii. Generate options for other practices of the crop.

ix. Finalize the PoP of the crop.

On-field training followed by implementation

Verbal instructions alone do not help farmers understand what exactly needs to be done in the field. The demonstration of detailed practices at the onset of crop season is very important. Until farmers get a feel of doing things through practical experience, their learning remains incomplete. And it affects the degree of command over the technology and, in turn, also the confidence of extension workers. Farmers feel diffident about adopting any new practices about which they have only heard. Therefore, the maximum possible number of demonstrations/training sessions should be held in as many villages as possible to ensure that all the target communities get proper orientation about the technology. The CSPs need to anchor these demonstrations.

These skill-based and component-wise training sessions are to be organized just before an event is to take place in field. Depending upon the crops selected, the training sessions are planned. The following are some sample training sessions needed as per the calendar

- **Crop husbandry:** Nursery raising training; transplantation training and pest management training
- **Plantation:** Laying out and pit digging; planting of saplings; inter-culture operation and pest management (year-wise), and pruning
- **Land husbandry through practice:** Tillage practices; biomass recycling and green manuring; crop rotation plans and vermi-composting

The sample training processes are as follows.

Training on nursery raising (Demo plot):

Objective: Transferring knowledge and skills of raising improved paddy nursery

Steps followed:

i. Schedule the date for training.

ii. Identify the participants for training/demo.

iii. Provide the list of items required for the training well in advance so that villagers can arrange it.

iv. Invite participants and mobilize people to attend.

v. Identify the resource persons and ensure their timely arrival to the demo site.

vi. Make preparatory visits (may be by the CSP) to the village to verify the situation in field/suitability/ preparedness for the training.

vii. Conduct the demo in small patch of the prepared land.

viii. Ensure all the participants have hands-on experience.

ix. Conduct a quiz on the new learning.

x. Give precise feedback on the performances and the knowledge gathered then and there.

Delineation of Tasks

Agriculture is a season-bound operation. The timely implementation of a particular crop is very important, for maximizing production and profit. It is important, therefore, to delineate the tasks to be undertaken. A sample detailed plan of a single crop (kharif SRI) in a particular phase is presented here. Depending upon the plan, making a season-wise activity calendar and working as per schedule are highly essential for quality implementation.

Task	Objective/ Details	Facilitating Agency	CSP	PI	Deadline
Detailed Task List for SRI Implementation					
Field-level training for nursery raising and main field status checking with CSPs. Also keep some nursery area free for batch-wise nursery	CSPs and professionals did the nursery raising by themselves after demonstrated by the resource person/ experienced professional. One-day duration. Can be combined with HYV wet-bed nursery training.	Practitioners	RP, CSP		30/06/10
Observing while CSPs do nursery raising	Skill development of CSP and new professional.	Practitioners	RP, CSP		
Nursery raising			CSP		07/07/10

Task	Objective/ Details	Facilitating Agency	CSP	PI	Deadline
Follow-up for giving remaining seed if rain is delayed	Usually farmers do not do this. So special focus has to be given to make this happen.	Practitioners	CSP		15-Jul
Field-level training for transplantation with CSPs	Very crucial to transfer this skill in detail to the CSPs and professionals.	Practitioners	RP, CSP		15-Jul
Observing while expert CSPs do transplantation training	As in HYV paddy	Practitioners			
Transplantation	Following up the transplantation		CSP		7-Aug
Sample checking by board members and professionals	By expert CSP, resource person for feedback on progress	RP, Practitioners		PI	30-Aug
Weeding and hoeing	Expert CSPs demonstrate once in every village.		CSP		20-Aug
Weeding and hoeing		Practitioners	CSP		20-Aug
Pest management and yield data collection training for CSPs	Clubbed with HYV paddy	Practitioners	RP,CSP		5-Sep
Sample yield data checking		Practitioners		PI	30-Oct
Data compilation		Practitioners			30-Nov

Colour coding

Colour	Meaning
	Independently doing
	Taken some responsibility with support from the facilitating agency
	Actors are only involved as observers or introducers.

As mentioned, this will also help to gradually groom the relevant actors/institutions to carry out the task independently.

5.11. Monitoring

Serious gaps have been noticed between prescribed practices and actual field-level adoption of newly introduced practices even if training is complete. Depending upon the level of entrepreneurship and other situations, different farmers adopt newly learned practices differently. Some of them may not adopt new practices at all. This needs rigorous monitoring in terms of quality engagement with the families. Monitoring not only helps ensure quality implementation but also gives excellent opportunities to bring required changes in the technology to better suit the changed situation, which may occur due to unforeseen factors.

For example, for SRI, in a flood or a drought situation, mobile nurseries can be planned immediately.

Mechanism for quality/quantity monitoring can be at the following levels.

- Self monitoring by the farmer
- Follow-up visit by the CSPs
- Weekly meeting of the CSPs
- CSPs reporting to HLA/SHGs/PIAs (relevant institution) periodically
- Field visit by practitioners
- Field visit by practitioners along with the CSPs and resource persons

Name of CSP										Intervention points of SRI								
						Nursery												
SHG name	Name of farmer	Main plot area	Dhaincha (in Kg)	Seed selection, Brine water test	Seed treatment	Nursery area	Nursery bed and drainage channel	FYM & Fertlizer and thimet	Sowing date	Puddling and fertilizer application	Transplanting date	Spacing	Drainage channel	No. of seedlings per hill	Second urea application	Wetting and drying	Pest control	Yield measure-ment

A. **Self-monitoring by family:** An individual family-wise card that details the land resource and plan of the family is essential. Important intervention points are mentioned in the card for assessing individually about the proper implementation of the activities at the family level.

B. **Follow-up visits by the CSPs:** The CSPs should make a follow up with to all the individual families at least thrice in a week and monitor the progress of the activities undertaken at the family. They also should collect all the relevant data from the family members.

C. **Weekly meeting of the CSPs:** A weekly meeting will be attended by the CSPs (8–12) and other stake holders of 4–8 adjacent villages (a cluster) in the presence of a person from the relevant institution. This meeting will serve as a forum for stock-taking of the work in progress. This meeting will be used for giving feedback on the quality of work and problem-solving on both social and technical issues. Besides these, continuous follow-up of the skill up-gradation training sessions will also take place. Depending upon the PoPs finalized for the crops, a monitoring format is provided to the CSPs, with the intervention points of the crops to be monitored.

D. **CSPs reporting to HLA/SHGs/PI s (relevant institution) periodically:** The CSPs are monitored by PIs or SHGs, as per the arrangements mentioned earlier. The monitoring plan is made in the following format.

Weekly Reporting Format for CSPs

Name of Farmer	Works Done Last Week	Works to Be Done in Coming Week	Dates to be Done	Crop Status (in Terms of Number of Leaves, Girth of the Stem)	Signature

E. **Field visit by the CSP:** On a sample basis or as per the need, visit the plot to understand the real situation.

F. **Field visit along with the CSPs and resource persons:** To help the CSPs and to set a standard amongst the CSPs, field visits are planned with CSPs and with expert resource persons. This will give an understanding of the quality of crop growth and the relevant measures to be taken.

Annexure A

Programme on

IMPLEMENTING INTEGRATED NATURAL RESOURCE MANAGEMENT STRUCTURES MICRO DESIGN

Objectives:

At the end of the programme, the participants will have enhanced:

- Understanding of Integrated Natural Resource Management (INRM) structures.
- Ability to implement INRM structures.

Day 1	**Event**	
10:00 am	*Plenary: -*	- Introduction of participants - Mapping expectations of participants - Setting – Objectives - Group norms - Timings - Logistics
11:00 am	*Tea/Coffee break*	
11:30 am	*Plenary:*	- Understanding the principle of soil moisture conservation (PPT) - Question and clarifications
12:00 pm	*Plenary:*	- Understanding the design of the 30'x40' model for implementation on a designated upland. [Power point presentation (PPT)]
12:30 pm	*Plenary:*	- Understanding the design of a staggered trench for implementation on a designated upland (Film) - Questions and clarifications
1:00 pm	Lunch break	
2:00 pm	Identifying components and their estimate *Small Group Activity (SGA):* Heterogeneous sub-groups of four with participants from different villages	- Provide a sample of components and estimates of a 30'x40' model. - Provide a sample of components and estimates of a staggered trench.
	Task:	- Identify components and their estimates (for both the 30'x40' model and the staggered trench). - Questions that require clarification (Record on chart paper)

	Event	
2:45 pm	*Plenary*:	- Presentation by sub-groups. - Consolidation - components and their estimates - question
3:45 pm	*Tea/Coffee break*	
4:15 pm	*Plenary*: Understanding the principle and design of a mango orchard with inter-crop and a timber plantation for implementation on a designated upland. (PPT)	
4:45 pm	Identifying components and their estimate	
	SGA: Heterogeneous sub-groups of four with participants from different villages	
		- Provide a sample of components and estimates of a mango orchard and a timber plantation.
	Task:	- Identify components and their estimates for a mango orchard and a timber plantation. - Questions that require clarification (Record on chart paper)
5:30 pm	*Plenary:*	- Presentation by sub-groups - Consolidation - components and their estimates - Summing up (PPT)
6:00 pm	*Plenary*: Preparation for next day's field visit.	
		- Divide the group into sub-groups of four. Each sub-group will perform the following task:
	Task:	- Select suitable patches of land. - Mark the layout on the land with lime stone for: - 30'x40' model - staggered trench - a mango orchard - timber plantation - Measure earth work in an ongoing/existing structure
6:30 pm	*End of session.*	

Day 2	Event
8:00 am	*Field work*
1:30 pm	*Lunch break*
2:30 pm	*SGA*: Preparation of presentation on field work
3:00 pm	*Plenary*: - Presentations by sub-groups. - Problems faced - Consolidation
4:00 pm	*Tea/Coffee break*
4:30 pm	*Plenary*: Understanding the principle and design of field bunding and land leveling for implementation on a designated upland.
5:00 pm	Identifying components and their estimate *SGA*: Heterogeneous sub-groups of four with participants from different villages - Provide a sample of components and estimates of field bunding and land leveling. Task: - Identify components and their estimates in field bunding and land leveling. - Questions that require clarification (Record on chart paper)
5:30 pm	*Plenary*: - Presentation by sub-groups. - Consolidation - components and their estimates - Summing up (PPT)
6:00 pm	*Plenary*: - Understanding the design of water harvesting structures (WHS) for implementation on a designated upland.
6:30 pm	Identifying components and their estimate. *SGA:* Heterogeneous sub-groups of four with participants from different villages. - Provide a sample of components and estimates of a WHS. Task: - Identify components and their estimates for a WHS. - Questions that require clarification (Record on chart paper)
7:00 pm	*Evening break*
7:30 pm	*Plenary:* Preparation for next day's field visit. - Divide the group into sub-groups of four. Each sub-group will perform the following task:

Task:
- Select suitable patches of land.
- Mark the layout on the land with lime stone for:
  - Field bund
  - a WHS
  - Measure earth work in an ongoing/existing structure

Day 3	**Events**
8:00 am	*Field work*
11:00 am	*Tea/Coffee break*
11:30 am	*SGA*: Preparation of presentation on field work
12:00 pm	*Plenary*: - Presentations by sub-groups. - Problems faced - Consolidation
12:30 pm	*Plenary*: Preparation of muster roll
1:30 pm	*IT:* Programme Evaluation.
1:40 pm	*Plenary:* Sample sharing by participants.
2:00 pm	*End of Programme.*
2:05 pm	*Lunch break*

Annexure – B

Enhancing ability to maintain books of accounts for INRM related works

Objective:

At the end of the module the participants will have enhanced ability to maintain books of accounts for keeping records of expenses and meeting registers on INRM structures

Micro-design

Day-1	**Event**	
10:00 AM	Plenary:	- Introduction - Expectation mapping - Objective setting - Setting group norms and logistics
11:00 AM	Tea break	
11:15 AM	SGA (4) : Task:	- Discuss the "importance of proper accounts keeping "
12:00 PM	Plenary:	- Presentation by sub groups - Facilitators capture the sharing in two broad categories (Accountability and Transparency, the name of the categories will be displayed after compilation is over) - Facilitator supplements
1:00 PM	Lunch	
2:00 PM	Plenary:	- Presentation on overview of different kinds of Accounts books and formats with purpose and examples - Questions and clarification
3:30 PM	Tea Break	

4:00 PM	SGA (4):	
		- See the vouchers (facilitator distributes the set of filled up vouchers) carefully and make your presentation based on "How to make vouchers"
4:30PM	Plenary:	
		- Presentation by sub groups - Consolidation and supplement by Facilitator
5:00 PM	SGA (4):	
		- Prepare vouchers for the given transaction (facilitator distributes the exercise)
6:00 PM	Plenary:	
		- Sample sharing - Questions and clarification
6:30 PM	End of the day's session	

Day - 2	**Event**	
9:00 AM	SGA (4):	
		- Prepare day book based on vouchers filled in the mock exercise yesterday
10:00 AM	Plenary:	
		- Presentation by SG (Facilitator announces who will present from the SG) - Questions and clarification
11:00 AM	Tea	
11:30 AM	SGA (4):	
		- Prepare ledger book based on day book filled up
12:30 PM	Plenary:	
		- Presentation by SG (Facilitator announces who will present from the SG) - Questions and clarification
1:00 PM	Lunch	
2:00 PM	Plenary:	
		- Presentation by SG facilitators on how to prepare trial balance - Questions and clarification
2:30 PM	SGA:	
		- Prepare trail balance based on the filled up ledger book

3:30 PM	Plenary:	
		- Sample sharing
		- Questions and clarification
4:00 PM	Tea and snacks	
4:30 PM	Plenary:	
		- Discussion on process of indenting and financial transaction related to the work
		- Questions and clarification
5:00 PM	Plenary:	
		- Discussion on importance of minute register and how to record meeting
6:00 PM	Plenary:	
		- Consolidation of learning
6:15 PM	Plenary:	
		- Feedback and closure

About this tool Kit

PRADAN is a registered voluntary organisation working in selected poverty pockets across seven of India's poorest states through teams based on the field. It focuses on working with the rural poor to improve their livelihoods and promote new ones.

This tool kit is an attempt to put together knowledge developed at the grass roots in to an easy to use format. It may be used for wider dissemination of practices, as a ready reference for practitioners in the field and as an input in designing training programmes for practitioners. This tool kit has been prepared by a task force of practitioners with rich experience of enhancing incomes of the poor around specific sectoral livelihood interventions.

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