# MANAGEMENT OF VERTISOLS AND ASSOCIATED SOILS

*S M Virmani[1], D Sharma[2] and J Venkateswarlu[3]*

**Abstract**

***Vertisols and associated soils cover a land surface of 72 million hectares in India. These are an important group of potentially productive dryland soils, but their production potential has not been fully realized. These soils are primarily used for raising cereals (sorghum and millets), pulses (pigeonpea, chickpea, mung beans, lentil, etc.), oilseeds (groundnut, mustard, sesamum, etc.), and commercially important crops like cotton, chillies, soybeans, sunflower, safflower, etc. In large tracts of Central India, wheat is also grown on the vertisols. The yields of crops in most instances are very low. They rarely exceed 1000 kg/ha. Further, the rainfall wateruse efficiency is low and soil erosion most common.***

***In this paper the results of the studies to increase and stabilize crop production of vertisols and associated vertic soil conducted at ICRISAT, and CRIDA research and cooperating stations have been summarized for both the dependable (> 750 mm annual rainfall) and undependable (< 750 mm annual rainfall) precipitation zones. The lessons learnt from the applications of technologies in on-farm research are enumerated; the components of the technologies that are robust and have wide applicability are identified.***

***Finally, a listing of districts in the states of Karnataka, Andhra Pradesh where different types of improved technologies could be applied for increased crop production in vertisol and associated soils has been included. This has been designed for use by the State Departments of Agriculture and by action agencies.***

## Introduction

Vertisols and Vertic soils, commonly called as Black Cotton Soils or 'Regurs' are found extensively in the semi-arid tropical India. They cover over 72 m ha of land in the peninsular India (Murthy,

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1981). Of the total soil area under the black cotton soils, nearly 6-12 m ha is taken up by Vertisols, soils that exhibit true properties of this group of soils, and the rest are classed under associated soils and are called as Vertic soils. Vertisols contain at least 30% clay, and the dominant clay mineral is one of the 2 : 1 expanding lattice clays. Therefore these soils can hold large quantities of water and nutrients. In the Vertisols of Indian peninsular region the moisture retention capacity usually exceeds 150 mm in 120-cm profile depth. These soils also show a high degree of shrinking when dry and swell when wet. Large cracks are formed which may be as much as 60 cm deep in some cases. In addition, surface level of these soils is difficult to maintain because of alternate swelling and shrinking properties. All of these physical factors result in the concomitant mechanical difficulties in handling Vertisols and associated soils.

### Current Use of Vertisols and Associated Soils

Most areas where Vertisols and Vertic soils occur in India are farmed mostly under dryland cultivation. Unfortunately, as is widely recognized, although these soils are potentially productive, the conventional dryland cropping systems of these soils are characterized by extremely low productivity. It is evident that the technologies currently in use for land and water management do not interface with the crop production technologies and thus lead to under utilization of available rainfall resource.

Vertisols and Vertic soils have been subject to many investigations in India during the past one decade. ICRISAT, the International Crops Research Institute for the Semi-Arid Tropics, in its resources management research has invested considerable effort in improving and stabilising the productivity of deep Vertisols in the semi-arid tropics. The Central Research Institute for Dryland Agriculture (CRIDA) has been devising strategies for the improved management of Vertisols and associated soils in different agroclimatic zones of India in cooperation with the agricultural universities and various research institutes of the Indian Council of Agricultural Research (ICAR).

In this paper, an attempt has been made to bring together the current information available to decide on the technological options for optimizing the productivity of Vertisols and related soils for increased and sustained harvests. We have also identified probable areas where available technologies for the improved management of Vertisol and associated soils may be applicable.

**Vertisols, and Associated Soils : Their Agro Environments in India**

*The Soils*

According to Murthy (1981) Vertisols and associated soils occur extensively in central and southern India, particularly in the states of Karnataka, Andhra Pradesh, Maharashtra, Madhya Pradesh, and Gujarat. Some areas are found in Tamil Nadu, Rajasthan, Orissa, Bihar, and Uttar Pradesh.

The Vertisols dominantly occur on plateaux and pediments and have gentle slopes. Most of the deep soils are located in the plateaux. Such soils are classified as Typic Pellusterts. Generally these soils are not well drained. Some Vertisols are predominately lentiler in structure and have somewhat better internal drainage, are called as Typic Chromusterts [*e g* the soils of Malwa plateau in Madhya Pradesh].

The 'associated group of Vertic soils' are usually contiguous to Vertisols. The Vertic soils do not exhibit all the properties of the Vertisols and are generally shallow. Their effective profile depth in most cases is less than 70 cm. In most instances these soils probably represent a 'truncated' Vertisols profile. The surface horizons of the profile may have eroded over time. At ICRISAT Center it has been noted that in small agricultural watersheds as much as 6 tons/ha of surface soil may be lost per year under monsoon fallow system of Vertisols management in soils where slopes are less than 2%. This loss of soil may be 12 tons/ha or more in areas with steeper slopes. Vertisols, as a group, are prone to soil erosion.

Improved crop production management practices for these soils must include some elements of soil conservation. Because of the



cracking and swelling processes, a marked uniformity of the physical and chemical properties of different horizons of the Vertisols profile is generally noted. The major difference between Vertisols and associated Vertic soils lie in their effective soil depth. This affects their water-holding capacity which in turn affects their management for dryland crop production.

The Vertisols and associated soils mostly occur in the semi-arid tropical India where the rainfall is seasonal. These soils are identified at the suborder level within the Ustic moisture regime. This implies dryness during most of the year. This regime typifies regions, in tropical India with monsoon climate, that have at least one rainy season lasting 3 months or more in a year.

*Rainfall and Thermal Regime*

Vertisols and associated soils in India are distributed over a wide range of rainfall regimes. The rainfall varies from less than 400 mm in Gujarat to more than 1400 mm in Madhya Pradesh. In Vertisols dominated Peninsular India, rainfall varies from 600 mm to over 1200 mm. The precipitation pattern of this region is unimodal, over 80% of the annual rainfall is received during the south-west monsoon rainy season extending from June to September/ October, and the coefficient of variation of the annual rainfall varies from 10 to 45%, and, as expected, the largest variation occurs at locations with the lowest rainfall.

The annual mean temperature in the region abundant in Vertisols and associated soils usually exceeds 18°C. In Southern India this temperature threshold is met almost in all the months of the year, while in the Northern India there is a period of 2-3 months when monthly average temperature ranges from 10° – 18°C. The thermal regime has a significant influence on the kind of postrainy crops that can be grown at a given place and the type of efficient cropping systems. For example, in southern India, pigeonpea and sorghum crops are grown in intercropping or in sequential cropping with rainy season crops but, in northern India, only cold tolerant crops are grown *e g* wheat, chickpea.

It is known that more important than the quantity of rainfall in a given season is the persistency in receiving a specified amount of rainfall over a short-interval: for instance, our estimates of the probabilities of receiving 10 mm of rainfall (to satisfy at least 1/3 of the PE demand during the rainy-crop growing season) along with the weekly rainfall amounts for Vertisols zones in Peninsular India show that:

- while annual rainfall at Sholapur and Hyderabad is somewhat equal at both the locations, it occurs at a lower probability at Sholapur than at Hyderabad;
- locations further south (*e g* Anantapur 14° 41′ N, 77° 37′ E) have a bimodal rainfall distribution, with two rainfall peaks separated by an 8-week period; and
- the persistance and probabilities of weekly rainfall are generally high in areas receiving an annual rainfall of 750 mm or more. Such areas are termed as 'Dependable rainfall' regions and areas receiving less than 750 mm annual rainfall are termed as 'Undependable rainfall' regions.

The distinct distribution, and the rainfall × soil × temperature interactions in drylands give rise to different levels of risk to dependable cropping. In the Vertisols and associated soils of the Indian peninsular region, two factors most important for crop production are: soil depth and rainfall pattern. For the purpose of the present discussion following criteria are used for characterizing Vertisols and associated soils in the peninsular Indian states of Karnataka, Andhra Pradesh, Maharashtra, and Madhya Pradesh (Table 1).

## Alternatives for Improved Management of Vertisols and Associated Soils for Increased Crop Production in Drylands

### (a) *Vertisols of Dependable Rainfall Areas Where Drainage is a Problem—CRIDA & ICRISAT Experiences*

The Vertisols of dependable rainfall areas located in the flood plains, valley-bottoms and plateaux have often times serious



TABLE 1

Rainfall and Growing Season Characteristics of Vertisol and Related Soil Areas of India

| Rainfall environment/ annual precipitation | Soils | Growing season (days) | Potential* for Crop production | Potential* for Erosion |
|---|---|---|---|---|
| Dependable/ more than 750 mm | • Vertisols and Associated soils having >1 m depth | 180—>210 | High | High |
| | • Vertic soils | | | |
| | —50—100 cm deep | 130—150 | High | High |
| | —<50 cm deep | 90—120 | Medium | Medium |
| Undependable/ less than 750 mm | • Vertisols and Associated soils having >1 m depth | 90—100 | Medium | High |
| | • Vertic soils | | | |
| | —50—100 cm deep | ≈90 | Low | Medium |
| | —<50 cm deep | >90 | Low | Low |

*High : >5 tons; Medium : 2—4 tons; Low : <2 tons crop production $ha^{-1}$ $yr^{-1}$ under high management.

internal drainage problems. Such soils are exposed even to short term water-logging during the rainy cropping season. These soils are classed as Typic Ustortherts and associates of Typic Pellusterts. CRIDA and ICRISAT experiences at Patancheru near Hyderabad (17° 27′ N) and at Indore (22° 43′ N) for improved management of these soils can be summarised as follows:

1 Land management practices that reduce runoff and erosion, and that give improved surface drainage leading to better aeration and workability of the soils.

2 Cropping systems and crop management practices that establish a crop at the very beginning of the rainy season, that make efficient use of moisture throughout both the rainy and post-rainy seasons, and that give high, sustained levels of yield.

3 Use of appropriate implements for cultivation, seeding, and fertilizing that enable the required land and crop management practices to be efficiently carried out.

4 Adoption of adequate plant protection practices, if needed.

(b) *Improved Management of Vertisols and Associated Soils in Undependable Rainfull Areas*

These areas are primarily located in rain-shadow regions in the states of Maharashtra and Karnataka. The average annual rainfall there ranges between 500 and 750 mm and is characterized by undependable onset, frequent occurrence of rainless periods between rainy spells, and a fairly large proportion of the annual rainfall is received in the months of September and October. Due to this peculiar distribution of rainfall, the cropping in these regions is delayed till sufficient moisture is available in the soil profile and results into delayed or extended kharif cropping utilizing only the stored soil moisture. For some part of the rainy season the land is kept as cultivated fallow to build up native fertility as well as soil moisture reserves.

CRIDA's experiences at Sholapur (17° 40′N, 75°54′E) research station has shown that in the Vertisol areas of undependable region :



1 Land management practices (e g deep ploughing in summer months) that lead to early soil moisture build up and water conservation are essential. The surface land treatments should allow for equitable distribution of moisture in the soil profile and protection against erosion when heavy rains are received.

2 Cropping systems and crop management strategies should aim at production of one good crop per year. In years of 'good rainfall' efforts should be made to intensify crop production by establishing a crop early in the season or as soon as the top 30 cm of soil is at field capacity Growing of drought tolerant crops *e g* castor; in years when August-September rainfall is normal, a crop of rabi sorghum gives good yields.

3 Recycling of water to establish/provide for at least one irrigation has been found useful.

4 Due to undependable nature of rainfall, the application of a set of principles of 'mid-course' changes in crop management technology may be necessary.

(c) *Management of Vertic soils*

In the Vertisols region of India there is considerable area under associated Vertic soils. These soils do not exhibit true Vertisol properties and are generally shallow in depth. Such soils present a serious challenge for the development of an economically viable and socially feasible technology. These areas are prone to high degree of soil erosion and water loss. Because of their shallow soil depth and other physical constraints, the Vertic soils do not provide a good plant nutrient base—thus, these soils have ecologically a very limited potential under low input systems for agricultural production. At present crops like pearl millet, safflower, field bean, setaria, and horse gram are being grown. We believe that in these soils the practices of agroforestry, silvi-pastoral land use and forestry may be more productive. A broad research data base on these subjects is under collection. Early results suggest the relative superiority of alley cropping of *Leucaena* with shallow rooted crops like millet/sorghum in some soils.

## Experiences of On-Farm Testing of Improved Technologies

### (a) *Vertisol and Associated Soil Located in Dependable Rainfall Areas*

Lessons learnt from the application of technology in two 800 mm annual rainfall locations (Chevella and Taddanpalle, Andhra Pradesh), in a 987 mm annual rainfall location at Indore, and in a 1393 mm rainfall watershed at Begumgunj, Madhya Pradesh are summarized below :

1 Shaping of land, field channels, and grassed waterways to ensure quick drainage of excess water has been found essential. Sowing on key lines on flat-on-grade and opening of 'dead furrows' on grade at an interval of 3 m, generally, improved drainage. At Taddanpalle broad-bed and furrows gave higher crop yields than flat. This resulted in a higher rainfall use efficiency.

2 Dry seeding for the establishment of crops like maize, sorghum, pigeonpea was successful and helped effective early establishment of rainy season crops.

3 In areas where the watershed is having hilly slopes (*e g* Indore area) the provision of diversion drains was found essential. It has been found that runoff of a 800 ha area of land was safely drained through a 10 m wide and 1 km long network of waterways for controlling soil erosion and water-logging. The construction of field drains, wasteweirs and the use of gabion and drop structures was found to be useful for both soil conservation and increased recharge of groundwater. The number of wells increased from 120 in 1974 to 284 in 1983, and the well irrigated area from 8.8% to 24.4%.

At Indore, it was further observed that by the judicious application of soil and water conservation practices during the rainy cropping season, the practice of fallowing reduced considerably thus the intensity of cropping increased considerably in the treated watershed. Currently only 32% area is left fallow. Cropping intensity is 170% for the watershed.

4 Intercropping of sorghum-pigeonpea in Taddanpalle, and soybean-pigeonpea, soybean followed by wheat, and maize followed by chickpea or wheat in Indore were found as the most productive cropping systems.

5 Fertilization of crops was essential to realize the benefits of improved water management. Application of 60-80 kg N/ha in split doses and 30-40 kg of P205/ha was found to be profitable.

6 The availability of credit, fertilizers, appropriate agricultural machinery, and marketing of crops were found as major constraints for the adoption of improved techniques.



### (b) *Vertisol and Associated Soils Located in Undependable Rainfall Areas*

CRIDA has conducted on-farm testing of the principles developed for improved management of Vertisols at Chinatekur (Kurnool district, rainfall 674 mm). ICRISAT conducted its studies at Farhatabad (Gulbarga district, annual rainfall 727 mm) and Adgaon (Aurangabad district, annual rainfall 736 mm).

Some lessons learnt from our research experiences :

(1) For effective conservation of rainfall, following practices were found useful :

- Summer ploughing.
- Planting on flat along contours ie contour cultivation.
- Provision of graded bunds (0.1 to 0.3% grade) and provision of waterways. Field drainage was effectively provided by having 'furrow' with small ties at appropriate intervals.
- Intensive interculture and weed management are necessary.

(2) In the undependable rainfall regions the emphasis is to be given to crop establishment, growing of drought tolerant crops and tailoring of fertilizer applications in relation to the soil moisture accumulation. Some improved cropping systems suggested for adoption are :

- Pearl millet/Setaria intercropped with Pigeonpea or Castor.
- Mung bean followed by Safflower/Sorghum/Sunflower or Chickpea.
- In years of failure of early monsoon rains, postrainy season crops like Sorghum or Chickpea or Safflower or Sunflower were found suitable.

Fertilizer use @ 40-30-0 for cereals and oilseeds and 10-30-0 for legumes is suggested.

**Some Case Studies in Vertisol and Vertic Soil Areas**

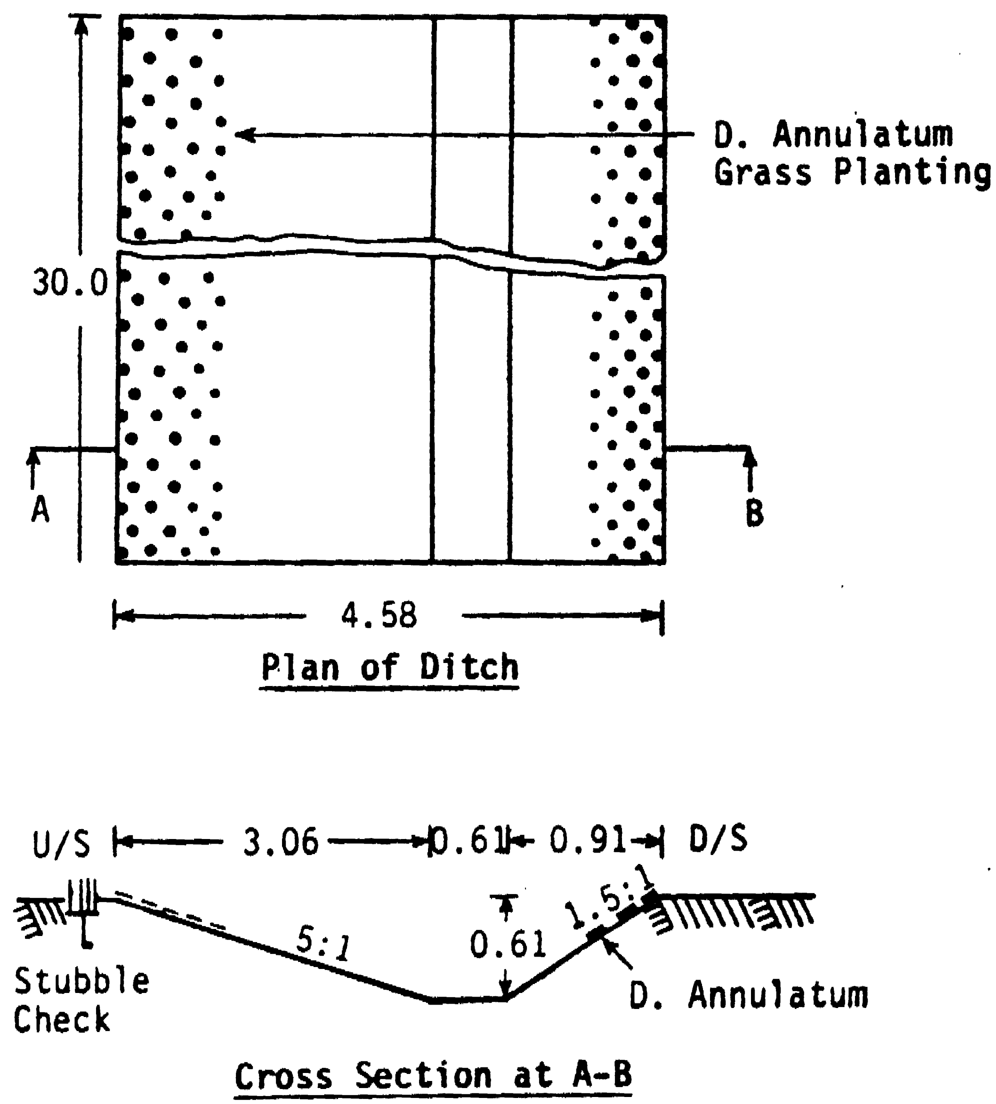
CRIDA and ICRISAT have examined the engineering, agronomic and economic aspects of rain water management under dryland conditions on operational scale in some agroclimates. A few examples are discussed here.

1 **Undependable rainfall areas**—(a) *Bellary region (annual) rainfall 503 mm)* : Two kinds of water storage and recycling devices were tried : These are farm ponds and conservation ditches. The gross water yield was observed around 10% of the annual rainfall. A 0.5 ha meter pond for a 10 ha catchment is suggested. The storage tank can be located on an existing drain. A silt trap has to be provided on the upstream side. Experiments have shown that about 40% of the donor area (ie 4 ha) can be irrigated with 2 irrigations of 5 cm each.

The conservation ditches consist of trapezoidal ditches laid on contour. The ditches serve as terraces and field storage structures for the collection of runoff water. The ditches may be stabilized by planting grasses on the side slopes. Some details of conservation ditches are shown in Figure 1.

At Bellary, it was found that up to 85% of the runoff water could be stored in these conservation ditches and some 24% of the donor area could be provided with one irrigation of 6.5 cm (Randhawa and Venkateswarlu, 1986).






NOTE : 1 Figure not to scale
2 Dimentions in metres

Figure 1 Details of Conservation Ditch [Source: Randhawa and Venkateswarlu, 1986].

(b) *Naranka region—Gujarat (annual rainfall 630 mm)* ; In this area the construction of percolation dams and the training of the drains through drop structures has been found to increase ground water recharge.

At Naranka, in an area of 2603 ha four fairly big (10-13 ha m size) and six small (0.2-0.25 ha m size) percolation tanks have been constructed. The water-ways were grassed. Initial results show that the number of wells in the area have increased by 37% (from 270 to 370). Thus, area under 'irrigation' has increased by about 30%.

2 **Dependable rainfall areas**—(a) *Hyderabad region (annual rainfall 780 mm)* : At ICRISAT Center an agricultural watershed based water storage and recycling tank having a storage capacity of 4300 m with a catchment area of 6.5 ha has been operationally evaluated intensively over the period 1981-82 to 1984-85 (Srivastava et al, 1985). The 4 m deep tank occupied 3% area of the catchment. About 50-65% of water collected in the tank could be used for irrigation; the remainder was lost as evaporation and seepage (Figure 2).

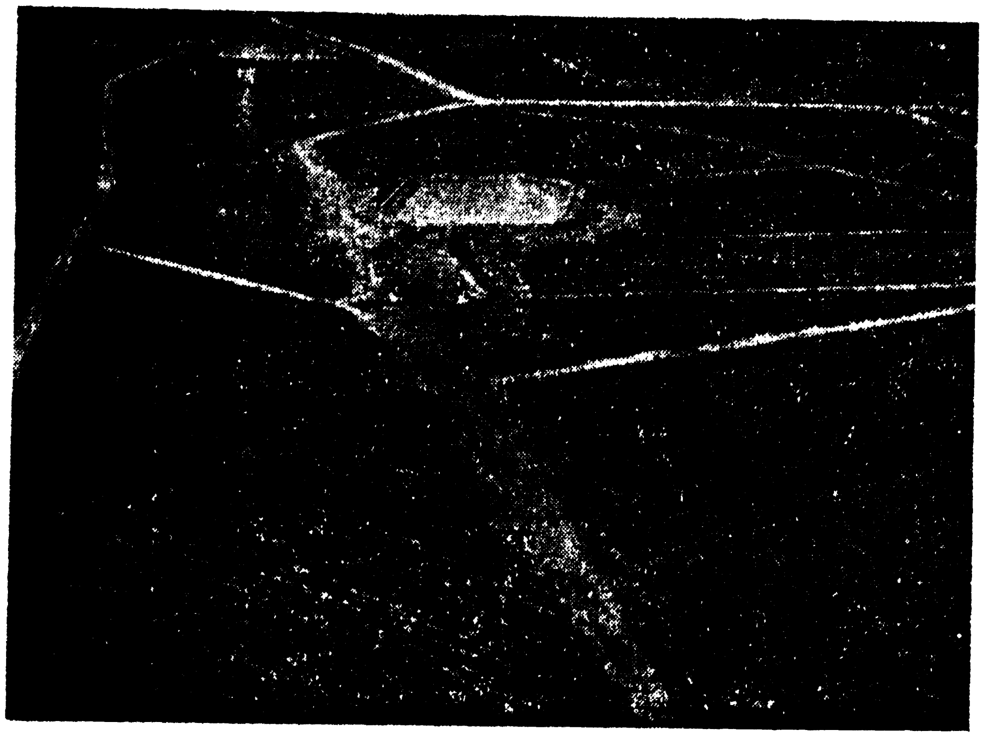


Figure 2 An Air Photo of the BW5 Vertisol watershed at ICRISAT.

The results showed that in 2 of the 4 years, the tank was completely 1/2 filled (seasonal rainfall 1126 and 956 mm); in the other two it was less than filled (seasonal rainfall 614 and 546 mm). In all of those four years one irrigation of 80 mm was applied at the



flowering stage of postrainy season crops. The irrigated area thus treated was about 10% of the catchment in low rainfall years and about 30% in the high rainfall years. The average additional gross returns due to supplemental irrigation was Rs 2210/ha for chillies, Rs 1680/ha for chickpea, and Rs 630/ha for safflower. The irrigation use efficiency (IUE) for the three crops in Rs/mm/ha was 26 for chillies, 21 for chickpea, and 8 for safflower.

(b) *Indore region—Madhya Pradesh (annual rainfall 990 mm)* : An integrated soil and water conservation approach has been adopted here. The program included laying out of water diversion drains, graded bunds, water-ways, and the provision of drainage areas between water-ways. In situ water harvesting was achieved by laying out graded furrows. Chutes and gabions were constructed at appropriate intervals. The excess water was managed by providing open dug-outs or conservation ditches and treating the watershed with bunds. These treatments helped provide percolation areas for recharge of ground water.

Over a 10-year period, it has been observed that number of wells in the watershed (2200 ha) increased from 120 to 287. The command area irrigated by these wells increased from 160 to 571 ha.

## Suitability of Different Improved Technologies

Probable areas of Vertisols and associated soils in peninsular Indian states that are potentially suited for application of different improved technologies evolved by CRIDA and ICRISAT for increasing and stabilizing crop production. The distribution of different agroclimatic areas in the states of Karnataka, Andhra Pradesh, Maharashtra, and Madhya Pradesh are shown in the maps annexed at the end of this paper.

## Acknowledgement

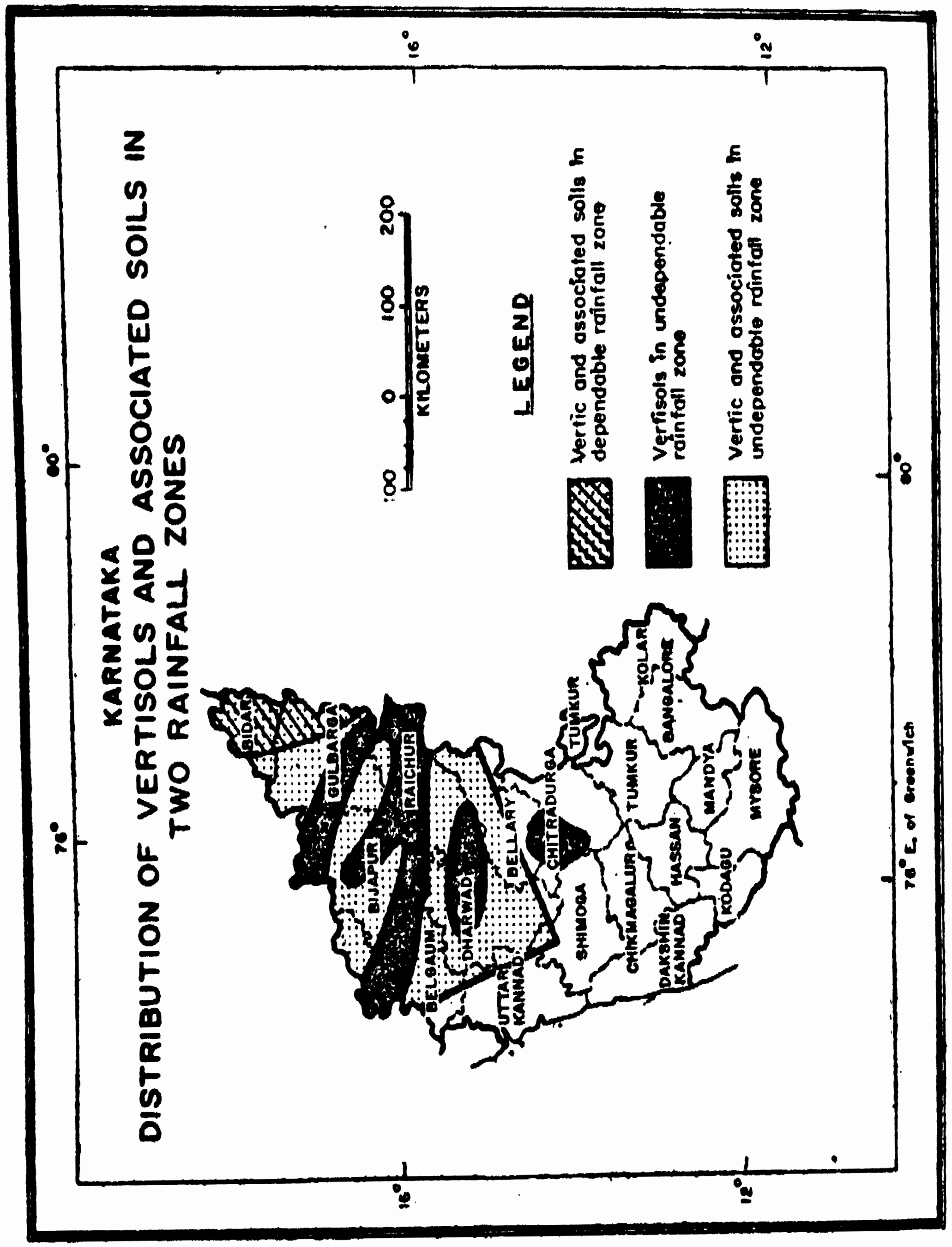
This paper is based upon the results of many research reports published by ICRISAT, CRIDA, and its cooperating centres on the management of Vertisols and associated soils. We wish to acknowledge their input most sincerely.

| Technology package | Agroclimatic characteristics & growing season length Gsl (days) | | Districts |
|---|---|---|---|
| Double cropping[1] watershed-based Vertisols management technology | Vertisols and associated deep Vertic* soils Rainfall > 750 mm dependable Gsl 180—>210 days | Karnataka : | Dharwar, Belgaum, |
| | | A P : | Adilabad, Karimnagar, Khammam, parts of Medak |
| | | Maharashtra : | Jalgaon, Baldana, Amaravati, Akola, parts of Parbhani and Nanded |
| | | M P : | Balaghat, Seoni, Hoshingabad, Narsingpur, Jabalpur, Damoh, Sagar, Raisen, Bhopal, Sehore |
| Double cropping[2] watershed-based Soil and water conservation technology for Vertic soils | Shallow Vertic soils Rainfall > 750 mm dependable Gsl 130—<210 days | Karnataka : | Parts of Bidar and Gulbarga |
| | | A P : | Nizamabad, parts of Medak and Adilabad, Rangareddy |
| | | Maharashtra : | Nagpur, Bhandra, Wardha, Chandrapur, Yavatmal, Osmanabad, Dhule |
| | | M P : | Betul, Chindwana, Mandla, Shadol, Panna, Satna, Rewa, Chhattarpur, Tikamgarh, Vidisha, Guna, parts of Shivpuri, Datia, Morena, Gwalior, Bhind, Rajgarh, Shahjapur, Dewas, East Nimar, West Nimar, Dhar, Jhabua, Indore, Ujjain, Ratlam, Mandsaur |
| Stabilization of crop production thru soil and water conservation technologies | Vertisols and associated deep Vertic soils Rainfall < 750 mm undependable Gsl <130 days | Karnataka : | Chittardurga, Bellary, parts of Gulbarga, Bijapur |
| | | A P : | Parts of Medak, Nizamabad, Mahbubnagar |
| | | Maharashtra : | Sholapur, Sangli, Aurangabad, Ahmednagar, Dhule, Jalgaon, Naski, Bir, Osmanabad |
| Monocropping agroforestry and alternative land use | Shallow Vertic soils | In all the Vertisol areas where the lands are either situated on steep slopes or the soils are very shallow having low moisture holding capacities | |

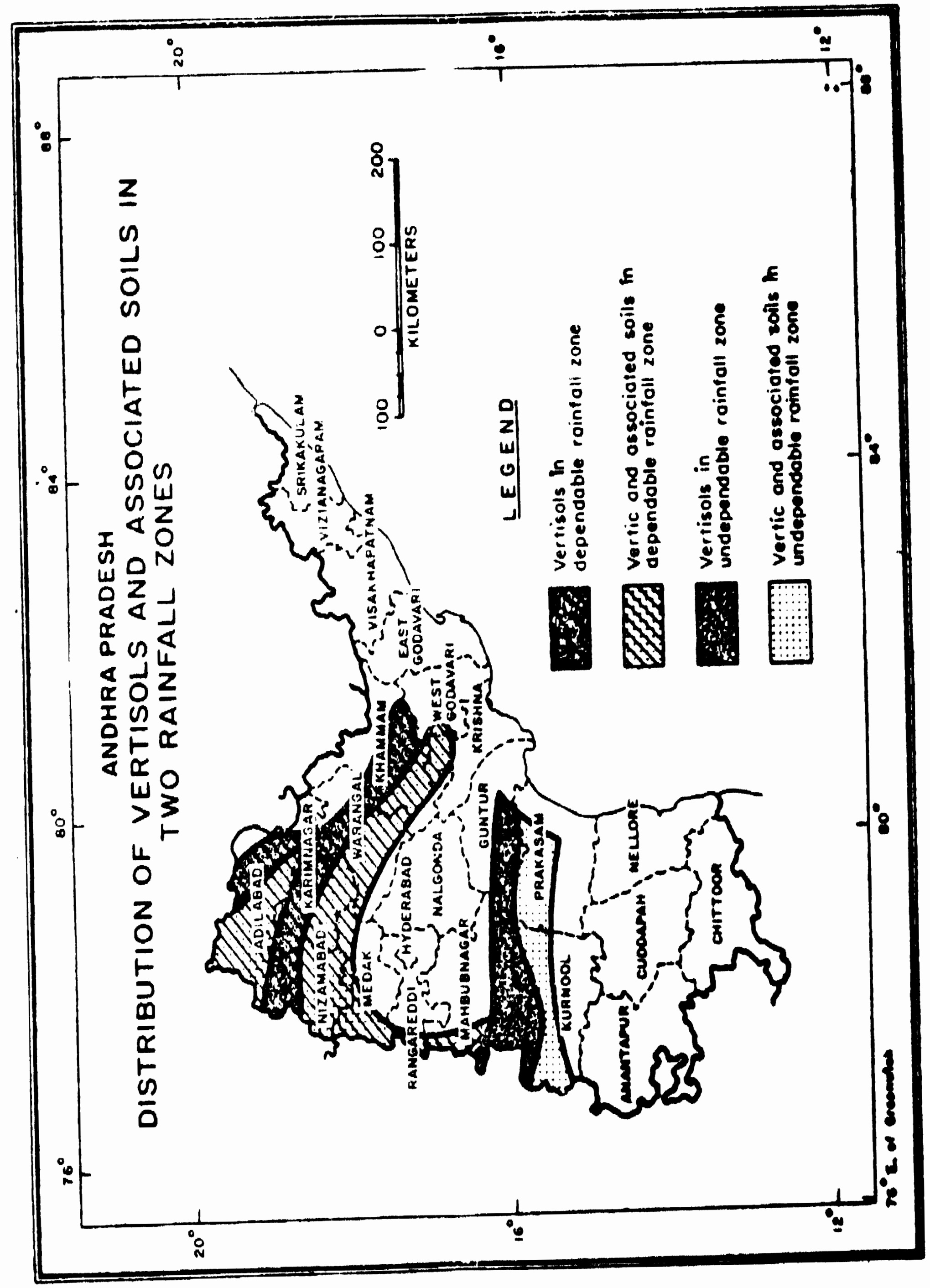
*Vertic soils having >1 m depth are called deep Vertic soils; others are called shallow Vertic soils.

1 Through adoption of sequential and intercropping practices.

2 Through adoption of intercropping practices.


KARNATAKA
DISTRIBUTION OF VERTISOLS AND ASSOCIATED SOILS IN TWO RAINFALL ZONES
100 0 100 200
KILOMETERS
LEGEND
Vertic and associated soils in dependable rainfall zone
Vertisols in undependable rainfall zone
Vertic and associated soils in undependable rainfall zone
BIDAR
GULBARGA
BIJAPUR
RAICHUR
BELGAUM
DHARWAD
BELLARY
CHITRADURGA
UTTARA KANNAD
SHIMOGA
CHIKMAGALUR
DAKSHIN KANNAD
HASSAN
TUMKUR
KOLAR
BANGALORE
MANDYA
MYSORE
KODAGU
76° E of Greenwich




ANDHRA PRADESH
DISTRIBUTION OF VERTISOLS AND ASSOCIATED SOILS IN TWO RAINFALL ZONES
100 0 100 200
KILOMETERS
LEGEND
Vertisols in dependable rainfall zone
Vertic and associated soils in dependable rainfall zone
Vertisols in undependable rainfall zone
Vertic and associated soils in undependable rainfall zone
SRIKAKULAM
VIZIANAGARAM
VISAKHAPATNAM
EAST GODAVARI
WEST GODAVARI
KRISHNA
KHAMMAM
WARANGAL
KARIMNAGAR
ADILABAD
NIZAMABAD
MEDAK
HYDERABAD
RANGAREDDI
NALGONDA
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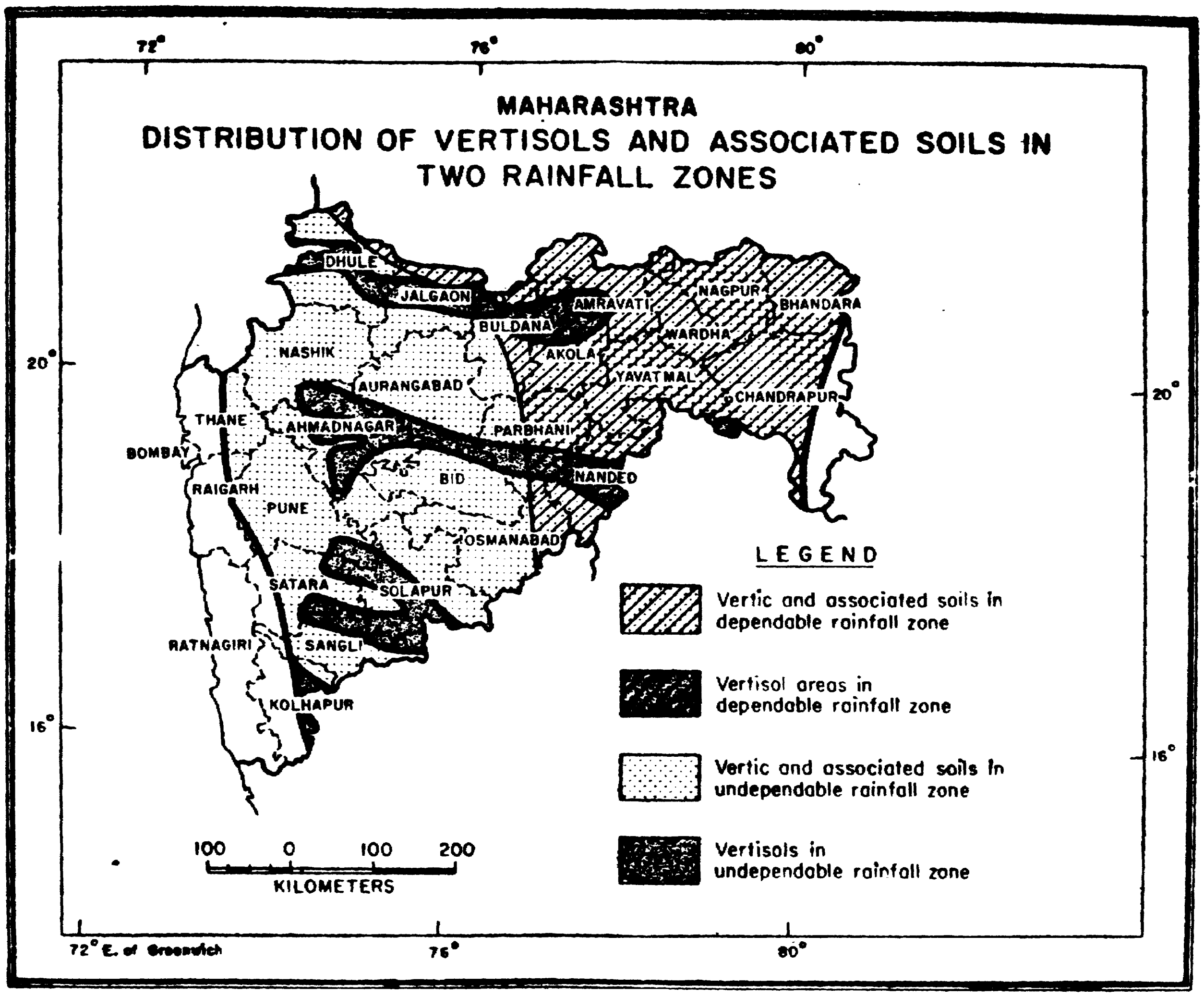
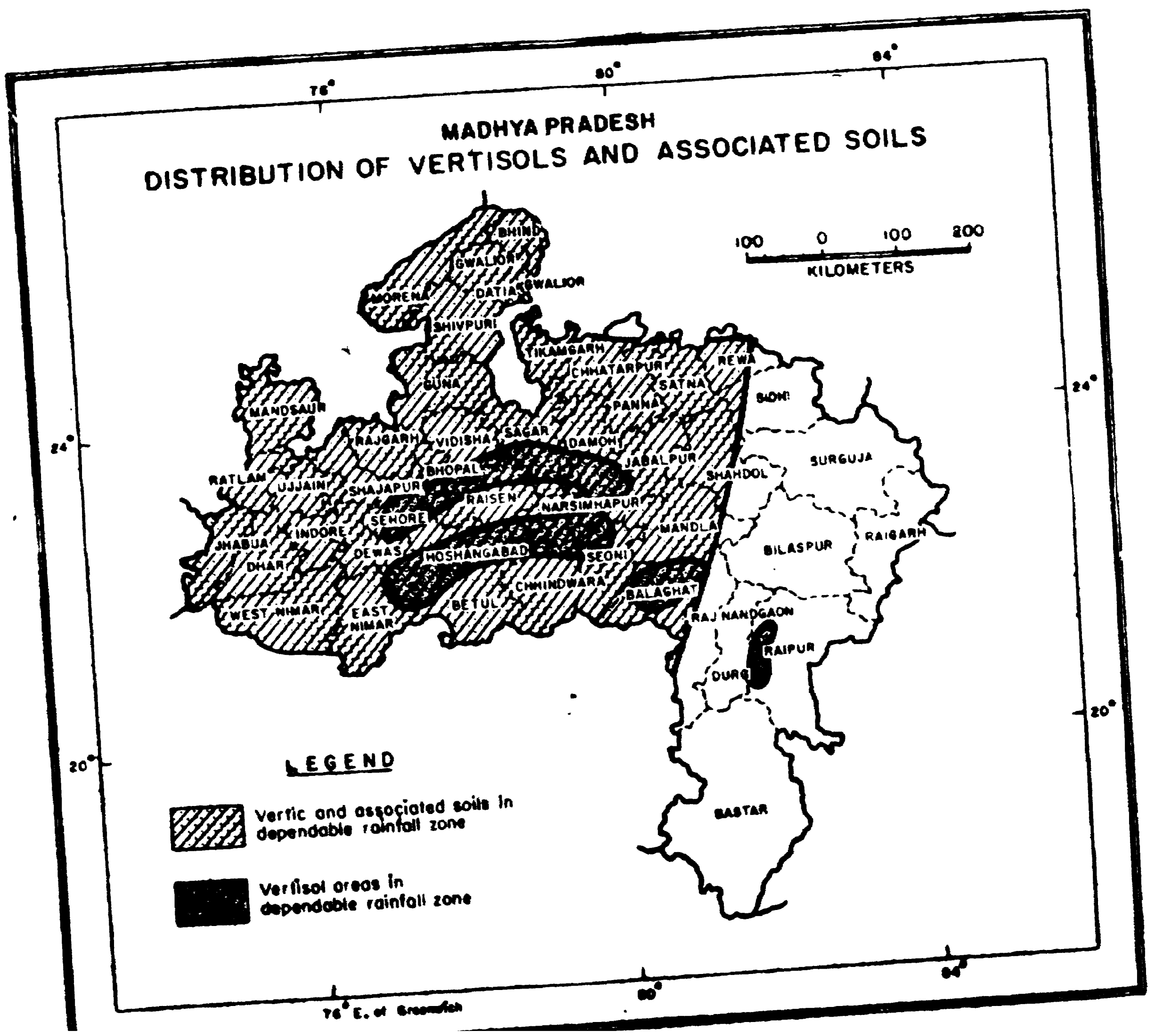
CHITTOOR
76° E of Greenwich


MAHARASHTRA
DISTRIBUTION OF VERTISOLS AND ASSOCIATED SOILS IN TWO RAINFALL ZONES
72°
76°
80°
20°
16°
DHULE
JALGAON
AMRAVATI
NAGPUR
BHANDARA
BULDANA
WARDHA
NASHIK
AKOLA
AURANGABAD
YAVATMAL
CHANDRAPUR
THANE
AHMADNAGAR
PARBHANI
BOMBAY
BID
NANDED
RAIGARH
PUNE
OSMANABAD
SATARA
SOLAPUR
RATNAGIRI
SANGLI
KOLHAPUR
LEGEND
Vertic and associated soils in dependable rainfall zone
Vertisol areas in dependable rainfall zone
Vertic and associated soils in undependable rainfall zone
Vertisols in undependable rainfall zone
100 0 100 200
KILOMETERS
72° E. of Greenwich


MADHYA PRADESH
DISTRIBUTION OF VERTISOLS AND ASSOCIATED SOILS
76°
80°
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24°
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100 0 100 200
KILOMETERS
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SIDHI
GUNA
SATNA
PANNA
MANDSAUR
RAJGARH
VIDISHA
SAGAR
DAMOH
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RATLAM
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BILASPUR
DHAR
BETUL
CHHINDWARA
BALAGHAT
WEST NIMAR
EAST NIMAR
RAJ NANDGAON
RAIPUR
DURG
BASTAR
LEGEND
Vertic and associated soils in dependable rainfall zone
Vertisol areas in dependable rainfall zone

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# RAIN WATER MANAGEMENT IN A DRYLAND WATERSHED—A CASE STUDY

*R P Singh and J Millette**


Abstract

*Efficient rain water management holds the key to success in dryland agriculture. Natural resources like water and soil are best managed on a watershed basis. The paper relates to a case study of a 1245 ha dryland watershed receiving an average annual rainfall of 690 mm. located at Mittemari in Kolar district (Karnataka) about 112 km from Bangalore city, on the Anantapur-Bangalore highway.*

*The major problems of the watershed relating to climate, soil and water, crops, animals and socio-economic problems have been identified. The possible approaches to tackling these problems have been highlighted. The base-line productivity of predominant crops grown in the watershed and impact of rain water management on crop productivity, cropping intensity, land use, etc are mentioned.*

*Soil and moisture conservation practices (SMCP) adopted in the watershed, together with actual cost incurred, are described. Crops and cropping systems introduced and alternate land use systems mounted are discussed in the paper.*

*Lessons learnt out of the experiences gained in this watershed and their implications for development of other watersheds are highlighted. Research needs for better management of available water in this watershed are outlined.*


Efficient rainwater management holds the key to success in dryland agriculture. Natural resources like water and soil are best managed on a watershed basis. As an example of such an approach, a case study of Mittemari watershed is examined. Mittemari watershed is situated in Kolar district (Karnataka) and comprises of three villages, Mittemari, Chinnaobaiahgaripalli, and Chokkampalli. The watershed is located about 112 km northeast of Bangalore city and

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