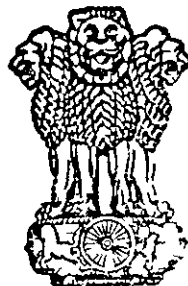


**STUDY ON SURVEY
AND
RECLAMATION OF RAVINES
IN INDIA**



सत्यमेव जयते

COMMITTEE ON NATURAL RESOURCES

PLANNING COMMISSION

NEW DELHI

1965

Price 11and Rs 1 40 P

3.2 17 51 00 118

**STUDY ON SURVEY
AND
RECLAMATION OF RAVINES
IN INDIA**



**COMMITTEE ON NATURAL RESOURCES
PLANNING COMMISSION
NEW DELHI
1965**

FOREWORD

The total extent of ravine lands in India is about 3 million hectares. The problem of such lands is acute in the States of Madhya Pradesh, Uttar Pradesh, Rajasthan and Gujarat. In addition considerable area known as marginal lands is in a state of acute erosion which requires immediate attention if it is to be prevented from coming under ravines. The magnitude of the problem can be gauged when one knows that the rate of ravine formation is of the order of 3 000 acres per year in Madhya Pradesh alone. These critical areas need immediate handling not only for preventing further formation of ravines but also for the reclamation of existing ravines for useful production. The land reclaimed from the ravines should be put to the use depending upon its use capability. It has been stressed in the study that deep ravines should be put under forest. I do hope that the recommendations made in the study will be found useful by the State Governments concerned and will receive immediate attention.

December 1 1964

M S THACKER

Member (Natural Resources)

CONTENTS

	<i>Page</i>
Preface	(iii)
CHAPTER I Introduction	1
CHAPTER II Survey and extent of ravines and their classification	2
CHAPTER III Methods of reclamation of ravines and cost of reclamation	13
CHAPTER IV Review of the progress of survey and reclamation of ravines	20
CHAPTER V Phased programme of utilisation and reclamation of ravines	35
CHAPTER VI Organisation for reclamation and allotment of reclaimed ravines	40
CHAPTER VII Summary	43
CHAPTER VIII Recommendations	46
References	49

PREFACE

The Committee on Natural Resources at its second meeting held on September 7, 1962 approved the study on 'Survey and Reclamation of Ravines in India'. The Committee felt that complete information was not available about the extent of ravine lands and the steps taken so far to reclaim them. The increase of ravines was adding to the problem and it was therefore felt necessary that a study on the survey and reclamation of ravines for fruitful utilisation should be undertaken. The scope of this study was (i) to survey the occurrence and extent of such lands in various States of the country (ii) to review the work that had already been done so far for reclamation and improvement of the fertility status of such impoverished lands and (iii) to suggest a comprehensive long-term plan of work in reclamation and utilisation of land and measures to check further erosion in agricultural land. The study was entrusted to Shri K D Sharma Research Officer under the guidance of Senior Specialist (Land Resources).

The draft of the study was circulated amongst the Directors of Agriculture Chief Conservators of Forests and other Soil Conservation Officers in States and the members of the Working Group on Soil Conservation in River Valley Projects and their views and comments were invited. The comments received were duly considered and incorporated in a revised study which was discussed at a meeting in the Planning Commission held on the 23rd September 1964. The study has undergone further revision in the light of the comments made at that meeting. The study has reviewed the methods and cost of reclamation which would differ from region to region depending upon the topography of the land and the soil conditions. It has been suggested that survey of these lands on the basis of aerial photographs should be completed within five years. The time limit for reclamation should not exceed fifteen years. The immediate measure that is necessary is protection of the marginal agricultural land from coming under ravines. It has been recommended that, by and large the deep ravines should be put under forest.

The study has been conducted by a team of experts whose names are attached. I express my thanks to the members of the study team for helpful cooperation in the preparation of this report.

December 1 1964

A B GUHA
Adviser (Resources)

STUDY TEAM

PLANNING COMMISSION

- 1 Shri A B Guha Adviser (Resources)
- 2 Dr S P Raychaudhuri Senior Specialist (Land Resources)
- 3 Shri K P Sagreya Senior Specialist (Forest Resources)
- 4 Dr V Nath Deputy Secretary (Natural Resources)
- 5 Shri P N Chaudhuri Senior Research Officer Resources Division
- 6 Shri K D Sharma Research Officer Resources Division

MINISTRY OF FOOD AND AGRICULTURE

- 7 Dr R V Tamhane Soil Conservation Adviser
- 8 Shri D H Kulkarni Deputy Inspector General of Forests

CENTRAL WATER & POWER COMMISSION

- 9 Shri V K Sharma Director (Soil Conservation)

STATE GOVERNMENTS

- 10 Shri R C Soni Chief Conservator of Forests U P
- 11 Shri T N Srivastava Chief Conservator of Forests, Rajasthan.
- 12 Shri R M Singhal Conservator of Forests Development Circle, Madhya Pradesh
- 13 Shri S R Umbarje Conservator of Forests Kotar Afforestation and Reclamation Baroda Gujarat

CHAPTER I

INTRODUCTION

There are vast stretches of land in States of Madhya Pradesh, Rajasthan, Gujarat Uttar Pradesh and Punjab which are lying uncultivated and are suffering from acute soil erosion due to wind and water. Every year the areas under ravines along the banks of rivers Jamuna Chambal Mahi and Sabarmati and all the major river courses in Gujarat except Saurashtra and their tributaries are increasing. Some of these with almost vertical sides are 50 to 100 feet deep. The gullies and ravines are eating into the cultivable land thus making it useless for agricultural purposes. Extending the cultivation right upto the bank of the river or nallah without planting border strips of grasses or trees made the situation worse. On a rough estimate 1.42 million hectares (3.5 million acres) of lands on the banks of Jamuna river in Uttar Pradesh and another 0.4 million hectares (one million acres) on the banks of Chambal in Madhya Pradesh and Rajasthan are covered by ravines.

The Second and the Third Plan had emphasised the importance of the survey and preparation of topographical maps of ravines and gullies with a view to formulation and execution of reclamation projects. In the Third Plan a provision of Rs 50 lakhs has been made to survey such lands. Pilot projects are being set up in the States of Madhya Pradesh and Gujarat. The Third Plan aims at reclaiming 16,200 hectares (40,000 acres) of ravine lands. Such lands if reclaimed can be used either for agricultural purposes or as pasture lands and for forests in a balanced manner. In addition to these, this particular type of wasteland has its social aspects as well. It has become the hide-out of unsocial elements like dacoits and a menace to the security of life of the community living around these areas. Since the last 10 or 12 years efforts are being made to fight this menace. To eradicate such unsocial elements the possible way is to reclaim the ravines and gullies and bring them under use.

The present study is directed to evaluate the extent of such lands, the methods and economics of measures for their reclamation and suggest future action.

CHAPTER II

SURVEY AND EXTENT OF RAVINES AND THEIR CLASSIFICATION

Wastelands—The total area under wasteland for each State as defined by the Committee on Survey and Reclamation of Wastelands set up by the Ministry of Food & Agriculture to include “other uncultivated land excluding fallows’ and fallows other than current fallows” is given below —

TABLE 1

(million hectares)

	Other un cultivated land exclud ing fallows	Fallows other than current fallows	Total wastelands
Assam	1 48 (3 06)*	0 17 (0 41)	1 65 (4 07)
Rajasthan	8 73 (21 75)	3 76 (9 29)	12 49 (30 86)
Andhra Pradesh	3 36 (8 31)	0 89 (2 19)	4 25 (10 50)
Bihar	1 15 (2 83)	0 81 (2 01)	1 96 (4 84)
Orissa	2 61 (6 46)	0 30 (0 74)	2 91 (7 20)
Gujarat	1 89 (4 66)	0 25 (0 63)	2 14 (5 29)
Himachal Pradesh	0 66 (1 64)	Negl (0 01)	0 66 (1 65)
Jammu & Kashmir	0 31 (0 76)	0 06 (0 15)	0 37 (0 91)
Kerala	0 43 (1 06)	0 08 (0 20)	0 51 (1 26)
Madhya Pradesh	7 27 (17 97)	1 63 (4 02)	8 90 (21 99)
Madras	1 37 (3 38)	0 66 (1 64)	2 03 (5 02)
Maharashtra	2 66 (6 57)	1 02 (2 52)	3 68 (9 09)
Mysore	2 86 (7 07)	0 48 (1 18)	3 34 (8 25)
Punjab	0 91 (2 25)	Negl (0 01)	0 91 (2 26)
Uttar Pradesh	2 66 (6 57)	1 47 (3 63)	4 13 (10 20)
West Bengal	0 61** (1 51)	not known	0 61 (1 51)
TOTAL	38 96 (95 67)	11 58 (28 63)	50 54 (124 90)

* Figures in paranthesis indicate million acres

** To be considered for the purpose of locating large sized blocks of land for reclamation and resettlement

The wastelands include ravines and gullies. Since the Committee was concerned in locating wasteland in blocks of sizes of 250 acres and above only it left out of its purview a significant proportion of land lying waste in blocks of sizes of less than 250 acres. To survey such waste lands including gullies and ravines which are scattered in small blocks a scheme costing about Rs 69 lakhs was sanctioned during the Third Plan period. According to this project each State would prepare schemes to undertake a survey to locate small blocks of wasteland and the Centre would bear the total cost. Most of the States have come forward with their schemes and others are taking steps to formulate such survey schemes.

Definition of a Ravine—The dictionary meaning of a 'Ravine' is a deep narrow gorge a long deep narrow hollow or gorge worn out by a stream or torrent of water a mountain cleft

The word ravine is many a time used for deep gullies and *vice-versa*. The ravine area as is understood is a system of gullies draining into major stream tributaries or a river. All deep gullies cannot be considered as ravines nor all ravines are necessarily to be deep. In general a ravine with its head starting from the table land and ending into deep gorge near the river or its tributaries may be considered as typical ravine.

The size and shape invariably depends upon the characteristics of the soil topography and the rainfall of the area. It begins with a shallow depth either through the formation of small rills and developing into gullies or through natural drains forming into gullies and those gullies ultimately ending into deep and wide gorges near the river. At places of alluvial tract specially in Indo-Gangetic plains where soil and sub-soil are commonly friable and is easily cut by flowing water on slopes the gullies develop into deep gorge with vertical walls.

Considering the above facts it would be better if the word 'Ravine' is used to connote for our purpose the following meaning —

A ravine means a system of gullies or gorges worn out by torrents of water and running more or less parallel to each other and draining into a major river or its tributaries after a short distance with the development of deep and wide gorges."

Improper land use leading to accelerated soil erosion leads to the formation of gullies and ultimately to very deep gullies or ravines. Once the gullying process has set in the slope and form of the

incissions are generally influenced by the relative stiffness or resistance of the soil strata and underlying rock material. Thus at places of alluvial soil and where both soil and sub-soil are commonly friable and easily cut by flowing water we have gullies with vertical walls. Such gullies are U shaped. Where the sub soil is resistant to rapid cutting because of its heavy texture or toughness and especially where the underlying geological material or substratum is not essentially softer than the horizon above gullies develop sloping banks and take a V shaped form. This type is commonly found in areas where the soil is underlain by a stiff clay. Although V shaped gullies usually develop less rapidly than other types they frequently present an equally serious hazard.

Another peculiarity of the gully erosion is that in case of soils having tough clay or claypan subsoil such as the shallow loessal soils overlying intractable clay it expands laterally about as rapidly as in the direction of the head leading to bank erosion undercutting and caving out the enclosing walls.

Ordinarily when a gully bed cuts into the soil with an immediate drop of 3 to 4 metres and gradually flattens out a ravine is formed. The depth of a ravine may extend to even 30 metres or more.

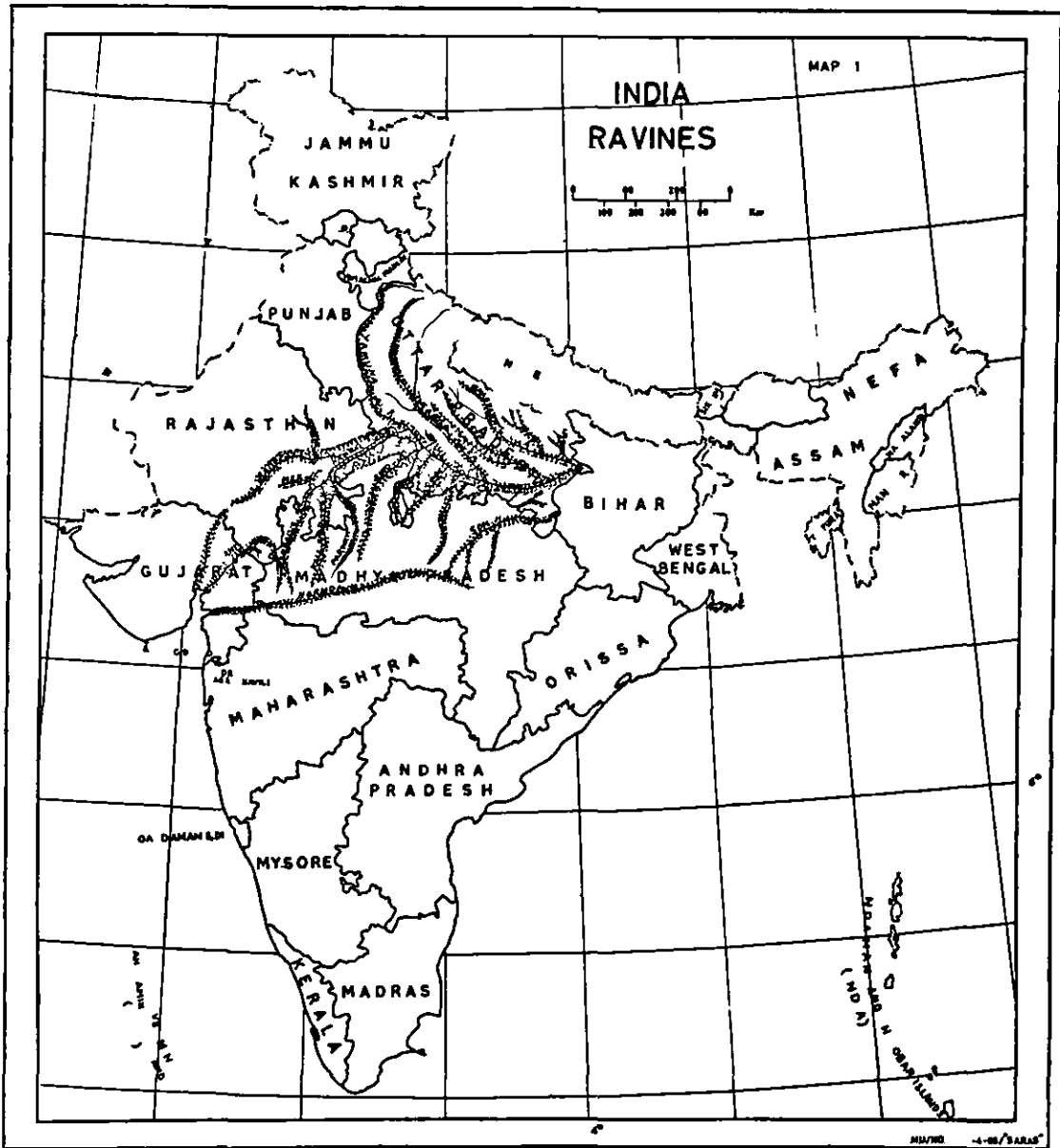
Survey—Tentative estimate of total area under ravines in the country is given in the following table (Table 2)

TABLE 2

Statement showing extent of ravines in India statewise

State	Rivers and their tributaries	Total area of ravines (Approximate)
Uttar Pradesh	Jamuna Chambal Gomti Betwa and Kholas of Ganges	1 23 lakh hectares (3 04 lakh acres)
Madhya Pradesh	Chambal and Aasan	In three districts of Morena Bhind and Gwalior in the State the area affected is about 2 43 lakh hectares (6 lakh acres)
Rajasthan		2 8 to 3 2 lakh hectares (7 to 8 lakh acres)
Gujarat	Sabarmati Mahi Watrak Meshon Banas and Narmada	400 000 hectares (988 000 acres)
Maharashtra		About 20 000 hectares (49 400 acres)
Punjab		About 1 20 000 hectares* (2 96 400 acres)

*R. M. Gorie— Soil and Water Conservation in Punjab —1946



State	Rivers and their tributaries	Total area of ravines (approximate)
Bihar		About 0.6 million hectares (14 00 000 acres) in the Upper - Damodar Catchment extending mostly in parts of Palamau Ranchi, Hazaribagh Dhanbad and Santal Parganas
Madras		60,000 hectares (1.4 lakh acres)
West Bengal		1,03,935 hectares (2.496 lakh acres)
TOTAL		3.13 to 3.17 million hectares (7.45 to 7.51 million acres)

The approximate distribution of ravines in the country is shown in Map I

It would be clear from the above statement that a very significant area is under the grip of ravines

The aerial survey carried out for the purpose of the Chambal Development Scheme has revealed that the area of ravines upto 4.6 to 6.1 metres (15 to 20 ft) depth is nearly 50 600 hectares (1 25 000 acres)

Madhya Pradesh—The extent of area affected by ravines in State of Madhya Pradesh is mostly along the banks of rivers Chambal Kalisind and their tributaries. The terrain through which these rivers pass is hilly and the rain water has to pass through steep slopes thus every year adding to the land under ravines by its corrosive action. S V Subbaya* points out that there are evidences to show that there existed flourishing villages at places where we now find ravines in Madhya Pradesh. He further points out that the ravines had started in the villages on the cattle paths and cart tracks which naturally lead to the river and pass through a steep slope. It is estimated that 0.42 to 0.81 million hectares (about 1 to 2 million acres) of land must be under deep gully and ravines. Out of this about 2.43 lakh hectares (6 lakh acres) is in the 3 districts of Gwalior Morena and Bhind. Almost about an equal extent of land is in acute advance stage of ravine formation.

Uttar Pradesh—In deep soils such as the Indo-Gangetic alluvium wherever the rivers and nullahs flow into deep channels such as Jamuna Chambal Gomti and their tributaries erosion first starts from the banks of natural drainage channels where the run off has

*Chambal Ravines and its Reclamation by Machines—S V Subbaya—Second Seminar on Soil Conservation M/Food & Agriculture, 1958

to negotiate steep slopes. These banks have been denuded of their forest cover and in almost all cases cultivation has been carried to the water line. This has caused serious gully formation which creep in land. These gullies go on growing longer deeper and broader with every rain criss cross each other and take the form of a ravine. It is expected that the deepening process will continue (if the ravines remain unprotected) until the bottom of the ravines struck rock. It has been roughly estimated that about 1.23 lakh hectares (3.00 lakh acres) are in the form of ravines. The problem is acute in the districts of Mainpuri, Etawah, Jalaun, Jhansi, Hamirpur, Banda, Mirzapur and Agra. In other districts of the State the deep gully formation has almost set in. Some tentative estimates about the extent of ravines and deep gullies in the areas under the Forest Department are given in Table 3.

TABLE 3

(Hectares)

River system	Gangetic basin	Vindhyan region	Total
Yamuna Chambal	62 557	11 175	73 732
Betwa		42 398	42 398
Ken		3 138	3 138
Gomti	3 388		3 388
TOTAL	65 945	56 711	1 22 656 (3 04 000 acres app.)

The break up of the above figures (hectares) on the basis of territorial Forest Divisions is given below —

TABLE 3(A)

Forest Division	Gangetic		Vindhyan		Total	Gaon Samaj khand included in Total
	Yamuna Chambal	Gomti	Yamuna Chambal	Betwa Ken		
Vrajbhumi	26,496				26 496	6 109
Southern Doab	36 061				36 061	8 750
Bundelkhand			7 165	18 017	25 182	6 559
Banda			4 010	24 381 } 3 138 }	31 529	11 194
Gomti Rapti		3 388			3 388	
TOTAL	62 557	3 388	11 175	45 536	1 22 656	32 612 (3 04 000 acres approx.)

These estimates do not include agricultural land affected by gully formation in advanced stages. If about half as much area is assumed to be so affected the total would come about 1 89 000 hectares or about 4 55 000 acres *

Resources in UP MP Gujarat and Rajasthan

There is a need of early aerial survey of large areas of ravines in Uttar Pradesh Madhya Pradesh Gujarat and Rajasthan by a Central agency of the Government of India within a period say of five years and maps in 4" = 1 mile scale supplied to the State Government for action. In case maps of some of the existing aerial photographs are old these areas need be covered again by such aerial surveys and maps prepared again for taking further action similarly.

Madras—The problem of ravines in Madras State is very acute in parts of many of the districts like South Arcot North Arcot Kanyakumari, Tiruchy Chingleput Salem Coimbatore etc.

West Bengal—In West Bengal extensive ravines and gullies do not occur but the total area of such eroded and waste lands works out to about 1 03 935 hectares (Communication from the Chief Conservator of Forests West Bengal). These gullies and ravines which occur in upper catchment areas of Kangsabati river in the Purulia district require immediate anti erosional measures and reclamation.

Classification of ravines—In order to have a correct appraisal of the problem of reclamation of gullies and ravines it would be useful to classify them according to some criteria.

Tejwani and others have classified gullies and ravines into four classes on the basis of their form gully head characteristics length breadth and depth namely very small (G 1) small (G 2) medium (G 3) and deep gullies (G 4). The specifications in each type are given in Table 4 below —

TABLE 4

Classification of Gullies and Ravines

Particulars of the gully/ravine	Description and symbol of the gully/ravine			
	Very small (G 1)	Small (G 2)	Medium (G 3)	Deep (G 4)
1 Depth in metres	Upto 1	1 to 3	3 to 9	Greater than 9
2 Bed width in metres	Upto 18	Not less than 18	Not less than 18	Varies
3 Side slopes in per cent	varies	varies	Uniformly sloping between 6 to 12	Sloping more than 12. Mostly steep or even vertical with intricate and active branch gullies

*Note from Shri R. C. Sonu Chief Conservator of Forest U P

They have evolved a land use capability classification of ravines. The table (4 A) below gives the classification and measures necessary to manage such lands.

TABLE (4-A)

Land use capability classification and measures for proper management

Class	Slopes	Distance from gully rim	Remarks
I	2	3	4
I	Perfectly level	Very far away	No measures except good farming practices necessary
II	0-3%	minimum 60 m	(i) Contour bunding in the catchment. Bund cross section 10 sft (bottom width 6-6 top width 1-6 height 2-6) was found suitable. This can be tried for peripheral bunds also. (ii) Good agronomical measure such as contour cropping strip cropping cover strip cropping cover cropping etc.
III	0-3 / 3 6 /	Between 6 to 60 m from 6 m onwards	(i) Contour and peripheral bunding (specifications shown as above) cost of bunding by human labour Rs 172 00 per hectare. Cross section of the bund 10 sft. (ii) Provision of safe outlets at gully heads (pipe outlets. Cost of one pipe outlet is Rs 30 00) to discharge excess run off. (iii) Intensive agronomical measures such as contour cropping strip cropping cover cropping etc.
IV	6 12%	Shallow and medium gully sides and beds (G1 G2 G3) the slopes must be uniform and the gully should not be deeper than 9m	(i) Peripheral control with bunds and safe outlets. (ii) Clearing and minor leveling on gully sides and beds. (iii) Putting up composite check dams across the gully bed at 4 vertical interval or 400 horizontal

1	2	3	4
			<p>distance Cost of one 8 spillway check dam is Rs 665 00 including earthen portion And also cost of the 25—0 spillway is Rs 2355-00 including both sides earthen portion and sodding</p>
			<p>(iv) Terracing on gully sides (upto 12%) at 3 to 4 vertical interval having 1 50 inward slopes 1 00 longitudinal grade towards grassed water way Ter race face slope 1 5 and soddied with <i>ichan thum annulatum</i> grass Good application of manures fertilizers for quick soil building Cost of reclamation per ha including the cost of check dam is Rs 1769 50</p> <p><i>Cost of reclamation per hectare</i></p> <p>a) Construction of composite brick masonry earthen check dams costs Rs 718 00</p> <p>(b) Clearing and minor level ling and terracing Rs 899 00</p> <p>(c) Sodding with grass Rs 152 00</p> <p>Therefore total cost of re clamation per ha. is Rs 1769 50</p> <p>The above check dams were constructed on $Q=CIA$ and $Q=3.33 (CLH_{3/2})$</p>
V	12 20 %	Wide humps (mi nimum 42 0 m wide with no gully intrusion) or gully sides	<p>(i) Controlled grazing after pasture development</p> <p>(ii) Development of horticul tural trees if irrigation is available</p> <p>(iii) Contour staggered trench ing and afforestation</p>
VI	—	Marginal land be- tween the gully rim and the cultivated land (peripheral bund)	<p>(i) Grazing strictly prohibited</p> <p>(ii) Cut the grass for stall feed to the cattle</p> <p>(iii) Contour staggered trench ing and afforestation</p>

1	2	3	4
VII	Greater than 20 /	Gully sides and beds (G4)	<ul style="list-style-type: none"> <li data-bbox="839 360 1196 433">(i) Contour staggered trenches for moisture conservation and afforestation <li data-bbox="839 469 1196 542">(ii) Gully plugging and easing of the rapids along the gully beds <li data-bbox="839 578 1196 687">(iii) Brush wood dams can be put in gully bed if the bed is upto 15 wide and side slope upto 10% interspace is upto 100 <li data-bbox="839 724 1196 1348">(iv) Earthen dam can be put if the gully bed is 15 to 25 wide at intervals of 150 to 200 Cross section of the gully plug is 16 sq ft to 24 sq ft Grassed water way or pipe outlet should be provided to dispose of excess run off Sand bag dams can be put at the confluence of 2 gullies Gully bed width should be 25 to 50 At the confluence of all branches of a compound gully brick check dam should be provided having sufficient space to dispose of run off Bed width should be 25 to 50 and above In narrow gully whose width does not exceed 10 live hedges consisting of Euphorbia were planted across the gully in 3 rows spaced 6 apart each row alternate staggered <li data-bbox="839 1379 1196 1421">(v) Development of pasture and afforestation
VIII	Greater than 20%	Gully sides and gully beds (G4) with rock or murrum on surface	(i) Complete closer to grazing and felling

The work of standardisation in respect of classification of ravines with reference to depth width side slope and land use capacity etc. which is at present being carried out by the Central Soil Conservation Board should be expedited

All-India Soil and Land Use Survey has proposed to classify gullies into three grades for mapping purposes. The grades suggested are

- (i) G-1—Narrow gullies with 0.3 metre to 1.5 metres (1 to 5 ft) width
- (ii) G-2—Medium gullies with 1.5 metres to 3 metres (5 to 10 ft) width
- (iii) G-3—Wide gullies with over 3 metres (10 ft) width

Classification of gullies and ravines according to their suitability for agricultural purposes or otherwise can be attempted only with the knowledge of their land capability classification. Since erosion is the cause of ravines and gullies, areas affected by them must only form a marginal or sub-marginal land for agricultural use as such. However, with proper reclamation measures which may be expensive, such lands may become suitable for agricultural purposes. Otherwise such lands are only suitable for forestry or pasture land open for periodical selective grazing.

Areas of agricultural land affected in the interior where the gullies are very small can be reclaimed by check dams combined with growing of grasses or other soil binding plants. Still further up there may be regions where the erosion has just set in and the cost of reclamation may be least in such areas. Here simple measures as closure to grazing and providing outlets for excessive run off and controlling soil erosion may be sufficient to reclaim such lands in a period of 2-3 years and bring them under cultivation.

It is necessary that the gullies and ravines occurring in large blocks should be surveyed and land use maps and work plans prepared. Such survey and work plans for the entire country should be completed within a period of 10 years. The ravines in the catchment of the Damodar Valley Project have been classified under two heads

Particulars of ravines	Shallow R ₁	Medium R ₂	Deeper R
Depth	0—1 metre	1—3 metres	More than 3 metres
Width	0—1.5 metres	1.5 to 3.5 metres	More than 3 metres

Gorrie* has classified gullies into two broad classes as follows —

- (i) Chhotanagpur type or DVC type with a definite gully head cutting back into the plateau land, with an immediate drop of 3 to 4 meters and gradual falling out of ravine bottoms thereafter and

*R. M. Gorrie, *Torrent Types and Torrent Control*, J. Soil and Water Conservation Society of India, 1958, Vol. VI, No. 3

- (11) Siwalik type with a gully head of 20 to 100 drop cutting into irregular foothills topography with a narrow channel confined by hills and suddenly broadening out later into bed in the plains. The Chambal, Jamuna and Mahi ravines have the same general type but finish generally in the main river bed and in such areas the ravines have extended from the river banks to the interior following the trail of run-off water, depth gradually decreasing progressively as one moves from streams or river beds towards the head waters of the sub-catchments of each of the substreams draining towards the parent rivers.

CHAPTER III

METHODS OF RECLAMATION OF RAVINES AND COST OF RECLAMATION

The urgent work on protection and reclamation need not be held up till the aerial survey is completed but should proceed simultaneously

As described earlier ravines in general consist of lands under two erosion classes which run in almost parallel strips along the banks of rivers

- (i) deeply ravine lands adjoining banks of rivers, and
- (ii) marginal lands with varying degrees of sheet and gully erosion,

In principle for a complete programme of erosion control, these lands should be tackled on a water shed basis. The following steps are normally taken

- (a) Appropriate land treatment both mechanical and vegetative on the top land is essential to check undue run off and soil erosion from agricultural lands. There should be provision for throwing surplus water through water ways
- (b) marginal land should be levelled and terraced as far as possible when it is not economical. partial levelling and gully plugging should be done and left for pasture development and afforestation including growth of horticultural plants, and
- (c) deep gullies should be used for afforestation and gully plugging. Whenever possible tanks may be made out of such gullies

For (b) and (c) above complete closure should be strictly enforced for the success of the work

The ravines themselves can be brought under cultivation if they are sufficiently wide by the formation of a series of terraces one below the other as is done in the Machkund catchment in Orissa. Where they are less wide they can also be terraced and used for growing horticultural crops like grafted mangoes, guavas, etc depending upon the financial resources of the farmers concerned the extent

of the area they own proximity to towns etc While demarcating ravines for planting of fruit trees one should ascertain the available irrigation facilities In general such ravines can be well used for afforestation wherever possible so that they may serve as a source of fuel and timber Land thus reclaimed could also be utilised for setting landless labourers where possible Steep ravines can be reclaimed by retiring them for fuel forests medium type ravines can be reclaimed for horticultural plants

Based on experience and the efforts made in this direction by the other countries particularly that in United States, we observe that the initiation of dual programme of mechanical and silvicultural operations in the ravine and gully eroded lands would put a check to continued deterioration of land This would also help in raising the economic conditions of the inhabitants of the area, who are now living in ignorance and backwardness Any delay in undertaking such programmes would create difficulties in future and would also raise the per acre cost of reclamation

The dual objective of control and reclamation of ravines can be achieved by

- (a) Construction of marginal bunds or diversion channels taking into consideration the areas of the catchment intensity of rainfall, discharge of water from the catchment, after making due provision for drainage of surplus water through waste weirs and spillways
- (b) Contour terracing or trenching or contour bunding of the catchment feeding the ravines
- (c) Construction of check dams or gully plugs in the ravines at proper intervals
- (d) Toning down or easing the steep slopes of the gully banks to the angle of natural repose and sodding the slopes with vines and grasses having soil binding tendencies
- (e) Planting of suitable fast growing trees and shrubs along the bank of the river and in the cut up areas which are unfit for other purposes.
- (f) Define gullies which are to be maintained as drainage lines for the catchment water and then level up such of the other gullies with mechanical means of manual labour into terraces of convenient size for being brought under agricultural crops

- (g) Introduction of better farming practices and soil conservation measures in the table lands of the catchment if the lands are cultivable. If the lands consist of steep slopes, contour or bench terracing will be introduced.

The areas under shallow and medium deep ravines—the Damodar Valley area—can be reclaimed with the active cooperation of the farmers in the region whereas areas under deep ravines should definitely go under afforestation and specific mechanical methods of erosion control and stabilisation of ravines. The engineering phase in the development in all phases should be taken up ahead at least *pari-passu* with other measures.

The following engineering phases in the reclamation of ravines have been found useful in the Damodar Valley catchment area

- (i) Protection of ravine areas from over land flood by construction of diversion bunds over the ravine heads and dispersal of excess water through stabilised outlets and water courses. With this measure and protection grazing, luxuriant growth of grass helps up at the heads.
- (ii) Construction of chain of earthen bunds across the water course in large blocks and dispersal of water through drop spillways or waste weirs.

A chain of storage *cum* detention dams in the lower deep ravine areas will help in —

- (i) Acting as silt traps
- (ii) growth of afforestation plantations in such area by improvement of water regime and a source of water for reclamation of adjoining areas
- (iii) Flood moderator from such areas assuring a controlled flow below the structures
- (iv) Development of pisci culture

In the afforestation programme in the ravine belt both productive as well as protective aspect of plantation programme should be kept in view and it is preferred that mixed plantations instead of pure plantations should be aimed at Eucalyptus species like *E camandulancis*, *E hybrid*, *E panicolates*, *E citrodora* and *E crebra* may be tried in the ravine lands. Another species which is doing very well in the gullied areas of the catchment of the Damodar valley region is *Accasia auricaliforaias*. It grows in very denuded soils, has appreciably good cover and is a fast growing species suitable for use as fuel. Its bark contains appreciable quantity of tannin.

TREES AND SHRUBS FOR STABILISING AND RECLAIMING GULLIES

Species used in planting gullies and surrounding territory are chosen chiefly on the basis of their ability to control erosion. Each gully includes three sets of ecological conditions bottom which periodically receives a considerable quantity of run-off water eroded slopes with "raw", humusless soil, bordering banks with a normal soil profile undisturbed by erosion. The slopes and the drier bottoms may be planted to drought resistant trees with a fibrous soil binding root system such as *Dicanthium annulatum*, *Ipomaea carnea* and *Agave americana*. The wet gully bottoms may be stabilised by moisture-loving trees, such as willows. The border strips are planted to a variety of trees and shrubs such as *Acacia arabica* and *Azadirachta indica*.

COST OF RECLAMATION

Existing information on the cost of reclamation of ravines is only approximate at the present moment. Steps should therefore be taken to make comprehensive study of cost benefit on reclamation of ravines along with the annual cost of each measure against the extent of damage occurred to the productivity of land. It is advisable to set a time limit for reclamation of ravines and gullies. Fifteen years as the limit for reclamation of reclamable lands should be quite sufficient for the purpose.

The data regarding economics of reclamation and the cost per acre has not been authentically worked out. However some rough estimate of the cost based on the experiences of the few projects worked in the States is available.

Uttar Pradesh—According to the estimates of the Department of Agriculture in Uttar Pradesh the cost of reclamation varies according to the depth of ravines and gullies (3a). The minimum cost comes out to be Rs 810 per hectare per meter depth (Rs 100 per acre per ft depth) of ravine. Two studies were conducted at Agra Soil Conservation Research Training and Demonstration Centre to find out the most economical method of ravine reclamation. In the first case of mechanical reclamation bulldozer was used for levelling and manual labour was used for bunding while in the other case bullock power was used for terracing and levelling and manual labour for bunding. The overall average cost of reclamation of ravines into agricultural fields by machine *cum*-manual labour and bullock-*cum*-manual labour per hectare was Rs 1562 00 and Rs 2436 00 respectively.

Rajasthan—The magnitude of the problem in Rajasthan in general and in the Chambal in particular both in term of acreage to be

treated and the cost involved including the marginal land and table land as calculated by the Committee appointed by the Rajasthan Government is given below

TABLE 5

	All Rajasthan		Chambal area	
	Area (lac hec tares) (acres)	Cost (Rs in crores)	Area (lac hec.) (acres)	Cost (Rs in crores)
1 Area under ravines	2 8 3 2 (7 8)	10 5	1 6 (4)	6 0
2 Area of marginal lands	2 8 3 2 (7 8)	10 5	1 6 (4)	6 0
3 Area of table lands	14 2 16 2 (35 40)	14 0 18 0	8 1 (20)	9 0
TOTAL	19 8 20 2 (49 50)	35 10 42	11 3 (28)	21 0

Cost of reclamation and treatment for the above categories of lands has been estimated by the Committee at Rs 445 per hectare (Rs 180 per acre) for ravines (afforestation measures only) Rs 371 per hectare (Rs 150 per acre) for marginal lands (afforestation or reclamation to cultivation) and Rs 111 per hectare (Rs 45 per acre) for the table lands (for adoption of soil and water conservation measures for cultivated lands)

The cost of reclamation per acre by afforestation combined with gully plugging fencing and closure to grazing varies from circle to circle depending upon the method of fencing and intensity of various works carried out. On the average however with angle iron fence posts and 4 strands of barbed wire and with check dams and gully plugging with earth the cost comes to Rs 494/- per hectare in the 1st year of plantation and about Rs 62/ per hectare (Rs 25/ per acre) in the 2nd year which accounts for beating up the failures and maintenance of fence (7) etc

Madhya Pradesh—A pilot project for reclamation in an area of 404 hectares (1 000 acres) in the Morena district under Central Tractor Organisation (C T O) using machinery with the object of collecting data on the economics of utilisation of machinery for such reclamation was sanctioned by the Central Government in 1955. In actual practice however the C T O's scheme and one pilot scheme of the State Government (in Nayakpura area of Morena district) were taken up in the same area forming one complete catchment. While bull dozing was done by the C T O the check dams were provided by the State Government. Upto the middle of 1959 about 300 hectares (740 acres) have been reclaimed in the catchment of

Nayakpura ravines by the CTO though actual operations were conducted only on 142 hectares (352 acres) A number of difficulties were encountered in executing the project It was also found that without taking into account the expenditure incurred under the State Government's scheme the expenditure incurred under the CTO scheme was also as high as Rs 2220 per hectare (Rs 900 acre)

By now four projects have been completed in the district of Morena at Chhonda Bagchuni Nayakpura and Hingona One ravine reclamation project is under operation in the village Jawasa on the bank of River Kunwari in District Bhind A brief statement of the ravine area reclaimed and the cost of reclamation per acre in the State is given in Table 6 The cost of ravine reclamation for agricultural purposes varies between Rs 469 per hectare to Rs 2224/ per hectare Also the cost of protecting the top land varies from Rs 62/- per hectare to Rs 494/- per hectare There is no data available about the annual return from such lands after reclamation—wherever agriculture is possible the cost of reclamation may be recovered in about 5 years time

TABLE 6

Statement showing the schemes undertaken in Madhya Pradesh for ravine reclamation during 1st 2nd and 3rd Plan and cost of reclamation per hectare/(acre)

S No	Name of the Scheme	Approximate expenditure incurred (Rs)	Area reclaimed hectare/(acres)	Approx cost of reclamation per hectare/ (acres) (Rs)	Remarks
<i>First Plan</i>					
1	Chhonda	11 000	23 5 (58)	462(187)	
<i>Second Plan</i>					
1	Nayakpura	39 000	182 1(450)	2199(890)	
2	Bagchuni	24,000	161 9(400)	1544(625)	
3	Hingona	13 000	11 7(29)		
<i>Third Plan</i>					
1	Jawasa	52 000	21 4(53)		
2	Hingona	120 000	85 0(210)	1411(571)	

At one place it will be economical to reclaim ravines for agricultural purposes while at other places it may be economical to put them under afforestation

It must be mentioned that the data on the economics of the cost of reclamation of ravines are only rough. The reported information for a few States furnish only the approximate costs of the works involved. It will be useful to have information highlighting the method of complete economic analysis of the benefits of reclamation measures giving the total cost of various reclamation measures, the annual benefit that can be expected as a result of ravine reclamation, the productivity of the land in terms of monetary value which will indicate the loss that could be avoided by the reclamation measures, the annual benefit that can be expected as a result of ravine reclamation and the benefit cost ratio can be worked out. The economics of reclamation of ravine lands will also have to be studied from the point of view of land value in a particular locality after reclamation. For example reclamation of ravine lands at a total expenditure of Rs 1000 or above per acre may not be very reasonable, for Madhya Pradesh and Rajasthan but may be useful for Gujarat where such reclaimed lands may be useful for horticultural crops and grasslands.

CHAPTER IV

REVIEW OF THE PROGRESS OF SURVEY AND RECLAMATION OF RAVINES AND GULLIES

The problem of survey and reclamation of gullies and ravines was discussed at an *ad hoc* Conference of State Ministers in charge of Soil Conservation held in April 1956 and the Conference fully appreciated the importance of the problem and had agreed that the concerned State Governments should formulate suitable schemes. The Ministry of Food & Agriculture drew pointed attention of the States to the seriousness of the problem stressing the desirability of taking adequate effective measures for ravine reclamation.

In the Second Plan, some work has been done in Uttar Pradesh and Madhya Pradesh but this has been quite insignificant compared to the magnitude of the problem. It was estimated that about 15 lakh acres of such lands would be reclaimed at a total cost of Rs 77 lakhs by contour bunding, gully plugging and afforestation of ravines, submarginal and table lands. Survey of ravine lands is a pre-requisite for taking up any comprehensive measures for the reclamation of ravines and for this purpose the Government of India have made a provision of Rs 50 lakhs in the 3rd Plan for giving assistance to the States for survey of ravines under a centrally sponsored programme. There are also provisions in the State Development Plans for reclamation of ravine lands.

A physical target of 16188 hectares (40 000 acres) was proposed as a modest target considering that there were vast areas of ravine lands in four States—Gujarat, Rajasthan, Madhya Pradesh and Uttar Pradesh and some areas in Jammu and Kashmir. This was because the ravine reclamation programme were very complicated and expensive. This could therefore be tackled slowly depending upon the resources available.

Table 7 shows the State wise allocation targets in the Third Five Year Plan and achievements.

TABLE 7

Statement showing progress under ravine reclamation (Third Plan period)

Sl. No	Name of the State	Physical Targets	Achievements during the 1st two years of the Third Plan (1961-63)	% of target achieved
		Plan		
1	Gujarat	4856.4 (12 000)*	(700)*	5.83
2	Madhya Pradesh	809.4 (2 000)	(1400)	70.00
3	Jammu & Kashmir	(5000)	(200)	4.00
4	Rajasthan	2428.2 (6000)	(1800)	18.00
5	Uttar Pradesh	4047.0 (10 000)	Nil	
TOTAL		12141.0 (30 000)	(4100)	10.51

*Figures in parenthesis indicate acres

Research

Although the general principles of control and reclamation of gullies and ravines are known details of the technique to be employed for different types have not yet been worked out. The Central Soil Conservation Board has planned an integrated programme of survey and research for reclaiming such areas. Research Stations have been established at Kotah in Rajasthan, Agra in U.P., Vasad in Gujarat and Chandigarh in the Punjab for this purpose. The research programme takes into account various aspects of reclamation measures such as forestry, engineering, agronomy and horticulture including horticultural practices. It is expected that the methods of controlling and stabilising gullies and ravines for specific areas will be worked out in due course.

WORK ON SURVEY AND RECLAMATION OF GULLIES AND RAVINES CARRIED OUT IN MADHYA PRADESH, UTTAR PRADESH, RAJASTHAN AND GUJARAT

Madhya Pradesh

In the year 1919 the then Gwalior State seized of the problem had appointed a committee under the Chairmanship of Colonel Shri Babu Rao Pawar. The Committee had the following terms of reference:

- (i) to suggest ways and means to arrest the further extension of ravines and
- (ii) to suggest means for making available fodder, fuel and agricultural timber to such villages which had no forests nearby.

The recommendations of the Committee were as below

- (a) 198,000 acres of the ravine areas should be constituted as reserved forests
- (b) Out of the area referred to in (a) 40 000 acres in Bhind and Ambah tehsils to be put under a regular afforestation scheme
- (c) The remaining area of 63 943 hectares (158 000 acres) to be closed against cattle grazing and removal of forest vegetation therefrom

For actual reclamation of land inside the ravines the Committee suggested that no land revenue was to be charged for a period of 15 to 20 years from farmers who raised protective bunds. Loans to finance such private efforts were also to be made available. The Commission laid greater emphasis on afforestation and as a result of the concessions offered some 1200 protective bunds were put up and about 4 047 hectares (10 000 acres) of land was reclaimed.

In the year 1945 Dr Schuhart an American expert on Soil Conservation was invited by the Govt of India. He visited the ravine affected areas of Chambal and made the following suggestions to protect the land and prevent further losses

- (a) Contour bunding starting from the ridge
- (b) Control grazing and
- (c) Afforestation

In 1948 the Gwalior State merged into the union of Madhya Bharat States. But the problem continued to exercise the minds of those who were connected with the problem. The Agriculture Department of the new State invited Major Basrur Mechanical Cultivation Engineer of the Bombay State and later Dr J K Basu the then Soil Physicist to the Government of Bombay for consultations and advice. Their recommendations were as under

- (a) Reclamation should be restricted only to the low basins of the ravines which were sufficiently wide for formation of sizable plots for cultivation
- (b) The existing 4.6 to 6.1 m (15 to 20) wide lanes should be used for diverting rain water for protection of reclaimed area
- (c) Top cultivated areas should be protected against further soil erosion and

- (d) The lower reclaimed basin should be given adequate protection against soil erosion

The department then took up two projects, one at Chhonda near Morena and another at Bagchini about 20 miles away. The following programme of work was drawn up

- (a) contour bunding of the peripheral area and
 (b) plugging the mouth of the ravine at suitable points

In the year 1956 the Government of India at the request of the erstwhile Madhya Bharat Government appointed a Committee to go further in the question of ravine reclamation. The committee presided over by Shri P. R. Ahuja, Director Hydrology and Statistics of the Central Water & Power Commission, estimated the areas under ravines to be 2.43 lakh hectares (6 lakh acres) in the 3 districts of the State. The Committee inspected the ravine affected areas and the pilot project at Bagchini and made the following recommendations of a short term nature

- (a) Contour bunding and conservation practices on top table lands
 (b) Afforestation or putting up grasses on marginal lands
 (c) Easing of slopes and stabilization of gully heads
 (d) Reclamation of ravine lands by construction of soil saving dams and
 (e) Afforestation in suitable compact areas

In the long term plan the Committee recommended that there should be a detailed contour survey in order to prepare realistic plans and specific schemes. It was also suggested that on the basis of surveys classification of entire ravine area into lightly eroded and deeply eroded areas should be made and then on the basis of that classification priorities of work should be fixed.

The Committee in its report published a statement showing ravine area in the three districts of Gwalior, Bhind and Morena. According to the statement between 1943-44 to 1950-51 (Table 8) i.e. in a period of 8 years the ravine area increased from 2,44,449 to 2,50,568 hectares (6,04,025 to 6,19,146 acres). The total net increase in the ravine area is 6,119 hectares (15,000 acres) in a period of 7 to 8 years or say 809 hectares (2,000 acres) per year.

TABLE 8

Statement showing ravines in three districts of Madhya Pradesh (1943-44 to 1950-51)

Year	Ravine Area (hectares)
1943-44	2 44 449 (6 04 025 acres)
1944-45	2,43 173 (6 00 871)
1945-46	2 39 217 (5 91 098)
1946-47	2 37 094 (5 85 852)
1947-48	2 34 547 (5 79 558)
1948-49	
1949-50	2 51 950 (6 22 561)
1950-51	2 50 568 (6 19 146)

The Committee appointed by Central Water & Power Commission have observed that the rate of extension of ravines in the State is approximately 809 hectares (2 000 acres) annually. Recently the Government of India have sanctioned a scheme for Survey of Ravine lands to estimate the extent of ravines.

The report of the Committee however did not give any idea of the financial aspects of the long term and short term measures but it was subsequently ascertained that these would cost about Rs 32 crores and Rs 80 lakhs respectively. The Committee suggested that as a beginning a pilot project on the reclamation of such land in an area of about 40 hectares (100 acres) should be sanctioned so that data regarding the cost of reclamation per acre and a suitable technique for reclamation of such areas could be gathered. Besides, this it was also proposed that demonstration on a complete watershed basis in an area of 162 202 hectares (400 500 acres) should also be taken up. Simultaneously the question of such works being taken up by private individuals to a limited extent (as was being done in the erstwhile Bombay State) was also considered and it was felt that while the major works would be carried out by Government or other suitable agencies minor works could be carried out by the local inhabitants with the help and guidance of Government.

Subsequently it was felt that the size of the proposed pilot scheme was too small and would not form a good basis for estimating the requirements of a much larger scheme. The MP Government was invited to send another pilot scheme for reclamation of 202 hectares (500 acres) on a catchment basis so that these two projects together would cover a total area of 405 hectares (1 000 acres). This scheme was sanctioned about the end of 1957. The primary objective of this pilot project was to determine the economics of reclamation and to arrive at the cost estimation. The work has been completed and the details of the results are summarized in Chapter III.

Recently the State Department of Agriculture has initiated a scheme on Survey of Ravine Lands in MP with an annual target of 436 hectares (1 200 acres) in which catchments are selected on each 80 K metres (50 miles) of river length on right bank of Chambal Similarly on each 70 4 K metres (44 miles) of river length along Kunwar a block on catchment basis is selected alternately on its right and left banks One such catchment has been selected on River Aasan for purposes of survey

Recently the Forest Department have attempted to plant Eucalyptus (hybrid) and bamboos in these ravines At present these ravines are with the Revenue Department. It will be necessary to transfer them to the Forest Department for management purposes It is also felt that these ravines do not have any legal status They should be declared as protected forests in the first instance

Uttar Pradesh

Efforts to assess the spread of gullies and ravines and to reclaim the area by afforestation and other measures had been initiated in the State since 1952 under the various schemes

Total area of such land planted under various schemes of afforestation up to date is more than 26 710 hectares (66 000 acres) in various circles and forest divisions as under —

TABLE 9

Sl No	Circle	Division	Area afforested in hectares (acres)
1	(a) Southern circle	Bundelkhand (Jhansi)	1 659 (4 100)
	(b) Do	Banda	1 416 (3 500)
2	Land Management Circle	Vrajbhumi	13 190 (32 591)
		Southern Doab	6 173 (15,253)
		Northern Doab	5 683 (14 043)
3	Western Circle	Saharanpur	405 (1 000)
		TOTAL	38 526 (70,487)

The efforts have proved undoubtedly beneficial and have resulted in providing a vegetative cover to the landscape and also in checking further spread of gullies and filling those which already existed.

Fisher Forest (Southern Doab Division Etawah)

The history of afforestation work in Fisher Forest dates back to 1884 when Mr J H. Fisher the then Collector of Etawah called together all the Zamindars who owned the ravine lands west of Etawah town and suggested that the land which was under ravines be handed over to the Collector for checking further deterioration of the soil by means of afforestation and for creation of a fuel and fodder reserve. The owners of land were also to provide the necessary funds and the profits were to be divided according to the money furnished and the land held in each case. The area was closed to grazing. The soil was broken with country ploughs and babul, shisham and neem were sown. Bunding of ravines was done at suitable points to conserve the moisture and raise the water level. Expenditure incurred was recouped within a few years by the sale of grass and light fellings. The growth of babul was so promising as to attract the Copper Allen Company of Kanpur to take the forest on a fifty years lease in 1902 for extraction of babul bark for tanning on payment of Rs 4 9 per hectare (Rs 2 per acre) plus an annual rent of Rs 2 5 per hectare (Rs 1 per acre). This company had practically worked out the whole forest by 1914. The transfer of this forest to the control of Forest Department was negotiated and the lease was transferred to the Forest Department by the Company for Rs 2 500 and annual rental payment of Rs 2 832 to the Zamindars. Thus Fisher forest has been under the control of the Forest Department since 1914 although the afforestation had started since 1884. Since 1914 the work has been done in two directions

- (a) Prevention of further erosion by erecting bunds at suitable points and gully plugging from the ravine heads downwards,
- (b) Contour trenching and planting and sowing of suitable forest species to provide a vegetative cover which would protect the soil from being washed away and in the course of time to grow up make the fuel resources and in due course improve the soil texture and moisture contents.

The principal species tried were *babul*, *shisham*, *amalina*, *papri*, *neem*, bamboo and *Cassia*. During the course of time it was noticed that when the trees reached the age of about 12—15 years they started dying. This was so particularly with babul. In the first instance this was ascribed to hot winds. To add to the belief babul bark was found cracking in the direction of the winds. Digging up of the roots of a few babul trees revealed that the root system traversed horizontally and made persistent unsuccessful attempts to pierce through the hard kankar pan in search of the permanent water level. When they were unable to do so the trees started dying.

It is the underlying kankar pan through which the babul roots can not penetrate which prevents babul from being grown on any but a short rotation. In 1932 Shri R G Marriott of the Indian Forest Service suggested that further sowings and planting should be stopped and the emphasis should be laid in making the forest as self supporting fodder reserves.

Direct sowings helped by cutting are the only economically feasible way of afforesting these areas. Planting is rather costly and can not be resorted to on a large scale. Dry sowings are done during the last fortnight of May or early in June. The area is effectively closed for grazing with the help of barbed wire fencing. Where fencing materials are not available anti browsing trenches 1.5 meter (5 ft) at the top 1.2 meter (4 ft) deep and 1 meter (3 ft) at the bottom are dug up all around the plantings. The earth is heaped up on the inner side of the ditch and sown with babul to form a hedge. The whole area of 1146 hectares (2832 acres) has gone over for planting purposes. The erosion has been arrested to a very considerable extent. The nala beds where the silt deposit is heavy are blooming with sisoo plants. The quantity and quality of fodder grass has much improved. The reclamation of ravine lands which is always a long term project is now showing its effects in this particular area. The construction of roads and culverts has also been very successful in arresting the soil erosion and has facilitated inspection of the area even during the rainy season.

*Rehmankhera Farm**

The Government of UP undertook to reclaim a big area under ravines at Rehmankhera under the State Soil Conservation Programme which was started in the district of Lucknow in June 1950.

Most of the land in the farm had been so badly damaged by the erosion and cut up by the ravines that agriculture of any type was impossible. There did exist small patches of cultivated land which grew nothing except poor crops of coarse grains like *jowar* and *bajra*. The soil of the area was also of poor quality of sandy loam or loamy sand in texture. There was severe gullying and the ravine formation was at its extreme. Even the grass refused to grow on this land. Scattered bushes of *munj* (*Saccharum munja*) *Kans* (*Saccharum spontaneum*) and few trees of inferior variety of *Acacia* could be found. As a result of adoption of soil conservation and good farm management practices on the arable part of the farm the land has been completely reclaimed. It is now possible to raise all kinds of

*This is based on a paper by A D Khan Joint Director of Agriculture (Soil Conservation) UP entitled "It can certainly be done" *Journal of Soil and Water Conservation in India* Vol 8, 1960

crops The achievement in crop production during 1950-51 to 1958-59 is given in the table 10 below

TABLE 10

Production of arable crops at the State Soil Conservation Farm Rehmankhara

Sl No	Year	Net area cropped (hectares)	Production (quintals)	Yield (quintals/hectare)	Yield/hectare, when the yield of 1950-51 is kept 100
			**	***	
1	1950-51	(324) 131	(645) 241	(1 91) 1 8	100
2	1951 52	(189) 77	(313) 117	(1 65) 1 5	83
3	1952 53	(290) 117	(2 244) 838	(7 74) 7 2	388
4	1953 54	(309) 125	(1 886) 704	(6 10) 5 6	306
5	1954 55	(275) 111	(1 627) 607	(5 92) 5 5	297
6	1955 56	(274) 111	(2 762)1031	(10 07) 9 3	506
7	1956 57	(276) 112	(5 357)1999	(19 42)17 8	975
8	1957 58	(302) 122	(3 897)1455	(12 90)11 9	648
9	1958 59	(296) 120	(6 408)2392	(21 61)19 9	1 086

*area in parenthesis indicate acres

**lbs in parenthesis

***lbs/acre in parenthesis

A perusal of the table shows that the yield during 1958 59 is about 10 times that of 1950 51 This marked increase in the productivity of land has been brought about by a combination of soil conserving and other scientific farm management practices such as bunding levelling provision of outlets effective and timely cultivation growing of covered crops green manuring application of manures and fertilisers and irrigation to a part of the area

When the farm was started in 1950 there were practically no irrigation facilities and data for the first two years represent the unirrigated conditions Since then irrigation facilities have been developed and at present irrigation is available to about 35 per cent of the area The intensity of irrigation is of the order of one 18 8 cm to 25 1 cm per hectare (3 to 4 per acre) per month Almost all the area was put under improved seeds from the very beginning

Actually the average production over the last four years is of the order of 14.8 quintals per hectare (16.04 maunds of wheat per acre). The factors responsible for this increase in yield are the soil conservation practices adopted at the farm such as bunding, levelling, provision of grass and masonry outlet and the last but not the least the effective timely cultivation.

The achievements of Rehmankhara farm are only guide posts which clearly indicate that the land which is lost to ravines and gullies when properly reclaimed and put under scientific agriculture can be of very high productive value, and that it is possible with resources and determination to upgrade these highly eroded land. Nutrients which are vitally required for stepping up productivity can be procured locally to an extent of 85 per cent or even produced in the form as green manures on the area that is being reclaimed.

Bah Reclamation Scheme

This scheme of Survey of Ravines of about 2595 hectares (6400 acres) was taken up during the 2nd Plan in the year 1960-61. The area selected for survey was situated between Agra Kachoraghat road (Mile stone 46 to 49) and Jamuna river. This area lies about 5 to 6 miles from Bah Tehsil in Agra district.

Marginal bunds with masonry or sod chutes have been provided at the end of the agricultural land where ravine formation starts to check the top agricultural land from being turned into ravines progressively. Suitable disposal of excess run off will be done through masonry chutes for smaller drops and small discharges.

Earthen check dams—113 in number have been provided in the Nalas in the ravine area and suitably placed to serve as silt collecting dams and to help in the reclamation of the area in the upstream of these dams for cultivation. It is expected that the area of about 405 hectares (1000 acres) will thus be reclaimed which will be a very good and fertile land for cultivation purposes.

Masonry Structures Suitable provision of masonry structures in the shape of drop spillways and chutes has been made for these earthen dams to dispose of excess run off. In a few of these structures bridges will be provided to enable the villagers to go to the different villages during the rain. An area of about 121 hectares (300 acres) with a slope of 33% has been reserved by bench terracing.

In an area of about 1 457 hectares (3 600 acres) the programme of afforestation and pasture development is proposed

In addition to these programmes several other programmes like protection of villages which are under serious danger of ravining at present the provision of grass nurseries and the general soil conservation programme in the land already under cultivation 607 hectares (1 500 acres) will be carried out After the construction of the dams the programme of breaking up the small hillocks will also be taken either with the help of explosives or through the help of the water jets to encourage silting upstream of the dams A pilot project in a village of Halwapur Lucknow has been initiated by the State Government It covers an area of about 3 944 hectares (9 746 acres) It is proposed to have detailed study of mechanics of ravine formation in this pilot project

Cropping Studies

With a view to evolve economic and profitable cropping pattern for such lands experiments have been conducted at the Soil Conservation Research Demonstration and Training Centre Agra with *bajra*, *arhar*, mustard and cowpeas in various combinations and crop rotations The results tentatively indicate that a mixed crop of *bajra* and *arhar* in kharif followed by mustard in rabi are better than any other cropping pattern

(c) *Rajasthan*

In this State also the ravine and gully eroded land occurs along the river Chambal i.e. in the districts of Kotah Bundi Bharatpur Sawai Madhopur etc No exact data about the extent of such land is available anywhere However according to Third Plan report the extent of area under ravines in the State is more than 3.2 lakh hectares (8 lakh acres)

Rajasthan Government appointed a Committee under the Chairmanship of Shri S L Kakkar Commissioner of Kotah in February 1960 to examine the problem of survey of ravines and their economic utilisation

The Committee estimated that about 2.8 to 3.2 lakh hectares (7.8 lakh acres) of culturable land are affected by the ravines in Rajasthan Out of this about 1.6 lakh hectares (4 lakh acres) lie along the banks of the Chambal and its tributaries such as Kali Sind, Parbati and Banas

The Committee suggested that as a first step the table lands which mostly constitute the cultivated area should be treated with

soil conservation measures Further the Committee felt that the problem could not be confined to the Chambal river alone and the ravines along its tributaries must also be taken into consideration

The Committee also recommended that marginal lands not fit for cultivation should be brought under pasture and afforestation In the opinion of the Committee it will not be economical in any way to reclaim ravines for agricultural purposes alone There may be parts of ravines which belong to Class V land and may be suitable for pastures with a cost of Rs 148 per hectare (Rs 60 per acre) Lands belonging to classes VI and VII should be put under afforestation not only because reclamation of these lands for cultivation involves very huge financial outlay but because these lands have in most cases lost their fertility The erodability of soil in these lands has become very high and it is felt that even after reclamation it will take many more years to bring the fertility and the other soil conditions to their original levels This would also involve various agronomic and mechanical practices The State Government is carrying out reconnaissance survey of the ravine area under a centrally sponsored scheme with the total financial outlay of Rs 1 lakh This survey would yield valuable information about the distribution of ravines the ownership rights over these lands land use pattern and would ultimately help in tackling the reclamation of these ravines in a systematic and rational manner The physical and financial targets are given below —

	1961-62	1962-63	1963-64	1964-65	1965-66
Financial outlay (Rs lakhs)	0 20	0 20	0 20	0 20	0 20
<i>Physical Targets</i>					
(in lakh hectares)	0 8 (2 00)*	0 8 (2 00)*	0 8 (2 00)*	0 8 (2 00)*	0 8 (2 0 0)*

* Figures in lakh acres

The extent of ravines will be surveyed on the G T sheets by actually going on the spot and necessary data with regard to their extent land use pattern capability class socio economic condition agriculture etc will be simultaneously collected and compiled for each river and tributary separately

Due to lack of funds the plan targets of reclaiming such lands during Third Plan period has been reduced from 2428 to 1214 hectares (6 000 acres to 3 000 acres) The area covered in 1961-62 was one thousand acres and the target for 1962-63 was 324 hectare (800 acres) The work had been done near Dholpur and Kotah

Soil Conservation Research Demonstration and Training Centre Kotah was started in November 1954 by the Government of India Ministry of Food and Agriculture (Department of Agriculture) to tackle the soil erosion problem along the alluvial banks of the Chambal ravines. It includes the task of establishment of Chambal lands and ravines its proper land use in addition to formulating a comprehensive programme of soil and water conservation and its adjoining watershed. The farm of this centre comprises an area of 168 acres (72 hectares) of land consisting of 84 acres of cultivated and 84 acres of ravine land.

The work on the control of ravine land was started in 1956. A marginal (diversion) bund was constructed along the periphery of ravine and gullied land to control the run off from the table and agricultural fields passing over the gully heads. Two masonry drop spillways were constructed for the safe disposal of the surplus water. Simultaneously the area was completely protected from biotic agencies and fenced.

Along with this the farm area was surveyed and classified into different land use capability classes. The table agricultural land was put under class II and the margin land which is unfit for cultivation was put into class VI and ravine land into class VII.

Due to the above measures within about 2 years the entire area was covered by thick natural vegetation of trees shrubs and grasses namely *Acacia arabica*, *Prosopis juliflora*, *Balanitis roburgi*, *Capparis delidua*, *Aristida* spp, *Themeda* spp, *Heteropogon contortus*, *Apluda* spp, *Cenchrus setigerus* and *Dichanthium annulatum* etc.

In the bottom of the barren ravines brushwood and bolder check dams were put which functioned well in reducing the flow of water. In addition to the other type of check dams *Ipomea carnea*, *Arundo donax* have proved to be very useful species for live checks.

The vertical sides of the ravines were stabilised by providing vegetative cover. Seeds of *Acacia arabica* and *Prosopis juliflora* were dibbled in pockets. The toe of the side walls was planted with *Ipomea carnea*, *Arundo donax* and *Salix tetrasperma* which have proved to be very effective.

The ravine land comprising 84 acres had been divided into 3 blocks. The gully heads were eased by giving different angle of repose i.e. 1:1, 2:1, 3:1 and vegetative cover consisting of grasses and legumes was provided. It has been found that (1:1) slope is sufficient to establish good cover provided the contour trenching along with afforestation is followed in the catchment of ravine. It

has been found that while the effectiveness of the trenches is decreased by regeneration of vegetative cover in the catchment area, the run off is reduced. *Dicanthium annulatum* was found to be suitable grass for sodding the eased slope.

Grasses have also been found to play a useful role in the control of gullied and ravine lands. These provide an effective protective cover during the monsoon season and save the soil from further erosion. On the basis of the experiments conducted it has been found that these can be cut in September- November months and used as forage and thus ravines can serve as a useful source of fodder supply which is in ever increasing demand. In the gradual succession going on in the ravine lands better species like *D. annulatum*, *Schima nervosum*, *Cenchrus abaris* and *Cenchrus setyuns* replaces the inferior like *Aristide spp*, *Themeda spp*, *Appluda spp* and *Heteropogon contortus* in due course. The grasses are also good soil binders through their root system.

Experiments have also been conducted for introduction of useful economic forest species in the ravine lands and found that *Holoptelea integrifolia* (80% survival), *Pongamia glabra* (95 per cent survival), *Glyricida maculata* (65 per cent survival), *Albizia lebbek* (80% survival) and *Azadirachta indica* are good species for the afforestation of the ravines. *Glyricida maculata* was raised by branch cutting and the rest by planting one year old nursery seedlings.

In 1957 Bamboo (*Dandrocalamus strictus*) was introduced in the degraded ravine bottom. One year old seedlings were planted in $1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}$ pits dug at the bottom of ravines and have given 73 per cent survival. This has been found to be one of the promising species for planting in the bottom of ravine lands.

More recently in 1962 experimental trials to introduce hybrid Eucalyptus species and Teak (*Tectonia grandis*) have been started for their introduction in the marginal and ravine lands. Survival percentage has been good and the results are quite encouraging. Studies are required to be carried out for some more time before making specific recommendations.

After 8 years of effective closure and protection as well as due to various efforts made in the establishment of vegetation the gullied and ravine lands are fully stabilised.

(d) Gujarat

In the State of Gujarat gullies and ravines occur along the banks of river Mahi, Sabarmati and other major water courses which have been stripped naked of natural vegetative cover and are exposed to

the ravage of nature and further ravine formation. It is estimated that the extent of such lands is about 0.4 million hectares (one million acres). Such lands are known as *Kotars* in the State. These ravines and gullies are found both in the lands of private persons most of which are under cultivation as well as in the Government waste lands which are either declared as *Gauchers* or kept as waste lands. These *Kotars* exist on either banks of all the major river courses and their tributaries varying from a few feet to a distance of about one mile. The districts affected by such lands in the State are Surat Broach Baroda Kaira Panch Mahals Ahmedabad, Sabarkantha and Banaskantha.

The following two schemes have been sanctioned for utilisation and reclamation of such lands in the State during the third Plan period —

- (1) The scheme for afforestation of Kotar lands in which it is proposed to afforest an area of 5059 hectares (12 500 acres) at a cost of Rs 26.21 lakhs.
- (2) The scheme for reclamation of Kotar lands in which it is proposed to afforest an area of 3642 hectares (9 000 acres) and reclaim 1214 hectares (3 000 acres) for cultivation. In addition 5 lakh acres are to be gone over and mapped indicating the lands affected by *Kotars*. The scheme is estimated to cost Rs 100.50 lakhs.

Provision for funds was made during the year 1961-62 to start both the above mentioned schemes by the Government of Gujarat but as the sanction was received rather late in the season only preliminary work could be taken in hand during that year. These preliminary works included not only the establishment of the office but also purchase of dead stock articles survey of the areas to be tackled during 1962-63 appointment of the staff required transfer of *kotar* affected lands from the Revenue Departments etc. The works were started at Bahedra and Sindhrot in Baroda district and Anghari and Attarsumba in Kaira district during the year 1962-63. An area of 264 hectares (652 acres) was taken up for afforestation under the scheme for reclamation of *kotar* lands during 1962 rainy season. As more area was transferred the works under the scheme for afforestation of *kotar* lands were also started in November 1962. So far besides surveying and mapping of 38423 hectares (94 941 acres) and afforestation of 264 hectares (652 acres) soil conservation works such as gully plugging check damming construction of ring bunds etc have been carried out over an area of 857 hectares (2117 acres).

CHAPTER V

PHASED PROGRAMME OF UTILISATION AND RECLAMATION OF RAVINES

Extent and the magnitude of the problem involved in ravine eroded land reclamation is so enormous that it calls for huge human and material resources. It is therefore necessary to have properly phased programme based on scientific lines setting out in very clear term the priorities. With this end in view the following programme is suggested in order in which it may be taken up

1 SURVEY OF RAVINE LANDS

The extent of land under ravines and the rate at which additional land every year is coming under such conditions should be known as a first necessity. It is therefore suggested that a survey to locate the ravine lands may be carried out. Although there is a provision of about 55 lakhs of rupees to carry out such surveys in the Third Plan the progress in this direction is slow. What is needed is a visual and rapid field survey by a trained scientist with background of economics to enable him to decide whether the ravine in question is suitable for agricultural purposes after reclamation or it is better to relegate it to forests or grass land management. During the survey the information about the depth and width of ravines, the bed and bank material, the different crops grown in the region, availability of water, demand of land by the people of adjoining areas and proximity of such lands near towns should be collected. Such a rapid survey should not take long time and on the basis of the survey land should be earmarked for different uses and reclamation work started immediately. The survey of the ravines and gullies should also indicate the type of soils in the particular region or the tract. This would help to locate the vulnerable points belonging to the ravineous tract which are susceptible to much rapid rate of erosion than the other areas. It would then be possible to reclaim such lands on priority basis and also take necessary protective measures. Since all the ravines and gullies may not be suitable for agricultural purposes or it may not be an economic proposition, this survey therefore should demarcate ravines that are suitable for agriculture and those that are suitable for afforestation or pasture lands only. The survey should be completed in the minimum period of 3-4 years. While it is agreed that the different States should survey the actual acreage under ravines as well as the marginal lands

and top lands on the periphery of these ravines it may be considered very desirable that Government of India may undertake an aerial survey of the contiguous ravineous areas and supply topographical survey sheets to the States concerned so that the states are able to carry out a detailed survey of such areas expeditiously. Major portion of the ravineous lands lie outside forest demarcation. For proper utilisation of the land resources of the country, it is necessary that during survey of the ravines it is clearly ascertained whether the land would be fit for agricultural purposes after reclamation operations. The ravineous lands which are suitable for tree planting and for being maintained as fuel and fodder reserves should be put to that use. For handling this problem a separate Soil Conservation Department in the States is necessary. Alternatively an Extension Forestry Wing will have to be created.

At present we have no reliable data to indicate the rate at which ravines or gullies are extending further into the agricultural lands. It should be possible to determine this rate as well. This would help in formulating schemes to check the further ingress of ravines in agricultural marginal land and would also unfold the magnitude of problem involved in stabilising the ravines and gullies.

2 PROTECTION OF TOP LAND

Any programme of ravine reclamation should start from the top and move towards deeper gullies and ravines and not the *vice versa*. It is therefore necessary that we should start from the top lands by providing adequate anti erosion measures. Quite a substantial amount of work is required to be done on the top table land of the ravines since it is the erosion from such lands which gathers momentum and extends ravines backward. On an average the ratio of ravines and top land works out to be as 1:3 i.e. for every hectare of ravine land there are three hectares of top lands. In order to reclaim just one hectare of land protective measures are called for the three hectare of top land as well. We have at present no reliable statistics to give an exact estimate of the total land under ravines. Hence it is not possible to give how much of top land needs to be protected. Working on the basis of the rough estimates as given in this study we find that there are about 2.4 million hectares (6 million acres) of land under ravines. The protective measures are therefore required to be taken on 7.2 million hectare (18 million acres) of top land. The highest priority should be given to the soil and water conservation programme on the table lands and stabilisation of the marginal lands and trained heads. The work of protecting the top land against soil erosion is protracted in a period of 15 to 20 years. Once all the top land is adequately protected against

further erosion, we can take effective steps to reclaim the shallow and medium gullies and ravines adjoining the top lands. The work of proper ravine reclamation can be taken up simultaneously along with the work of protecting the top lands. The usual protective measures adopted for such lands are bunding or contour bunding. There are programmes of providing bunds as soil conservation measures in each state, but its progress is very slow. This is because before undertaking any bunding work the consent of the villagers is to be obtained. It is therefore necessary that the State legislation should be adequately amended to provide for compulsory bunding of the top land wherever it is found necessary. In this regard it may be mentioned that State of Madhya Pradesh is already thinking of amending the existing legislation.

3 SPEED OF RECLAMATION WORK

We have at present no reliable data to indicate the rate at which the ravines are eating into our agricultural land. From the estimates though tentative and rough furnished by Madhya Pradesh it is found that every year about 809 hectares (2000 acres) of good agricultural land are lost to ravines. The rate of ravines extending into agricultural land may not be much different from this in other States as well. With the slow speed of reclamation as at present it is likely that the rate of deterioration may continue faster than the pace of reclamation. It should be possible that within ten to fifteen years all the top land be protected against the further ingress of ravines and gulches.

4 SHALLOW AND MEDIUM RAVINES ADJOINING THE TOP LAND

Most of the ravines adjacent to the top land are of shallow or medium depth. Such lands can be reclaimed by adopting any of the following methods or a combination thereof.

- (i) Easing the slopes
- (ii) Terracing
- (iii) Plugging the gullies by putting up soil saving structures at suitable points and diverting the waters through waste weirs or pipe channels discharging the water at the gully head.

The experience of working at the projects of Bagchini Hingona and Jawasa has shown that with proper bunding of the top lands the soil saving structures get sufficiently silted up in one or two years and that the ravines are converted into flat areas suitable for agriculture. At Jawasa in Madhya Pradesh the cultivators had raised a very good crop of millets although the work of easing the slopes and terracing

had not been completed. Similarly at Bagchini at another project in the same State the work of reclamation was completed only about 2 years ago the gullies have silted up by about 8 to 9 feet. The whole area has become flat and the people there have raised good crops of millets this year. The cost of reclamation in such lands comes to somewhere between Rs 1000 to Rs 1300 per hectare (Rs 400 to 500 per acre). Reclamation of such land should get the second priority in the programme of ravine reclamation.

There is one particular point in favour of reclamation of suitable ravines for agricultural use. In many cases especially in watersheds of river valley projects and in hilly areas farmers have gone up for cultivation in very steep and unsuitable areas which result in heavy erosion. In such cases reclaimed areas from ravines may offer a suitable and better agriculture as an exchange for agriculture higher up in unsuitable areas.

While the protection and reclamation of ravines should have high priority each ravine needs specific treatment. No uniform procedure can be laid down for these purposes. After protective measures for stopping the progress of ravines have been taken priority should be given to soil conservation measures for agricultural table land at the head of ravines and adjoining areas having incipient gully formation. Emphasis should be on the protection of existing agriculture by protective measures like contour bunds, check dams, etc. In gentler slopes existing agricultural practices may continue but only with suitable conservation measures. If economic and permanent agriculture is possible in suitable areas it should continue. In deep gullies and ravine areas and areas of steeper slopes afforestation would be the best method of reclamation. Flat valley bottoms may be used for agriculture or forestry depending on the nature of the area.

5 UTILISATION OF DEEP RAVINES

The real difficulty of reclamation for agricultural purposes which is both a cumbersome physical process and also involves heavy financial outlays lies in the reclamation of deep ravines. There is no good communication available so that equipment and material cannot easily be transported. The ravines with broad basins or U shaped may be suitable for agriculture after reclamation. As far as possible such areas should be fenced and closed to grazing. Afforestation of ravines with narrow basins of V shaped gullies would be economical.

6 SPATIAL CONTIGUITY OF THE PROJECTS OF RAVINE RECLAMATION

At present the projects that are being undertaken to reclaim and utilize the ravine lands are scattered wide apart. In order to have

a proper and effective supervision it is necessary that these projects should be near about each other. Moreover after one particular area has been reclaimed or properly utilized it would be desirable to reclaim and utilize the adjoining area. This would speed up the process of reclamation and at the same time lead to efficient use of human and material resources. The impact of such a programme of reclamation and utilisation would also be visible in much short a time. To arouse the public interest and to secure their cooperation such lateral spread of reclamation would serve as good example. As far as possible earth work and bunding should be done by employing the surplus labour of the adjoining villages. This would serve double purpose of giving employment to the surplus labour and would also be economical in the long run. The area taken for reclamation should be complete watershed of the ravines under reclamation. The bulldozers or tractors may also be employed in either levelling the ground or in putting up bunds where it is convenient and economical to work them. Since there is good amount of surplus labour available at cheaper rates it would be comparatively economical in employing them on reclamation projects near about their villages.

In order that useful information may be obtained to provide guidance in tackling the various problems arising out of ravines and gully erosion in all types of lands in the country it will be necessary to undertake rapid reconnaissance of representative problems in the various States so that the different problems based upon the terrain source or causes for different types of ravines and gullies occurring, *vis a vis* soil and climate problems can all be studied classified into standard survey groups and then appropriate reclamation measures suitable for such groups can be recommended. In this matter it may be necessary to work out standard methods of capability classification for ravines affected land for deciding the appropriate land use.

CHAPTER VI

ORGANISATION FOR RECLAMATION AND ALLOTMENT OF RECLAIMED RAVINES

1 DESIRABILITY OF SUITABLE SOIL CONSERVATION ORGANISATION OF THE FUNCTIONAL TYPE FOR RECLAMATION WORK IN THE CONCERNED STATES

In the States where the land is affected by ravines the work of reclamation is at present handled either by the Director of Agriculture or by the Chief Conservator of Forests. The magnitude of soil conservation problem in the States requires that there should be a separate Soil Conservation Organisation in each State with adequate finances and trained men. This organisation may have a unit devoted to the problem of ravine reclamation. The technical advice of experts in forestry, agriculture and irrigation engineers should be available to this unit. The unit should first undertake the survey to locate the extent of ravines and demarcate the area that is to be put under afforestation. The tree and grass species that are put on such lands should be fast growing and of economic value and should also have soil stabilization properties. In the active programme for the reclamation of ravines more and more participation of local population in all phases of development should be encouraged to the maximum possible extent. Further the problem of ravine tracts calls for special emphasis on developing a unified planning and action programme for the whole tract affected by ravine problem. This will necessarily call for inter state coordination of the development programme. Unless this unified approach is made on the problem piecemeal work by different state agencies will lead to duplication of work confusion and possible delay in execution of the programme which will lead to loss and wastage of funds. It is therefore suggested that an Inter-State Control Board with statutory powers be instituted under the aegis of Central Board of Soil Conservation for formulation of priority and planning of certain programme taking the whole region as a unit of operation.

As protection and reclamation of ravines in agricultural lands, waste lands and marginal lands warrant high priority the State Soil Conservation Board, Agricultural Department and Forest Department should be given the responsibility of this urgent work. The Forest Department would be the best agency for management of lands which are predominantly affected by deep ravines. A coordinating committee at the Central level in the Planning Commission

may fix up priorities for reclamation of ravines and coordinate inter State work where the ravines extend over more than one State

2 PUBLIC COOPERATION

In a programme of reclamation of ravines affecting the economy of the region it should be possible to work up the enthusiasm of the local population and secure their active co operation and participation To protect vast area from the villagers and their cattle is the most difficult part Introduction of suitable legislation to this effect will go a long way to afford protection It may also be pointed out that public cooperation is the main key to success to protect such lands from uncontrolled grazing

Besides public cooperation legislative measures to control grazing may also be necessary Suitable programmes for both public co operation and legislative measures should be initiated where necessary

3 ALLOTMENT OF RECLAIMED LAND

Whenever a ravine area is reclaimed and is to be allotted for settlement purposes it should be given to the landless labour of the adjoining village on a payment basis There is a certain amount of doubt about the usefulness of allotting land to landless labourers It is feared that it may not achieve the desired objective of stepping up agricultural production because these landless labourers lack the necessary resources in the form of ploughs bullocks etc While drawing up any scheme of allotment of land these factors may be borne in mind and adequately provided for To begin with these landless labourers may be asked to adopt orthodox methods of cultivation to be gradually replaced by scientific agricultural practices The present practice in Madhya Pradesh is to allot the land on year to year basis to the cultivators in the adjoining villages This is not desirable It leaves uncertainty in the mind of the cultivator whether he would be ploughing the same land the next year or not He is therefore not much interested in taking necessary precautions while cultivating the reclaimed land It is therefore possible that he may undo the effort put in to reclaim the land It is therefore necessary that all the formalities regarding allotment and settlement be cleared simultaneously as the land is being reclaimed and the cultivators in such areas may be given free implements and fertilisers or other agricultural inputs by way of incentives for at least 5 years

Some State Governments give large blocks of ravines to individuals or cooperative societies on a long term lease If the land is reclaimed within a certain time the lessee may keep the permanent right without occupancy charges Thereafter only assessment is

charged on a sliding scale. This is a good way of reclaiming ravines through cooperative effort. Village panchayats can put ravines to fuel trees and other crops and thus make it possible to reclaim such lands which otherwise will be impossible for individuals to do.

CHAPTER VII

SUMMARY

There is a need of early aerial survey of large areas of ravines in Uttar Pradesh Madhya Pradesh Gujarat and Rajasthan by a Central agency of the Government of India within a period say five years and maps in 4 = 1 mile scale supplied to the State Governments for action. In case maps of some of the existing aerial photographs are old these areas need be covered again by such aerial photographs maps prepared again for taking further action similarly.

The problem of control and reclamation of ravines falls into essentially two groups —

- 1 in agricultural lands and
- 2 in waste lands and marginal lands

The first problem *viz* control and reclamation of ravines in agricultural lands should have the highest priority. There are different forms of ravines in the agricultural lands in all States particularly where the areas are undulating and soils are erosive. Because of the comparatively high cost of reclamation the protection and reclamation of ravines are not receiving adequate attention. It is very necessary that schemes on the reclamation of ravines should be encouraged. Further, since each of such ravines has its own problems there cannot be any uniform technique of reclamation of such problem land. Therefore any uniform cost of reclamation of gullies cannot be laid down. Generally the reclamation of ravines is attempted by using stone check dams planting quick growing vegetation on the slopes and edges and by diversion of headwater. While these techniques should prove useful in specific cases other techniques should also be tried according to the nature of the gullies in agricultural land. These methods are

- (1) terracing the ravines for ultimately converting them into fodder lands if there is adequate water for growing highland crops

- (ii) converting these ravines into ponds if the soils at the bottom of the gullies is sufficiently clayey for water to be retained. The water in these ponds may then be used for supplemental or protective irrigation and also for fish culture.

The urgent work on protection and reclamation need not be held up till the aerial survey is completed but should proceed simultaneously.

The work of standardisation in respect of classification of ravines with reference to depth, width, side slope and land use capability etc which is at present being carried out by the Central Soil Conservation Board should be expedited.

Besides public cooperation legislative measures to control grazing may also be necessary. Suitable programmes for both public cooperation and legislative measures should be initiated where necessary.

While the protection and reclamation of ravines should have high priority each ravine needs specific treatment. No uniform procedure can be laid down for these purposes. After protective measures for stopping the progress of ravines have been taken priority should be given to soil conservation measures for agricultural table land at the head of ravines and adjoining areas having incipient gully formation. Emphasis should be on the protection of existing agriculture by protective measures like contour bunds, check dams etc. In gentler slopes existing agricultural practices may continue but only with suitable conservation measures. If economic and permanent agriculture is possible in suitable areas it should continue. In deep gullied and ravine areas and areas of steeper slopes afforestation would be the best method of reclamation. Flat valley bottoms may be used for agriculture or forestry depending on the nature of the area.

The reclamation of ravines in agricultural lands may involve the coordinated efforts of reclamation of such lands if two or more farms are affected by a common gully. It may be necessary to enact such a legislation or other measures which may permit such problems to be tackled. It is also desirable that although the reclamation of ravines may be given low priority as compared to the reclamation of agricultural lands or marginal lands amongst the ravines in agricultural lands according to the cost of reclamation the priority have to be laid down. However protection and reclamation of ravines in agricultural lands should be given higher priority than protection and reclamation of ravines in waste lands.

In other areas where ravines are steep and where reclamation for agricultural purposes is very costly the best course would be to

arrange for its reclamation through forestry and grass land management methods. It would be a wise policy for all the State Governments to hand over such lands for development of forests. In fact what is happening is that this subject is not being undertaken by the Governments concerned and therefore reclamation of such lands is delayed. The present land use of the existing gullies gives room for its extension.

The treatment of the ravines in waste lands and marginal lands involve by and large measures of afforestation and control of ravines by stone check dams. Depending on the soil and nature of the ravines terracing for livestock agriculture or horticultural practices may also be resorted to. Again if the sub soil in certain cases be impervious ponds may be built by setting up dams across the ravines. As the reclamation of ravines in such areas will involve high cost it is necessary that utmost care be taken while laying down priorities. In order to clarify ravines topo sheets in the scale of 1:15840 (4 = 1 mile) or aerial photographs of suitable scale will be useful for the purpose as there are extensive areas which are difficult to approach. Also these deep ravines should be classified according to their length depth and width and cost of reclamation. Such categories will be helpful in giving priorities for reclamation of these gullies and ravines. In the States where the land is affected by gullies the work of reclamation is at present handled either by the Director of Agriculture or by the Chief Conservator of Forests. As protection and reclamation of ravines in agricultural lands waste lands and marginal lands warrant high priority the State Soil Conservation Board Agriculture Department and Forest Department should be given the responsibility of this urgent work. The Forest Department should be the best agency for management of lands which are predominantly affected by deep ravines. A coordinating committee at the Central level in the Planning Commission may fix up priorities for reclamation of ravines and coordinate Inter State work where the ravines extend over more than one State. The magnitude of the soil conservation problem in these States requires that there should be a separate soil conservation organisation in each State with adequate and trained personnel.

Existing information on the cost of reclamation of ravines is only approximate at the present moment. Steps should therefore be taken to make comprehensive study of cost benefit on reclamation of ravines along with the annual cost of each measure against the extent of damage occurred to the productivity of land. It is advisable to set a time limit for reclamation of ravines. Fifteen years as the limit for reclamation of reclaimable lands should be quite sufficient for the purpose.

CHAPTER VIII
RECOMMENDATIONS

Sl No	Recommendations	Action to be taken by
Uttar Pradesh		
1	<p>(a) Ravines occurring in U P Madhya Pradesh Gujarat and Rajasthan should be aerielly surveyed by a Central agency of the Government of India within a period of 5 years and maps in 4 = 1 mile scale supplied to the State Governments Some of the existing aerial photographs are old and while taking aerial photographs these areas may be covered again</p> <p>(b) Aerial survey of ravines should be taken up urgently but the work on protection and reclamation should also proceed simultaneously</p>	<p>State Governments, Central Soil Conservation Board and Surveyor General of India</p> <p style="text-align: right;">Do</p>
2	<p>The work of standardisation in respect of classification of ravines with reference to depth width, side slope and land use capability etc which is at present being carried out by the Central Soil Conservation Board should be expedited</p>	<p>State Governments and Central Soil Conservation Board</p>
3	<p>The protection and reclamation of ravines should be given high priority Each of these ravines will need specific treatment and no uniform procedure should be laid down but it is necessary to emphasise that the first step has to be protective measures which stop the progress of ravines In the agricultural table land at the head of ravines and adjoining areas having incipient gully formation, priority should be on soil conservation measures, like contour bunds check dams etc which aim at protection of existing agriculture In the gentler slopes existing agricultural practice may continue but only with suitable conservation measures Other</p>	<p style="text-align: right;">Do</p>

Sl No	Recommendations	Action to be taken by
	<p>suitable areas should be prepared for cultivation <i>if this is economical and permanent agriculture is possible</i> In the more deeply gullied and ravine areas and areas of steeper slopes afforestation would be the best method of reclamation Flat valley bottoms may be used for agriculture or forestry depending on the nature of the area</p>	
4	<p>Legislation to control grazing should be enacted Efforts to enlist public cooperation is most vital for successful control of grazing Suitable programmes in both directions (i.e. legislative measures and public cooperation should be initiated</p>	<p>State Governments and Central Soil Conservation Board</p>
5	<p>The protection and reclamation of ravines in agricultural lands wastelands and marginal lands should be given high priority and handled by State Soil Conservation Board/Agriculture Department/Forest Department in each State For the management of lands which are predominantly affected by deep ravines the Forest Department would be the best agency</p>	<p>Do</p>
A	<p>Coordinating Committee at the Central level in the Planning Commission should be set up to fix priorities for the reclamation of ravines and coordinate Inter State work where the ravines extend over more than one State</p>	<p>Planning Commission</p>
6	<p>As the existing information on the cost of reclamation of ravines is only rough it is recommended that steps be taken urgently to make comprehensive analysis of the benefits of reclaiming ravines giving the total cost of various reclamation measures The annual cost of each measure the damage that have occurred to the productivity of the land in terms of monetary value (which will indicate the loss that can be avoided by the reclamation measures) the annual benefit that can be expected as a result of ravine reclamation and the benefit cost ratio should be worked out</p>	<p>State Governments and Central Soil Conservation Board</p>

Sl No	Recommendations	Action to be taken by
	This work will be useful in fixing priorities for future reclamation	
7	In view of the menace of ravines while survey of such lands should be completed within five years the time limit for reclamation should not be more than 15 years	State Governments and Central Soil Conservations Board

REFERENCES

(A) Reports

- (1) Report on Ravine Reclamation in Madhya Bharat Government of India Central Water & Power Commission Team (1956)
- (2) Report on Ravine Reclamation in Rajasthan Committee of Government of Rajasthan (1960)

(B) Notes Received

- | | |
|---|--|
| (3) A D Khan
Joint Director of Agriculture
(Soil Conservation) (U P) | (a) Rehman Khera Farm
(b) Reply to questionnaire
(c) Report on Bah Reclamation Scheme
(d) Note on Fisher Forest |
| (4) Balbir Varma
Soil Conservation Officer
Vasad | Reply to questionnaires |
| (5) S R Umbarje
Conservator of Forests
Baroda | Note on ravine lands in Gujarat |
| (6) N W Tiloo
Joint Director of Agriculture
(Land Development)
Madhya Pradesh | Reply to questionnaire |
| (7) R C Soni
Chief Conservator of Forests
Uttar Pradesh | Reply to questionnaire |
| (8) Shri Karnikar,
Madhya Pradesh | Note on Ravine Reclamation |
| (9) Shri Inderpurkar
Divisional Soil Conservation
Officer Gwalior
Madhya Pradesh | Reply to questionnaire |
| (10) Annual Reports of Soil and Water Conservation Research Training and Demonstration Centres at Kotah Vasad Agra and Chandigarh | |

(C) Books and Journals referred to

- (11) Journal of Soil and Water Conservation
Soil Conservation H Bennett 1939 McGraw Hill, New York

- (13) Second Seminar on Soil Conservation Central Board of Soil Conservation 1958 Ministry of Food and Agriculture
- (14) Study on Wastelands including Saline Alkali and water logged land and their reclamation measures—Committee on Natural Resources Planning Commission 1963
- (15) Centenary Souvenir Forest Department of Madhya Pradesh 1960
- (16) Soil Conservation in India—M S V Rama Rao Indian Council of Agriculture Research 1962
- (17) Ravines and what to do about them I C A R Information leaflet No 41 Ministry of Food and Agriculture
- (18) R M Gorrie—Soil and Water Conservation in Punjab 1946 (Published by the Punjab Government)
- (19) K G Tejwani and others—Reclamation of ravines and gullies in Gujarat —Second Seminar on Soil Conservation (Central Board of Soil Conservation Govt of India 1958)

(D) *Comments received on the first draft of the study*

- (20) R C Soni Chief Conservator of Forests U P (Letter No 7798 W dated 8 2 64)
- (21) K L Lahiri Chief Conservator of Forests West Bengal (Letter No 4312/B & D/30 31 dated 15 4 64)
- (22) S Krishnamurti Director of Agriculture Madras (Letter No SC(B/107451/64 dated 1 5 64)
- (23) S P Sahi Chief Conservator of Forests Bihar (Letter No 3796 dated 5-5 64)
- (24) R D Joshi Chief Conservator of Forests Gujarat (Letter No P/23/187/A dated 17 4 64)
- (25) M S V Rama Rao Soil Conservation Adviser Department of Agriculture Punjab (Letter No 252/31-473 III Sc dated 8 4-1964 and No 4548 Sc dated 2-5 64)
- (26) Balbir Verma Soil Conservation Officer Vasad (Letter No 4 28/64/Genl/513 dated 11 3 64)
- (27) M C Jacob Director of Soil Conservation, Assam (Letter No SCD/32/64 dated 9 4-1964)
- (28) K N Mishra Chief Conservator of Forests Madhya Pradesh (Letter No DC/ET/187 dated 11-4 1964)
- (29) R R Agarwal Director of Agriculture U P (Letter No SCE 4753 dated 18 4 64)
- (30) T S Gill Director of Agriculture Madhya Pradesh (Letter No 33/64/514I dated 16 4 64)

- (31) V K Sharma Director Soil Conservation Central Water and Power Commission (Letter No 15/2/63-Sc dated 25-4 64)
- (32) R V Tanhare Soil Conservation Adviser Ministry of Food and Agriculture (Letter No 6154 SC (PI) dated 8-5 64)

PUBLICATIONS OF THE COMMITTEE OF NATURAL
RESOURCES PLANNING COMMISSION

(1) Committee on Natural Resources Organisations and Problems proposed for Study (1962)

(2) Natural Resources of India (A brief statement) by M S Randhawa (1963)

(3) A Coordinated Study of Organisations concerned with the Surveys of Natural Resources *e.g.* The Survey of India Geological Survey of India Soil and Land Use Surveys Forest Surveys Cadastral Surveys and Town Planning Surveys (1963)

(4) Study on Wastelands including Saline Alkali and Waterlogged Lands and their Reclamation Measures (1963)

(5) Study on Cotton in India (1963)

(6) Study on Groundnut in India (1963)

(7) Study on Utilisation of Urban Wastes (1963)

(8) Study on Coconut in India (1963)

(9) Survey and Utilisation of Agricultural and Industrial By products and Wastes (1963)

(10) Study on Jute and Mesta in India (1964)

(11) Land Resources of India Volume I by S P Raychaudhuri (1964).

(12) Study on Arecanut in India (1964)

(13) Study on Cashewnut in India (1964)

PRINTED IN INDIA BY THE GENERAL MANAGER GOVERNMENT OF INDIA PRESS
NEW DELHI AND PUBLISHED BY THE MANAGER OF PUBLICATIONS DELHI 1965
