TECHNOLOGY TRANSFER AND PERFORMANCE OF IMPROVED VERTISOL MANAGEMENT TECHNOLOGY IN KARNATAKA STATE

N. Yaoi, D. Sharma and P.J. George

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics
ICRISAT Patancheru P.O.
Andhra Pradesh, India 502 324

C O N T E N T S

FOREWORD

Mr. H. Yaoi, a Scientist from Japan International Cooperation Agency (JICA), was deputed as a Visiting Scientist for four months from 24 September 1984 to 11 February 1985 at ICRISAT. His short stay at ICRISAT formed a part of two years study of traditional and improved farm practices and crop production technologies in Indonesia and India.

Since, ICRISAT has been conducting on-farm verification of Improved Deep Vertisol Technology (IVMT) in the farmers fields, it was thought that a study of "Technology Transfer and Performance of Improved Vertisol Management Technology" will provide him an opportunity to have a critical assessment of the traditional crop production practices and the improved technology options, their scope and institutional and organisational set up for the transfer of the technology.

The state of Karnataka was chosen for the study because it had taken the lead in implementing the ICRISAT's Improved Vertisol Management Technology under diverse agroclimatic and socio-economic, conditions of the Vertisol districts of Gulbarga, Raichur, Bellary, Dharwad, Belgaum and Bijapur at a large scale.

This report is an attempt to summarise the basic information about the agroclimatic conditions, traditional cropping systems and the extent of implementation of the various aspects of IVMT and to identify the problems in implementation.

Mr. Yaoi had to leave for Japan in a hurry, because his stay at ICRISAT was abruptly cut short by fifteen days. The information contained in the report is based on the rough notes and the data collected by him during his stay.

The on-farm research unit is highly grateful to Dr. T.V. Sampath, Director of Agriculture, Karnataka, and his officers at the district level to extend their valuable help and cooperation to Mr. Yaoi for collecting the information.

D. Sharma
Coordinator On-farm Research
FSRP/ICRISAT

SYMBOLS AND ABBREVIATIONS

IVMT	Improved Vertisol Management Technology
BBF	Broadbed and Furrows
ICAR	Indian Council of Agricultural Research
SAT	Semi-Arid Tropics
DAP	Diammonium phosphate
ADA	Assistant Director of Agriculture
PAO	Principal Agricultural Officer
K	Kharif (rainy season)
R	Rabi (postrainy season)
P.Pea	Pigeonpea
NA	Not available
+	Sequential cropping system
/	Intercropping system
X	Not undertaken
✓	Undertaken

LIST OF TABLES

LIST OF FIGURES

APPENDICES

TECHNOLOGY TRANSFER AND PERFORMANCE OF IMPROVED VERTISOL MANAGEMENT TECHNOLOGY IN KARNATAKA STAT

INTRODUCTION

Vertisol is one of the ten orders in the soil taxonomy. The formative element "Vert" is derived from the Latin word "Verto" meaning turn or invert. Inversion takes place in the soil because of cracking that is the characteristic of Vertisols.

They are deep black soils with low organic carbon content ranging from 0.3% to 0.7%. The clay content ranges from 40% to 60%, occasionally rising to as high as 80% and therefore the bulk density ranges between 1.5 to 2.1 g/cc (Murthy R.S. 1981).

In India most of the 72.9 million ha of deep Vertisols and associated soil types occur in the peninsular region (Fig. 1) and are distributed in the states of Maharashtra (29.9 m/ha), Madhya Pradesh (16.7 m/ha), Karnataka (6.9 m/ha), Tamil Nadu (3.2 m/ha), Rajasthan (2.3 m/ha), Orissa (1.3 m/ha), Bihar (0.7 m/ha) and Uttar Pradesh (negligible).

As the Vertisols have a high content of montmorillonite clay they are very hard when dry and extremely sticky when wet. Therefore, traditionally farmers in Vertisol areas with 750-1250 mm annual rainfall find it convenient to leave the land fallow during the rainy season and crop it during the postrainy season.

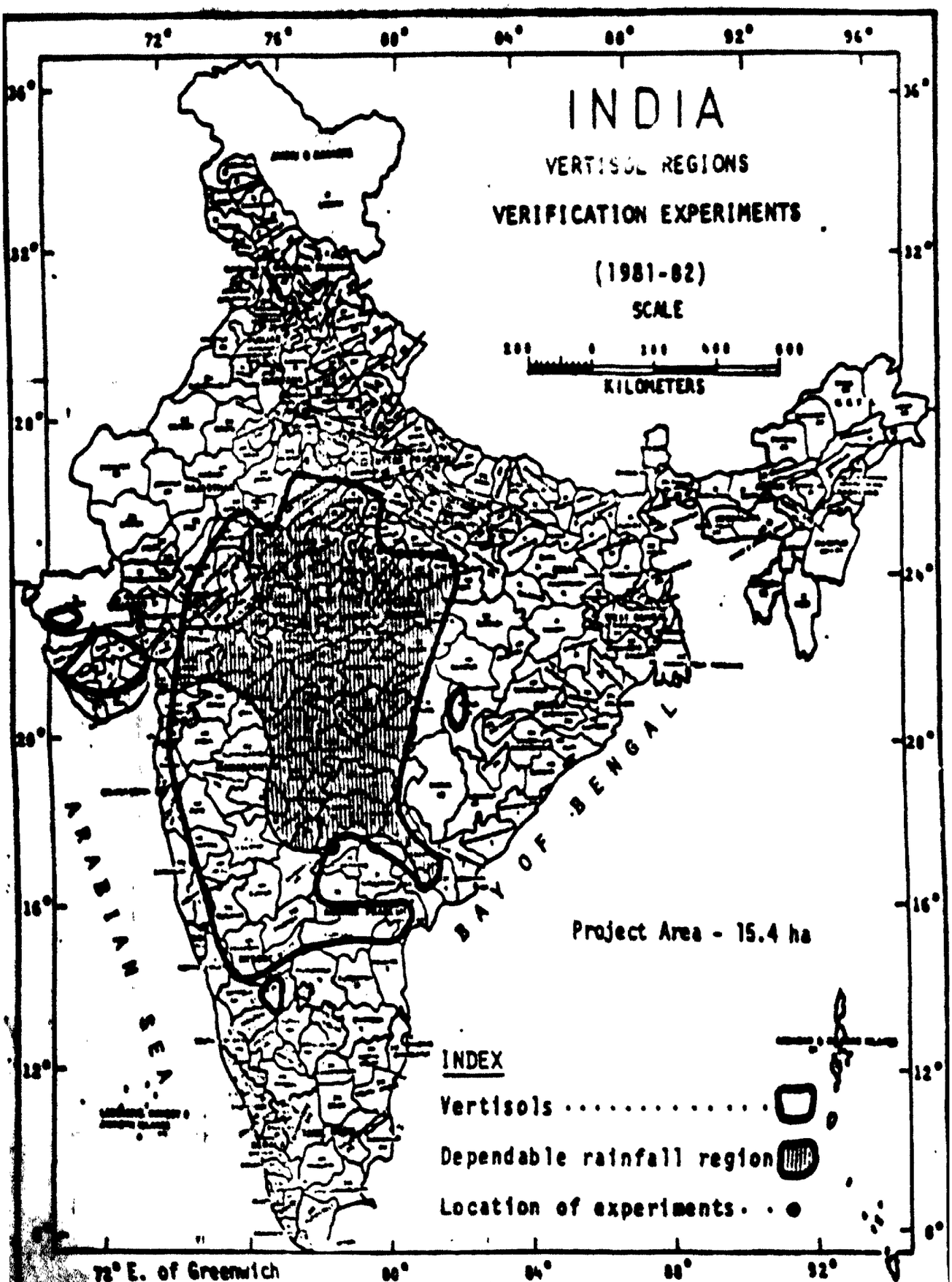
In absence of any crop canopy, bare land remains exposed to runoff and soil erosion during high intensity rainstorms. Often raising of crops during the monsoon and the postmonsoon season on the residual soil moisture is possible if adequate moisture is conserved and the problems of waterlogging are alleviated. Cropping during the monsoon season checks erosion and makes efficient use of available water which is in short supply in semi-arid tropics.

Besides the excessive soil moisture and associated soil structural problems during the monsoon, these soils are low in crop nutrients particularly in nitrogen and phosphorus.

Watershed based operational research at ICRISAT Center has showed that crops can be grown both in rainy and postrainy seasons. The Improved Vertisol Management Technology (IVMT) developed at ICRISAT involves:

- Cultivating the land immediately after harvesting of the postrainy season crop when the soil still contains some moisture and is not too hard.
- Improved drainage with the aid of field and community channels and the use of broadbed and furrows (BBF).

Figure. 1.



1. Murthy and Pandey (1978) DELINEATION OF AGRO-ECOLOGICAL REGIONS OF INDIA: IRRIGATION ATLAS OF INDIA (1972)

- Dry seeding of crops before monsoon rains commence.
- Use of improved seed varieties and right level of fertiliser.
- Appropriate cropping system and row arrangement.
- Improved placement of seed and fertilisers for better crop-stand.
- Improved plant protection methods particularly for leguminous crops.

Consistent performance of the technology at the experiment station encouraged the ICRISAT scientists to test its performance under real world of SAT farmers. In 1981-82 ICRISAT initiated technology verification trials at Taddanpally, Medak district of A.P. in collaboration with the Indian Council of Agricultural Research (ICAR), the Andhra Pradesh Department of Agriculture and A.P. Agricultural University. In 1983-84 the verification trials extended to 28 sites and are now carried out in 41 locations in the State of A.P.

Karnataka state has taken the lead in implementing the watershed based improved dryland agriculture technology and ICRISAT's IVMT is being applied on a large scale in predominantly Vertisol areas of the districts of Gulbarga, Raichur, Bellary, Dharwad, Belgaum and Bijapur. Since agroclimatic and socio-economic conditions of the six districts in which large scale implementation of IVMT has been taken up by the department of agriculture in Karnataka are highly variable and diverse, utility of the technology as a whole and contribution of each of the components may vary considerably from one place to another. It is therefore important to have sufficient feedback on the performance and the perception of the technology and the utility of its different components under different situations, so that suitable adjustments to meet the location specific needs are made in the technology to improve its effectiveness. Therefore the present study was taken up with the following objectives:

1. To survey the extent of implementation of the improved deep Vertisol technology in the different districts of Karnataka
2. To have an idea about the perception of the technology by the agriculture department officers and the farmers.
3. To evaluate the performance of the technology in terms of crop production and the farmers income.

THE STATE OF KARNATAKA

Karnataka is located between 11 10' and 18 28' N latitude and 74 15' and 78 30' E longitude in South-west India. The total geographic are is 1,91,773 sq. km. Three fourths of the cultivatable area in the state is dryland, much of it without any prospects of irrigation facilities.

Agroclimatic conditions:

A tropical climate characterised by high incidence of solar radiation, high temperature (maximum mean in July is 32.5 C) and unreliable rainfall, with spells of drought and flood, affects agriculture in most of the districts of Karnataka. The annual rainfall in major parts of the state ranges between 500 to 900 mm, which is not dependable during the first half of the monsoon season extending from June to October. However in hilly and coastal areas the rainfall ranges between 900 to more than 2500 mm.

Red Alfisols and black Vertisols are common soil types with 11.5 million ha and 6.9 million ha respectively. Coastal and inland climatic conditions cause large agroclimatic variations at short distances. However, broadly, the state can be conveniently divided into 10 agroclimatic and agricultural zones (Karnataka dryland development Project 1984). The Figures 2, 3 and 4 delineate the different zones and indicate rainfall and soil type and the important characteristics of the zones are summarised in Table 1.

Table 1: IMPORTANT FEATURES OF DIFFERENT AGROCLIMATIC ZONES

Zone No.	Name of zone	Districts	Range of annual rainfall (mm)	Major soil type	Soil depth	Crops grown
1.	North eastern transition zone	Entire Bidar and northern part of Gulbarga	829.5 - 919	Black clay red laterite	Shallow to medium	Jowar, oil seeds and pulses
2.	North eastern dry zone	Northern part of Raichur and southern part of Gulbarga	633.2 - 806.6	Black clay	Deep to very deep	Rabi, jowar, bajra, pulses, oilseeds cotton
3.	Northern dry zone	Entire Bijapur and Bellary Northern parts of Belgaum and Dharwad and southern part of Raichur	464.5 - 785.7	Black clay	Medium to deep	Rabi jowar, maize, bajra, groundnut cotton, wheat, sugar-cane or tobacco
4.	Central dry zone	Entire Chitradurga, northern parts of Tumkur, Hasan and Chickmangalur	453.5 - 717.7	Red sandy loam to black clay	Shallow to deep	Ragi, jowar, pulses and oilseeds
5.	Eastern dry zone	Bangalore, Kollar and southern part of Tumkur	679.1 - 888.9	Red loamy clay and laterite	--	Ragi, rice, pulses, maize, oilseeds
6.	Southern dry zone	Mandya, eastern parts of Mysore and Hasan	670.6 - 888.7	Red sandy and red loamy	--	Ragi, pulses, millet and sugarcane
7.	Southern transi-tional zone	Parts of Shimoga, Chick-mangalur, Hasan & Mysore	611.7 - 1053.9	Red sandy & red loamy	--	Rice, ragi, tobacco, pulses & jowar
8.	North transitional zone	Western parts of Belgaum to Dharwar	619.4 - 1302.2	Black clay, red sandy loam	Shallow to medium	Rice, jowar, groundnut, pulses, sugarcane, tobacco

Zone No.	Name of zone	Districts	Range of annual rainfall (mm)	Major soil type	Soil depth	Crops grown
9.	Hilly zone	Kodagu, parts of Hasan Chickmangalur, Shimoga Uttara Kannada to Belgaum	904.4 - 3695.1	Red clay loam	--	Rice & pulses
10.	Coastal zone	Dakshina Kannada western part of Uttara Kannada	3010.9 4634.4	Red latterite and coastal alluvial	--	Rice and sugarcane

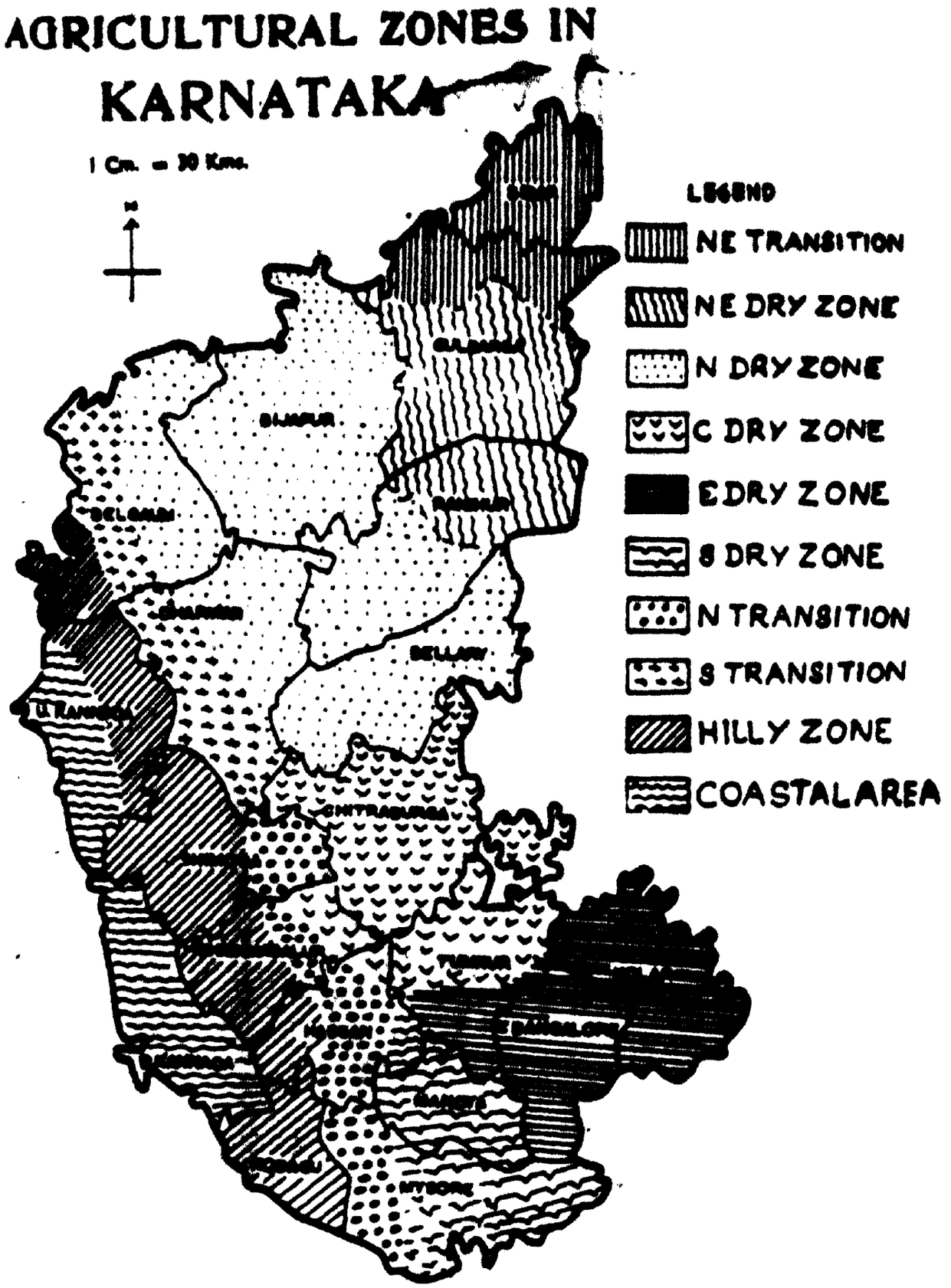


Fig. 2: Agricultural zones in Karnataka

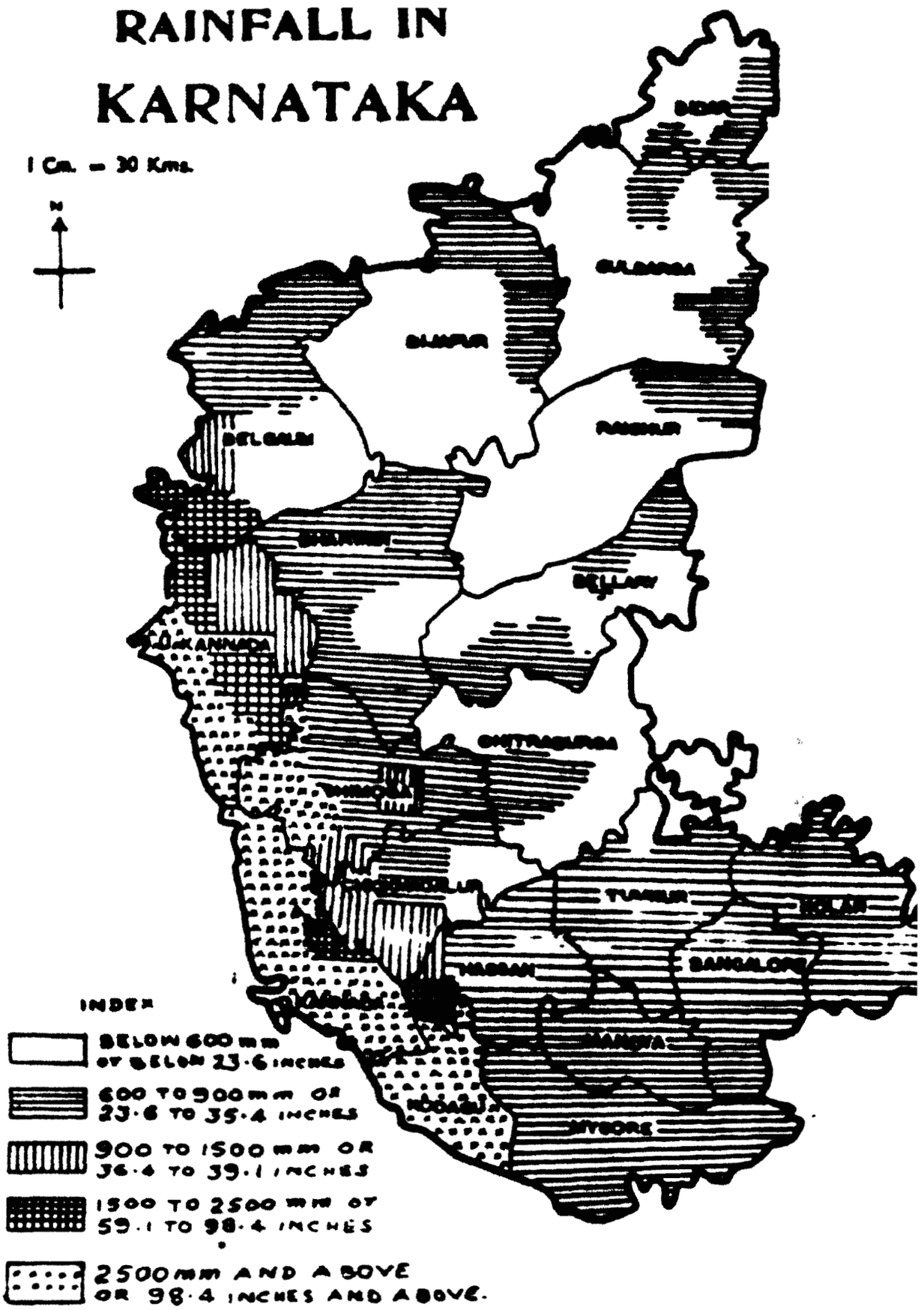


Fig.3: Rainfall in Karnataka

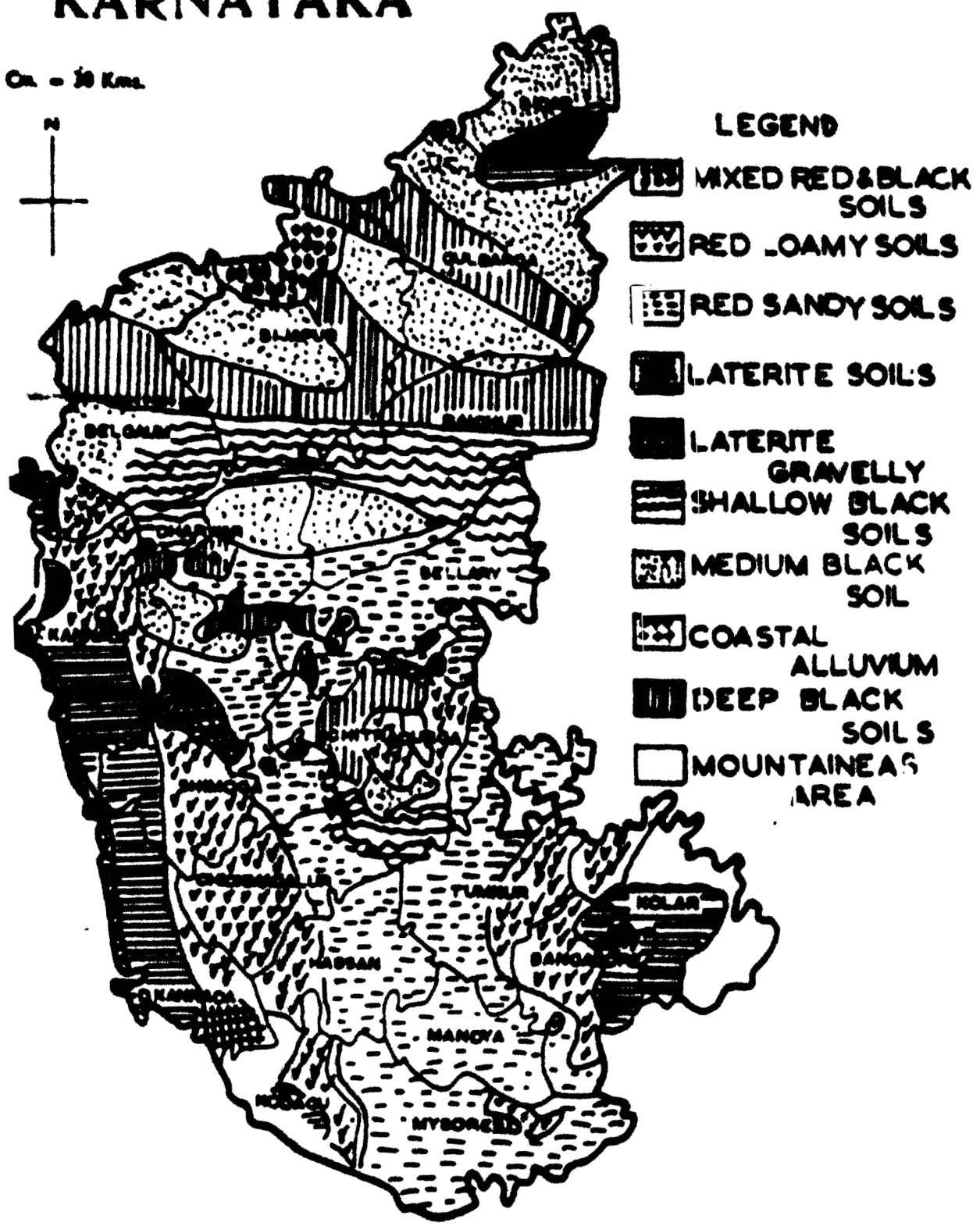


Fig. 4: Soils of Karnataka

DESCRIPTION OF THE DISTRICTS SURVEYED IN KARNATAKA STATE

Bellary:

The district of Bellary is situated in the eastern part of the Karnataka state and has a net cropped area of 583,000 ha out of which 96,000 ha is irrigated. The rainfall pattern varies from place to place and 60% of the total rain is received in Rabi season. Only some parts of the district receive 600 to 900 mm rains, while rest of the region receives below 600 mm.

Major areas of the region are characterised by red soils followed by shallow black soils. The main crops grown in the district are sorghum (98,868 ha), cotton (77,574 ha), groundnut (38,847 ha), pearl millet (35,530 ha) ragi (33,023 ha), sunflower (21,755 ha), maize (14,186 ha), pigeonpea (8469 ha), sugarcane (7687 ha), chickpea (3,477 ha), niger (3,741 ha), dry chillies (3,730 ha), wheat (3,367 ha), onion (2,426 ha) corriander (2,301 ha) and safflower (1,122 ha). Kharif or extended Kharif cropping in monoculture or intercropping is common. Rabi crops such as chickpea and wheat are grown under irrigated conditions only.

Bidar:

Bidar district occupies an area of 5448 sq. kms and is situated in the north eastern part of Karnataka. The total cultivated area is 346,000 ha, out of which only 23,000 ha are under irrigation. Except the eastern sector where the rainfall is 600 to 900 mm, the rainfall in the district is less than 600 mm. Black and laterite soils are predominant in the district.

The principal crops grown are sorghum (1,11,405 ha), pigeonpea (33,455 ha), chickpea (27,340 ha), pearl millet (21,903 ha), wheat (15,170 ha), niger (13,300 ha) sugarcane (13,010 ha), sunflower (10,985 ha), groundnut (9,860 ha), cotton (7,075 ha), mesta (3,775 ha), corriander (2,200 ha), sunhemp (1,575 ha) and dry chillies (1,400 ha). Sorghum is the predominant crop during Kharif as well as in Rabi. Mono and intercropping are prevalent. Some time Rabi sorghum follows a short season crop of mungbean and blackgram. Of late sunflower is becoming popular.

Bijapur:

Bijapur is located in the northern part of Karnataka with an area of 17,069 sq. kms and is the largest district in Karnataka. The net cultivated area is 14153 sq. kms out of which only 1159 sq. kms is under irrigation. Medium and deep black soils are found throughout the district and the average annual rainfall is only 520 mm.

The predominant crops are sorghum (4,77,136 ha), cotton (1,90,400 ha), sunflower (68,820 ha), safflower (50,050 ha) pigeonpea (28,560 ha), chickpea (27,340 ha), maize (22,551 ha), pearl millet (1,93,045 ha), sugarcane (14,630 ha), onion (7,615 ha), dry chillies (4,575 ha), niger (1,378 ha) corriander (911 ha) and sunhemp (434 ha).

During Kharif sorghum, maize, pearl millet, pigeonpea, sunflower, groundnut are the main crops and sorghum, wheat, onion, safflower, chickpea and chillies are grown during Rabi season. Kharif fallowing is also common in the district. Intercropping of other crops with pigeonpea is very common.

Dharwad:

Dharwad is the third largest district in Karnataka with an area of 13,738 sq. kms and is located in the northern part of the Karnataka state. Major part of the district receives dependable annual rainfall between 600-900 mm. Red sandyloam, medium black and deep black soils are predominant in the district. The net cultivated area is 1124,000 ha out of which only 72,000 ha are under irrigation.

The major crops are sorghum (2,15,108 ha), cotton (2,29,528 ha), groundnut (1,24,678 ha), wheat (94,909 ha), dry chillies (74,972 ha), pigeonpea (24,946 ha), chickpea (17,704 ha), safflower (17,687 ha), ragi (14,187 ha), maize (9,934 ha), onion (8,170 ha), sunflower (5,743 ha), and sugarcane (2,337 ha).

Sorghum, maize, dry chillies, mungbean and groundnut are the main Kharif season crops and planting of Rabi sorghum is also a common practice in the district. Wheat, cotton, safflower, chickpea are grown in Rabi season. A practice of relay cropping of desi cotton in the crop of chillies is common around Dharwad and Hubli. recently double cropping of groundnut or mungbean followed by sorghum is becoming popular.

Gulbarga:

Gulbarga is situated in the northern part of Karnataka having an area of 16,224 sq. kms and is the second largest district. The annual rainfall of the district is below 600 mm and the soil is predominantly medium to deep black. The net cultivated area is 1183,000 ha, out of which only 27,000 ha are under irrigation. The main crops are sorghum (3,64,522 ha), cotton (1,47,140 ha), pigeonpea (1,02,079 ha), pearl millet (91,694 ha), groundnut (86,689 ha), safflower (58,384 ha), mustard (34,417 ha), chickpea (33,515 ha), wheat (3,454 ha), niger (7,358 ha), sunflower (5,631 ha), cotton (5,637 ha) and onion (2,414 ha).

Sorghum, cotton, pigeonpea, pearl millet, groundnut and sunflower are sown immediately after the onset of monsoon as Kharif crop and wheat and gram is grown during rabi under irrigation. Intercropping of pigeonpea and pearl millet is common, however in recent years pure crop of pigeonpea is becoming popular due to high price of pigeonpea. The practice of Kharif fallowing and planting Rabi sorghum is quite common.

METHODOLOGY

ICRISAT Director of Research, Dr. J.S. Kanwar, arranged for a meeting with Dr. T.V. Sampath, Director of Agriculture, Karnataka state at Bangalore to discuss the objectives of the study and to select the districts for including in the study. The director of Agriculture explained in general the agriculture development program in the state and particularly emphasised the district programs where IVMT was being evaluated. He provided necessary introduction and the instructions to the district level officers of the selected districts to provide all relevant information required for the study.

Since the time available for completing the study was short (4 half months) it was difficult to generate any quantitative data for analysis and evaluation of the impact of the IVMT performance. An attempt was made to have information on the agroclimatic conditions of the different districts, existing crop production practices, implementation of the different components of IVMT and department officials and farmer's perception of the advantages and the problems of IVMT in different areas.

Data collection: The basic data were collected through:

1. By contact and personal discussions with the district level agriculture officers.

2. From the records maintained at the district offices, office of Assistant Director of agriculture and seed fa

The items of base data collection were:

1. Total geographic area of the district

2. Area under cultivation

3. Rainfall

4. Area under irrigation

5. Area of IVMT implementation in each district

Survey of IVMT project area:

The surveys were mainly conducted through:

1. Interviews with the agriculture department staff responsible for the project implementation

2. Interviews with the farmers

3. Field observations

OBSERVATIONS AND DISCUSSIONS:

The observations on the performance of the improved Vertisol management technology at the locations surveyed in each district are given below.

Bellary:

The IVMT trials were carried out at four locations--two each in Sirugappa (Sirugappa, Bhagiwadi) and Harapanahalli (Nichappur Block I and II) taluks of Bellary district and extneded to an area of 30.1 ha with the participation of 10 farmers.

Four tropicultors (two for each taluk) were supplied to the farmers by the department of agriculture.

Agroclimatic conditions during the season: Sirugappa taluk receives an average annual rainfall of 599.2 mm (mean of 5 years). The monsoon starts from end of April and extends to the beginning of November and the highest rainfall is received in September. Rainfall during 1984 was considerably less (459.8 mm).

A bimodal trend was noticed in rainfall of Harapanahalli with peaks in July and September. The annual rainfall is 667.6 mm (mean of 30 years). Harapanahalli recorded 854.6 mm rainfall during 1984.

Important crops and cropping systems: In Bhagewadi sowing was done in the first week of October and sole crops of sunflower, safflower, Rabi sorghum and intercrop of safflower with chickpea were grown. Encouraged by the previous year's results many cropping systems were adopted by the farmers in Harapanahalli taluk, and these were as follows:

1. Intercropping of sroghum + pigeonpea + horsegram
2. Greengram (Kharif) followed by intercrop of chickpea and safflower
3. Greengram (Kharif) followed by Rabi sorghum
4. Chilli + cotton intercrop (Kharif)

Nichapur Block II:

1. Greengram (Kharif) followed by Rabi sorghum
2. Sorghum + pigeonpea intercrop followed by safflower in between the rows of pigeonpea (Rabi)
3. Chilli + onion intercrop (Kharif)

Components of the technology implemented:

1. Land survey and mapping: Land survey and mapping was carried out by the Agricultural Department staff (Soil Conservation) at all locations.

2. Broadbed-and-furrows: Broadbed-and-furrows were laid out very well with the help of tropicultor with a slope of .3% to .6%.

3. Dry sowing: Dry sowing was only practised in Nichapur location. This had given good results in the past.

4. Grass waterway and community channels: Grass waterway or community channels were not made in any of the sites except in Bhagevadi.

5. Interculture: Tropicultor was not used for interculture.

6. Weeding: Hand weeding was commonly practised by the farmers in all locations.

7. Plant protection: Three sprayings were done to control Heliothis in pigeonpea.

Yield obtained: 1984-85 yield data was not available.

Conclusions and general observations:

1. Rainfall in Sirugappa taluk is too low to reflect the advantages of the improved technology, which envisages improved drainage and extending the growing season for intercropping and possible double cropping

2. Harapanahalli has the scope for implementing the technology as two crops can be raised in a year instead of the prevailing single cropping syst

3. Dry sowing has not been accepted by the farmers in Sirugappa since sowing was in October (Rabi zone).

4. Crop stand in Sirugappa was very poor due to less rainfall.

Bidar:

The technology was extended to an area of 67.61 ha with the participation of 23 farmers in 13 locations of Bidar, Balki, Humnabad and Aurad taluks of Bidar district during 1984-85. 20 tropicultors were supplied to the farmers by the department of agriculture.

Out of the 13 locations, 4 locations of Maligaon (Bidar tq.), Kotagil (Aurad tq.), Dubalgund (Humnabad tq.) and Balki (Bakli tq.) were surveyed.

Agroclimatic conditions during the season: The rainfall data of Humnabad taluk from 1974 to 1984 showed wide variations in annual rainfall (431.1 to 1032.7 mm) and 6 out of 11 years the annual rainfall was less than 750 mm. Onset of monsoon is normally from end of April and prolongs till beginning of November. July, August and September are the peak rainy months.

Balki taluk receives more dependable rainfall (mean of 1973 to 1984 is 827 mm) compared to Humnabad, although the pattern is the same. Rainfall during 1984 was low both in Humnabad (541.9 mm) and Balki (694 mm).

Important crop and cropping systems: Sorghum and pigeonpea intercrops were raised in Maligaon, Kotagil and Dubulgundi during Kharif. In Balki intercrop of safflower and pigeonpea and sole sunflower were grown during Kharif.

Components of the technology implemented:

1. Land survey and mapping: The land survey and mapping were carried out very well by the department of agriculture staff (Soil Conservation) in all locations.

2. Broadbed-and-furrows were maintained well with a slope of .3% to .6%.

3. Dry sowing: Dry sowing was practised in all locations and the germination and crop stand was good.

4. Grass waterway and community channels were not properly developed.

5. Fertilizer application: DAP @ 200 kg/ha was applied for sorghum-pigeonpea intercrop and 150 kgs for sole sunflower crop.

6. Weeding and intercultivation: Hand weeding was generally practised in all locations and intercultivation was carried out by local implements.

7. Plant protection: Dusting was done once for sunflower crop and three sprayings were done in pigeonpea crop for Heliothis control.

Yield obtained:

Location	Crop	Yield kg/ha
Kotgial	Pigeonpea	800
Aurad	Sorghum	1600
Balki	Sunflower	1360
Dubulgundi	Pigeonpea	Not available
	Sorghum	1560
Malegaon	Pigeonpea	1000
	Sorghum	900

Conclusions and general observations: Under the prevailing conditions of Bidar, dry sowing was quite successful and intercropping of sorghum and pigeonpea has considerable promise.

Bijapur:

In the district of Bijapur the technology was adopted by 18 farmers extended to an area of 98.6 ha at 13 locations in 6 taluks during the year 1984-85. The department of agriculture had supplied 22 tropicultors to the farmers.

Out of the 13 locations, survey was conducted in four locations of Budhihal, Otihal and Sindgi of Sindgi taluk and Sevalgi of Jamkandi taluk.

Agroclimatic conditions during the season: During 1984-85 the district received an average rainfall of 466.2 mm only. Though the normal rainfall of the district is 520 mm but it is highly erratic and undependable. The distribution of rainfall is bimodal with peaks in the beginning of July and at the end of September. In Jamkandi taluk the rainfall was very poor (314.9 mm) in 1984.

Crops and cropping systems: In Sindgi and Sevalgi sole crops sorghum, safflower, and cotton were raised after fallowing in Kharif. Rabi sorghum was raised in Budhihal and Otihal after fallowing in Kharif. The cotton crop in Sidgi had failed due to moisture stress.

Components of the technology implemented:

1. Land survey and mapping was carried out by the Department of agriculture staff.

2. Broadbed-and-furrows were well laid out with a slope of 0.3 to 0.4%. No grassway and terminal drainage was developed at any location.

3. Fertilizer applied: 75 kgs of DAP, 25 kgs of Urea and 25 kgs of Super phosphate were applied per ha, at both locations.

4. Weeding and intercultiviation: Hand weeding was done in all locations and intercultivation was done by local implements.

Yield obtained

Crop	Yield kg/ha
Rabi sorghum	800
Safflower	1000
Cotton	Crop failed due to dry spell

Conclusions and genereal observations:

1. Sowing was delayed for a month due to late monsoon and therefore crop stand was very poor.

2. Rainfall is too low to meet the demand of the technology envisaging double cropping or extended growing season through intercropping.

Dharwar:

The technology was adopted at 10 locations in Dharwar district with the participation of 93 farmers and extended to an area of 135.44 ha during 1984-85.

Survey was conducted in five locations of Garag (Dharwar taluk), Gabbur (Hubli taluk), Somanhally (Harekkerur taluk), Nagannur (Haveri taluk), and Bankapur (Shiggaon district).

Agroclimatic conditions during the season: Onset of monsoon in Kharif season was delayed for a month in all the five locations during 1984-85. A long dry spell of 50 days experience at Garag during the season had adversely affected the crop growth.

Important crops and cropping system:

Garag:

1. Groundnut was raised in Kharif followed by wheat in Rabi

2. Sorghum was intercropped with pigeonpea during Kharif

3. Sorghum was intercropped with soybean during Kharif followed by intercrops of chickpea, sorghum and cotton in Rabi.

Nagannur:

1. Groundnut was cultivated during the Kharif followed by wheat in Rabi.

2. Sole safflower crop during Rabi

Gabbur:

1. Groundnut was raised during Kharif followed by intercropping of safflower. chickpea and sorghum in Rabi.

Somanhalli:

1. Sorghum and pigeonpea intercrop was raised during Kharif

2. Groundnut in Kharif followed by intercropping of sorghum and safflower in Rabi.

Bankapur:

1. Cowpea in Kharif followed by Rabi sorghum

2. Greengram in Kharif followed by Rabi sorghum

3. Intercropping of sorghum and pigeonpea in Kharif

Major components of the technology implemented:

1. Land survey and mapping was carried out by the Department of Agriculture, Soil Conservation staff.

2. Broadbed-and-furrows were laid out with a slope of 0.4 to 0.8% by tropicultor.

3. Dry sowing was not practised in any location due the following reasons:

   a. Prediction of monsoon is difficult

   b. The cost of groundnut seed is high to take risk of dry sowing

   c. Serious seed damage caused by rats and birds in the past.

4. Grass waterways and terminal drainage were not developed.

5. Fertilizer applied: DAP was applied @ 100 kg/ha in all locations.

6. Interculture: Weeding was done with the help of sickle and intercultivation was done with local implements.

7. Plant protection: Plant protection measures were well carried out in all crops as directed by the department staff.

Yield obtained:

Location	Crop	IVMT plot yield kg/ha	Control plot yield
Gharag (Dharwar)	Groundnut	750	600
	Wheat	NA	NA
	Cotton	NA	NA
	Sorghum	1300	1000
	Soybean	NA	NA
Gabbur (Hubli)	Groundnut	1560	1050
	Greengram	515	413
Somanhalli (Hirekerur)	Groundnut	1100	800
Nagammur	Groundnut	1200	850

Gulbarga

37 farmers followed the IVMT in Gulbarga district extending to an area of 117.8 ha at 12 locations in Aland, Chincholi, Gulbarga and Yadgir taluks, out of which survey was made of 4 locations of Farhatabad, Pattan and Syed Chincholli in Gulbarga district, Aland Madugumki and Aland seed farm in Aland taluk, Karnagi Gumrical in Yadgir taluk and Navadagi in Chincholli taluk.

Agroclimatic conditions during the season: The rainfall (average) is more than 750 mm in all the four taluks. The monsoon lasts from April to October and September receives peak rains. The annual rainfall of the four locations during 1984 was 853 mm in Aland, 911.4 mm in Chincholli, 729.7 mm in Gulbarga and 647.8 mm in Yadgir.

Important crops and cropping system:

The crops and cropping system of the 9 locations visited are as follows:

Farhatabad:

1. Sole pigeonpea crop in Kharif

2. Mungbean in Kharif followed by safflower in Rabi

3. Rabi sorghum after fallowing in Kharif

4. Intercrop of pigeonpea, pearl millet and groundnut during Kharif

Pattan: Sole pigeonpea in Kharif

Syed Chincholli:

1. Sole pigeonpea

2. Rabi sorghum after Kharif fallowing

Aland: Greengram in Kharif followed by pigeonpea

Maduganaki:

1. Sole pigenoea in Kharif

Aland seed farm: Greengram in Kharif followed by Rabi sorghum

Karnagi: Intercrop of groundnut and pigeonpea during Kharif

Gurmitkal: Intercrop of bengalgram and pigeonpea during Kharif

Navadugi:

1. Sole cotton during Kharif

2. Sole pigeonpea during Kharif

Components of the technology implemented:

1. Land survey and mapping was carried out by the Department of Agril. staff.

2. Broadbed-and-furrows were laid out with a slope of 0.4% to 0.6%.

3. Dry sowing: Dry sowing was practised only in Aland, Madugunaki and Farhatabad.

4. Grass waterway and terminal drainage: No grass waterway and terminal drainages were provided at any of the locations.

5. Fertiliser applied: DAP was generally applied @ 50-120 kg/ha in different locations.

6. Weeding and intercultivation: Only weeding was done in pigeonpea + groundnut intercrop and pigeonpea + blackgram intercrop in Karnagi and both hand weeding and intercultural operations were done in rest of the places.

7. Plant protection: Generally one dusting and three sprayings were done for the pigeonpea crops for Heliothis control.

Yield obtained

Location	Crop	Yield/kg/ha
Karnagi	Pigeonpea	NA
	Groundnut	NA
Gurmitkal	Pigeonpea	NA
	Blackgram	Crop failed due to dry spell
Pattan	Pigeonpea	800-1000 kg—expected yield
Aland	Pigeonpea	-do-
Madagunaki	Pigeonpea	600 kg expected yield
Farhatabad	Pigeonpea	NA

Conclusions and general observations: At Farhatabad the sprayings were done on pigeonpea crop with the help of a tropicultor mounted ultra-low volume sprayer (with 3 nozzles) designed and developed at ICRISAT and it has been widely accepted by the farmers for the following advantages:

1. Only one labour is required to operate

2. No supervision is necessary

3. Only 5-8 ltrs of water required per ha.

4. 8-16 ha can be covered in a day

5. Less hazardous to labour

CONCLUSIONS

The districts of Gulbarga, Bidar, Bellary, Dharwad, Bijapur and Belgaum have taken up the implementation of ICRISAT improved Vertisol management technology (IVMT) under varying situations of rainfall and soil depth. Most of the area in these districts is characterised by low and erratic rainfall and therefore does not meet the prerequisite condition of high and dependable rainfall conditions envisaged for the technology.

The technology has been taken up as an improved dryland agriculture practice in general, facilitating moisture conservation and as an element of better soil moisture use rather than one ensuring better drainage during monsoon and allowing good rainy season cropping and possibly double cropping in areas where no crops could be grown during the rainy season due to waterlogging conditions.

The officers of the department of agriculture have identified the IVMT with the following elements in the order of their priority.

1. Use of tropicultor
2. Preparation of broadbed-and-furrows
3. Dry seeding
4. Fertilizer use
5. Plant protection
6. Double or intercropping

The project areas have been well surveyed and detailed maps for the development of micro-watersheds have been prepared by the soil conservation staff. However, the actual implementation is confined to marking the ridge and the keylines and preparation of BBF. Development of community drains and field to field grassed waterways and outlets has not been possible. Therefore, some water continues to stagnate near the field boundry or overflows through the neighbouring fields in certain cases.

Most of the sites selected for the implementation of IVMT do not suffer from the problem of waterlogging and therefore absence of waterways and main drains have not caused any serious probl

Preparation of BBF is symbolic of IVMT projects and therefore all out efforts have been made to make BBF structure either by tropicultor or by opening furrows by local implements at the distance of 1 m. Maintenance of BBF during the crop season and interculture operations has not been possible, since all subsequent operations are being done by the local implements.

The infrastructure of the department of agriculture in the district has ensured the supply of seed and fertilizer to the farmers involved in the IVMT projects.

Data on crop yields obtained from the implementation of IVMT and the traditional practice were not available from most of the locations. However, the discussion with the agriculture department officers indicated that the procedure followed for comparing the advantage of BBF over the traditional cultivation practices was not very scientific and therefore it is difficult to determine the relative contribution of land and water management treatment. The limited yield data reported for sorghum, pigeonpea and groundnut indicated that the yield levels obtained are comparable to otherwise well managed farmers fields in the district, since the district average for sorghum in Bidar and Dharwad is 1396 and 1426 kg/ha while pigeonpea yields are around 1000 kg/ha in Bijapur and Bidar.

Farmers seem to appreciate BBF for its possible role in soil moisture retention and draining excess water during heavy storms. However, they find it difficult to maintain the system throughout the season. They seem to perceive more need for moisture retention than for draining the water and therefore insist on field bunds and do not allow to flow the water out of their field. Also there is considerable resistance for waterways to pass through their fields since they do not want to loose the land for waterways. There is a need for establishing convincing advantage of BBF or develop other possible land treatment alternatives.

The prospects of double cropping and remunerative intercropping proposed in IVMT are very much appreicated by the farmers but, there is a need for developing specific recommendations for specific areas depending on the soil moisture availability and crop preference. The districts of Dharwad and Belgaum seem to offer good prospects for double cropping because of dependable well distributed rainfall conditions, while in other areas intercropping seem to be the more practical approach.

Tropicultor has appealed to the farmers in the Dharwad district as a labour and time saving implement, but they find that its draught is too much for their bullocks and its operations are restricted to very specific soil moisture conditions.

Plant protection measures for Heliothis (pigeonpea pod borer) control have found great appreciation by the farmers of Farhatabad in Gulbarga, particularly the CDA sprayer assembly developed at ICRISAT. A number of farmers have purchased CDA sprayer and are following the practice of pest incidence monitoring and insecticide application.

Information on the participation of the number of farmers in each of the IVMT project visited showed that in 14 of the locations the number of the participating farmers was less than four, while at 9 locations it exceeded four. Where the number of farmers involved was large (28) the area per farmer was less than one hectare. Actual involvement of these farmers could not be ascertained. It will be interesting to follow the involvement of the number of farmers in each of the locations in subsequent years (Table 2).

Table 2: Number of participating farmers and the area involved in IVMT at the locations visited

Sl. No.	Location	No. of farmers	Area (ha)
1.	Malegaon	1	1
2.	Bhalki	1	8.21
3.	Dubulgundi	3	3.2
4.	Aurad	1	1
5.	Farhatabad	5	29.36
6.	Pattan	2	8
7.	Syed Chincholli	6	29.6
8.	Aland	1	1
9.	Madugunuki	1	5
10.	Karnagi	2	8
11.	Gumritkal	2	5
12.	Nowadagi	11	8
13.	Darag	7	20
14.	Naganmur	5	10
15.	Gabbar	5	20
16.	Sommanhalli	28	20
17.	Bankappur	5	20
18.	Nichappur I	1	5.6
19.	Nichappur II	6	12
20.	Sirugappa	1	4.5
21.	Bhagewadi	1	8
22.	Sidgi	2	10
23.	Savalgi	1	10.46

PROBLEMS AND CONSTRAINTS OF IVMT

Tropicultor

Department of Agriculture has purchased a sufficient number of tropicultors for implementing the IVMT projects. Many of them are lying idle due to lack of maintenance and repair. Some major complaints of the tropicultor are listed below:

1. The draught is too much for the medium and small size bullocks owned by majority of the SAT farmers.

2. Interculture with local implements is convenient and efficient.

3. During ploughing considerable unploughed land is left on turning points.

4. Seed plates for all seeds particularly groundnut was not available.

5. It is difficult to repair punctures or other mechanical faults in the villages.

6. No tool kit or manual has been supplied to the farmers by the manufacturer.

7. Price of the implement is prohibitive for an average dryland famer.

Dry sowings:

Dry sowing has been risky and the farmers in Gulbarga, Bellary, Dharwad and Bijapur are not ready to adopt dry seeding practice.

Cultivation immediately after harvesting

Cultivation of land immediately after the harvesting of the crop has not been sufficiently impressed and in areas such as Dharwad it is difficult to cultivate the land after the cotton crop which extends upto March end.

SUGGESTIONS

Watershed development

1. Watershed should be planned as an ecological unit and integrated micro-watersheds should be planned for specific land and water management treatments and crop production practices.

2. Detailed surveys for soil depth and soil moisture availability should be done for crop production planning.

3. Crops and cropping systems suitable to the general area and the agro-ecological niches in the watershed should be developed for ready adoption.

Tropicultor

1. Proper training should be given to the village level staff of department of agriculture and to farmers who are directly involved in the field operations regarding tropicultor use.

2. Manufacturer should take the full responsibility for the quality of their product. After-sale service and fault repair facilities should be improved.

3. Improvements should be made in the tropicultor based on the requirements of the farmer.

Improving indigenous implements:

Studies should be made to improve the indigenous implements to prepare broadbed-and-furrows in view of the following:

1. The cost of the equipment could be considerably reduced which will be within the reach of the poor dryland farmers.

2. The weight and draft of the equipment could be reduced for small-size bullocks.

3. Ordinary carpenters and blacksmiths available in the villages can make such an implement and carryout the repairs as well.

REFERENCES

Agricultural situation in India: 1983 and 1984

Government of Karnataka: Karnataka Dryland Development Project (in 19 district watersheds).

ICRISAT 1981. Improving the management of India's deep black oils ICRISAT Patancheru, A.P., India: ICRISAT.

ICRISAT 1984. Watershed-based Dryland Farming in Black and Red Soils of Peninsular India. ICRISAT Patancheru, A.P., India: ICRISAT.

Kampen, J. 1982. An approach to Improved Productivity on Deep Vertisols. ICRISAT, Patancheru, A.P., India: ICRISAT.

Manorama year book: 1984.

Murthy. R.S. 1981. Distribution and properties of Vertisols Associated Soils, 1981.

Muthanna, C.T. ed. 1983. Strategy for Agricultural Production in Karnataka during 1983-84. Bangalore, KSDA, 1983.

Muthanna, C.T. ed. 1982. Strategy for Agricultural development in Karnataka, Bangalore. KSDA 1982.

Muthanna, C.T. ed. 1984. Strategy for Agricultural Production in Karnataka during 1984-85, Bangalore, KSDA, 1984.

The Times of India, 1984. Directory and year book 1984

APPENDIX I

ITINERARY OF VISITS WITH THE DEPARTMENT OF AGRICULTURE STAFF AND THE FARMERS

S.No.	Date	Place	Person/s contacted	Remarks
1.	17.11.84	Bangalore	Dr. T.V. Sampath Director of Agriculture Karnataka	Discussed the objectives of the study on technology transfer and performance of IWMT in Karnataka state and selected the districts for the study.
2.	28.11.84	Gulbarga	Prin. Agril. Officer	Discussed the schedule of visits
		Farhatabad	Mr. A.A. Khan, ICRISAT staff	Collected data and information from ICRISAT project village officer
3.	29.11.84	Aland	Asst. Director of Agril.	Held discussion with ADA Aland
			Farmers	Visited IWMT sites of Aland, Pattan and Aland Seed Farm.
4.	30.11.84	Yadgir	ADA	Held discussion with ADA Yadgir
		Karnagi	Farmers	Visisted Karnagi site
		Gurmitkal	Farmers and staff of Agril. Department	Visited Gurmitkal site and conducted joint field trip with the farmers
5.	1.12.84	Syed Chincholi	Farmers	Visited the IWMT site
		Chincholi	Farmers	Visited the IWMT site at Chincholi, seed farm at Mavedagi.
6.	3.2.84	Bidar	PAO	Collected data from PAO's office
7.	4.12.84	Aurad	ADA	Visisted ADA of Aurad and held discussions
			Farmers	Visited IWMT site at Kotgal
		Bhalki	Farmers	Visisted IWMT site at Bhalki

contd....2.

ITINERARY OF VISITS WITH THE DEPARTMENT OF AGRICULTURE STAFF AND THE FARMERS

S.No.	Date	Place	Person/s contacted	Remarks
8.	5.12.84	Bidar	ADA	Collected data and information
		Humnabad	ADA	Collected information from ADA office
		Dubalgandi	Farmers	Visited IWMT site at Dubulgandi
9.	11.12.84	Dharwar	PAO	Collected data and information from PAO's office
		Gareg	Farmers	Visited the IWMT sites
		Gabbar	Farmers	Visited the IWMT sites
10.	12.12.84	Somanhalli	Farmers	Visited IWMT site
		Nagennur	Farmers	Visited IWMT site
		Bankapur	Farmers	Visited IWMT site
11.	13.12.84	Dharwar	PAO and other officers	Collected data and information and attended the district level workshop
12.	18.12.84	Bellary	PAO	Collected data and information from PAO's office and held discussion
		Sirugappa	Farmers	Visited the IWMT sites at Sirugappa and Bhagewa
13.	19.12.84	Harapanahalli	ADA	Collected data and information from ADA's office and held discussions with ADA
		Nichapur	Farmers	Visited the IWMT site
14.	20.12.84	Bellary	PAO and other officers	Held discussions with PAO and other officers of PAO's office
15.	8.1.85	Bijapur	PAO and other officers	Collected data and information from PAO's office and held discussions
16.	9-10.1.85	Yersori	Farmers	Visited IWMT sites
		Sindgi	"	-do-
			"	-do-

Appendix - II MONTHLY RAINFALL AT SIRUGUPPA TALUK

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1984	-	-	-	8.8	-	32.5	182	29.8	121.3	83	2.4	-	459.8
1983	-	-	-	22	21.0	167	70	141	225	106	-	-	752
1982				31.4	57	82.4	88.2	68.4	217.6	26.8	41.2		615
1981	12.2			3.2	37.2	87.0	34	81.0	266.0	87	14	-	609.4
1980	-			13.6	42.7	34.8	74	228.0	103.0	30.0	34	-	560.1
Average	2.4			16.2	31.6	80.7	89.6	109.6	186.6	66.6	18.3		599.2

SOURCE: REVENUE DEPT. (from ADA office, Sirugupps)

APPENDIX - III MONTHLY RAINFALL AND POTENTIAL EVAPOTRANSPIRATION AT HARPANAHALLI TALUK (30 years av.)

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Rainfall	0.2	0.5	4.5	52.1	66.2	76.9	104.1	72.8	137.8	127.0	16.5	9.0	667.6
E.T.	115.1	128.5	170.9	130.9	194.8	167.0	155.7	152.8	138.4	123.4	105.0	104.0	1686.5

SOURCE: Action plan for 1984/85 "Improved management of vertisols at Hirehanur - Project No. 2" (from ADA office, Harapanahalli)

APPENDIX - IV MONTHLY RAINFALL AT HUMNABAD TALUK, BIDAR DIST. (1974-84)

	JAN.	FEb.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1984	-	-	-	-	8.4 (1)	43.0 (4)	262.0 (10)	52.0 (2)	93.6 (4)	82.9 (5)	-	-	541.9 (26)
1983	-	-	-	-	6.9 (1)	60.4 (5)	125.6 (6)	278.5 (18)	451.5 (16)	115.6 (6)	-	8.1 (1)	1046.6 (53)
1982	-	-	-	12.4 (1)	20.0 (3)	28.6 (2)	150.8 (8)	26.6 (3)	171.7 (8)	24.2 (1)	12.2 (1)	-	396/ (27)
1981	28.0 (2)	-	11.6 (2)	20.8 (1)	53.8 (6)	161.4 (10)	78.5 (8)	145.8 (8)	216.0 (18)	78.0 (5)	-	-	795.9 (60)
1980	-	-	26.2 (1)	24.2 (2)	2.2 (0)	167.6 (10)	48.8 (7)	214.5 (16)	122.4 (10)	-	-	19.8 (2)	625.7 (48)
1979	-	34.7 (4)	3.9 (1)	5.0 (1)	74.0 (5)	138.7 (8)	29.9 (4)	96.4 (7)	342.9 (13)	15.0 (1)	60.6 (4)	-	801.1 (48)
1978	6.2 (1)	88.3 (3)	-	46.4 (3)	47.2 (3)	155.4 (7)	235.2 (14)	174.1 (12)	174.6 (11)	81.9 (6)	23.4 (2)	-	1032.7 (62)
1977	-	-	11.9 (1)	30.7 (5)	38.1 (6)	84.8 (6)	68.2 (7)	196.4 (14)	42.2 (4)	46.2 (3)	139.1 (3)	-	617.6 (49)
1976	-	-	-	23.2 (2)	38.0 (1)	56.8 (6)	229.6 (17)	220.7 (13)	99.3 (6)	1.2 (0)	43.4 (3)	-	672.2 (48)
1975	17.0 (2)	20.0 (1)	6.0 (1)	10.0 (1)	41.0 (3)	74.9 (6)	217.4 (13)	93.9 (7)	197.5 (14)	233.8 (14)	2.0 (1)	-	913.5 (63)
1974	-	-	-	20.0 (1)	60.0 (2)	132.0 (6)	66.0 (7)	39.0 (4)	135.0 (9)	274.0 (12)	-	-	726.0 (41)

Note: Figure in parenthesis shows rainy days. normal rain fall is 800 mm.
Source: ADA Office, Humnabad "Agricultural Activities of Humnabad Taluk 1984-85"

APPENDIX - V MONTHLY RAINFALL AT BHALKI TALUK (1973-84)

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1984	-	-	-	-	-	73.8 (4)	317.2 (10)	74.3 (4)	85.4 (3)	143.3 (6)	-	-	694.0 (27)
1983	-	-	-	-	10.7 (2)	36.6 (5)	200.8 (12)	297.3 (14)	321.9 (15)	223.3 (4)	-	18.3 (1)	1068.9 (56)
1982	-	-	-	45.2 (1)	17.9 (3)	106.7 (7)	137.9 (11)	48.2 (6)	206.6 (14)	63.0 (5)	29.1 (3)		652.6 (56)
1981	-	-	-	48.0 (1)	9.6 (2)	76.0 (9)	61.4 (10)	149.3 (12)	397.6 (21)	19.8 (2)	-	-	721.7 (57)
1980	-	-	-	112.0 (5)	12.2 (1)	139.9 (9)	97.1 (7)	217.9 (13)	223.0 (12)	-	4.0 (1)	16.2 (2)	818.3 (50)
1979	-	-	-	5.4 (1)	60.2 (2)	114.7 (7)	52.3 (9)	54.9 (9)	370.5 (15)	37.0 (1)	102.6 (5)	-	797.6 (49)
1978	-	-	-	62.6 (4)	74.0 (2)	73.2 (7)	278.9 (20)	380.9 (21)	155.0 (12)	105.8 (8)	-	-	1130.4 (74)
1977	-	-	-	26.6 (3)	63.0 (3)	72.3 (9)	163.3 (12)	117.1 (9)	64.8 (4)	29.8 (4)	55.5 (3)	-	592.4 (47)
1976	-	-	-	3.1 (1)	44.4 (2)	79.4 (10)	128.8 (18)	357.4 (18)	60.8 (6)	-	42.2 (3)	-	716.1 (58)
1975	-	-	-	-	23.8 (3)	85.6 (7)	285.0 (16)	102.7 (15)	239.8 (21)	212.8 (16)	-	-	949.7 (78)
1974	-	-	-	4.1 (2)	18.4 (4)	229.9 (12)	308.0 (7)	124.1 (14)	93.0 (9)	189.1 (12)	-	-	922.6 (60)
1973	-	-	-	27.7 (3)	-	122.7 (10)	193.0 (16)	210.3 (20)	65.3 (7)	258.0 (12)	-	-	877.0 (68)

Note: figure in rentheseis shows rainy days
ADA Offic Bhalki Taluk, Bidar

APPENDIX - VI TALUK-WISE YEARLY RAINFALL OF GULBARGA DIST. (1978-84 av.)

YEAR	AFZALPUR	ALAND	CHINCHOLI	CHITAPUR	GULBARGA	JEWARGI	SEDAM	SHAHPUR	SHORAPUR	YADGIR
1984	[illegible]	382.3	915.6	539.5	928.0	584.0	1008.6	605.7	683.0	568.6
1983	1739.3	855.1	739.6	1378.4	761.6	1435.4	1237.5	1223.2	1323.9	957.5
1982	452.7	570.5	1217.6	624.1	586.0	647.4	461.6	1165.0	883.2	1206.9
1981	901.5	1024.1	1417.0	1022.8	1112.9	1424.7	984.6	1362.0	876.0	1206.0
1980	591.9	784.2	1068.0	430.9	557.3	928.8	591.3	1006.5	623.4	1017.7
1979	654.9	613.0	1185.4	780.5	739.0	1198.4	658.5	1119.0	658.3	1299.0
1978	614.4	896.7	1538.0	851.1	1136.9	1962.2	1174.8	1311.1	798.1	1324.4

SOURCE: PAO Office, Gulbarga

APPENDIX - VII MONTHLY RAINFALL AT ALAND SEED FARM - 1984

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
	-	22.2	2.1	-	-	16	171	68.4	98.1	70.3	-	-	448.1

SOURCE: ALAND SEED FARM

APPENDIX - VIII MONTHLY TALUK-WISE RAINFALL IN GULBARGA DIST. 1984

TALUK	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
1. Afzalpur	1.8	4.7	12.0	23.6	37.2	94.5	131.9	115.9	184.7	79.2	6.3	4.5	695.6
2. Aland	3.2	3.7	6.8	22.4	43.6	106.9	190.0	157.2	212.2	90.7	10.8	5.5	853.0
3. Chincholli	1.1	4.1	9.7	13.5	25.3	139.6	221.0	172.3	215.3	91.6	11.8	6.1	911.4
4. Chittapur	2.5	3.0	6.9	17.9	31.1	114.2	183.0	165.9	195.6	65.4	8.2	3.6	797.3
5. Gulbarga	6.1	7.1	9.1	19.1	27.9	106.4	136.1	136.6	185.4	64.3	12.5	4.1	729.7
6. Jewargi	7.5	4.8	8.9	21.0	32.2	96.0	119.7	121.2	192.2	77.1	12.4	6.2	699.5
7. Sedam	4.3	5.1	14.5	25.8	43.7	129.2	227.3	184.5	202.1	83.9	12.6	4.6	937.6
8. Shahapur	4.4	2.7	10.9	16.2	28.8	123.3	171.2	124.0	198.1	105.5	13.3	7.6	806.0
9. Shorapur	0.4	3.3	6.6	11.6	20.0	100.0	116.4	141.1	223.2	97.2	19.1	10.1	749.0
10. Yadgir	4.1	7.9	7.6	21.8	22.6	96.8	132.8	110.7	165.3	70.6	31.0	3.6	647.8

Source: P.A.O. office, Gulbarga

APPENDIX - IX TALUK-WISE MONTHLY RAINFALL OF BIJAPUR DIST. - 1984

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
Bijapur	-	-	-	7.4	-	14.6	102.0	41.4	120.4	130.6	-	12.0	428.4
Bagewadi	-	-	-	7.9	-	26.0	226.2	37.1	167.6	204.8	-	-	669.6
Sindgi	-	-	-	8.0	-	14.0	262.0	21.0	153.0	90.0	-	-	548.0
Indi	-	-	-	0.1	3.3	27.7	309.0	19.5	105.3	120.7	-	-	585.6
Muddebihal	-	-	-	-	-	-	176.4	60.8	68.0	83.8	-	-	389.0
Jamkhandi	-	-	-	4.2	-	8.4	111.9	45.8	68.4	126.8	-	-	365.5
Badami	-	-	-	79.2	-	2.3	90.9	29.4	165.0	148.8	-	-	511.6
Bilagi	-	-	-	16.4	-	12.8	198.5	22.0	207.6	134.4	-	-	591.7
Bagalkot	-	-	-	-	-	5.0	109.2	30.0	39.0	66.0	-	-	249.2
Hunagund	-	-	-	19.4	27.6	15.0	90.9	38.0	57.7	194.9	-	-	443.5
Hungund	-	-	-	9.8	2.0	25.1	145.8	48.2	47.2	117.1	-	-	395.2
Average:	-	-	-	13.9	3.0	13.7	162.0	35.7	108.3	129.5	-	1.1	466.2

Note: Normal rainfall is 520.0 mm Source: Office of Dy. Director of Agril., Bijapur.

APPENDIX - X ITEMWISE IMPLEMENTATION OF IWMT IN BELLARY DIST.

IWMT site	Land survey	Slope	Grass waterway	Year and crop	Cropping system	Variety	BBF	Dry sowing	Fertilizer	Weeding interculture	Plant protection	Yield kg/ha
Nichapur (Harapanahalli) 17.6 ha	✓		x	Greengram (84/85 K) Sorghum (84/85 R)	Sequence	Puna Bainaki CHS-5	✓	✓	✓	✓	✓	NA
	✓		x	Sorghum/ P.Pea (84/85 K/R)	Inter-cropping	CHS-5 PT-2-21	✓	✓	✓	✓	✓	NA
	✓		x	Sorghum/ P.Pea (84/85 K/R)	Inter-cropping	CHS-5 PT-2-21						
				Safflower (84/85 R)	Sequence	A-300	✓	✓	✓	✓	✓	NA
	✓		x	Chilli/ Onion (84/85 K)	Inter-cropping &	Byadagi Local						
				Sorghum-Havane (84/85 R)	Sequence	Jaydhar	✓	✓	✓	✓	✓	NA
Bagewadi (Siruguppa) 8 ha	✓		✓	P.Pea/ P.Millet (84 K/R)	Inter-cropping		✓	x	✓	✓	✓	NA 100
				Safflower (84/85 R)	Sequence		✓	x	✓	✓	✓	550
				Sunflower (84/85 R)	Sequence	Morden	✓	x	✓	✓	✓	500
				Safflower/ Corriander (84/85 R)	Inter-cropping		✓	x	✓	✓	✓	NA NA
Siruguppa (Siruguppa) 6.4 ha	✓		X	Safflower/ Bengalgram	Inter-cropping	A-300 A-1	✓	X	✓	✓	✓	550 300
	✓		X	Sunflower	Seq.	BSH-1	✓	X	✓	✓	✓	NA
	✓		X	Safflower/ Corriander (84/85 R)	Inter-cropping	A-300 Local	✓	X	✓	✓	✓	NA NA

APPENDIX - Xa ITEMWISE IMPLEMENTATION OF IWMT IN BIDAR DIST.

IWMT site	Land survey	Slope	Grass waterway	Year and crop	Cropping system	Variety	BBF	Dry sowing	Fertiliser	Weeding interculture	Plant protection	Yield kg/ha
Kotgial (Aurad)	/		X	P.Pea Sorghum	Inter-cropping	Local CMS-1	/	/	DAP 200	/	3 sprays	800
Nhalki (Bhalki)	/		X	Sunflower	Seq.	Morden	/	/	DAP 150	/	1 dusting	1360
Dubelgundi (Humnabad)	/		X	P.Pea/ Sorghum	Inter-cropping	CS-1	/	/	/	/	/	1560
Mulegaon (Bidar)	/		X	P.Pea/ Sorghum	Inter-cropping		/	/	Suphala 100 Urea 50	/	3 sprayings	1000 900

APPENDIX - 76 ITEMWISE IMPLEMENTATION OF IWMT IN BIJAPUR DIST.

IWMT site	land survey	Slope	Grass waterway	Year and crop	Cropping system	Variety	BBF	Dry sow-ing	Ferti-liser	Weeding inter-culture	Plant prot-ection	Yield kg/ha
Sindgi (Sindgi)	/	0.4	X	Safflower (84/85 R)	Seq.	A-1	/	X	DAP 75 Urea 25 S. Phos-phate 25	/	1 dust-ing 1 spray-ing	1000
Devalgi (Indibhavi)		0.3 0.4	Y	Sorghum (R)-Seq. Safflower Cotton (84/85 R)		M-35-1 A-1 Suyodhar	/	X	/	/	/	NA NA NA

APPENDIX - Xc IMPLEMENTATION OF IWMT IN DHARWAD DIST.

IWMT site	Land survey	Slope	Grass waterway	Year and crop	Cropping system	Variety	BBF	Dry sow-ing	Ferti-liser	Weeding inter-culture	Plant prot-ection	Yield kg/ha
Garag (Dharwad)	/	0.4-0.8	X	Groundnut-Wheat	Seq.		/	X	DAP 100	/	/	750 NA
	/		X	Sorghum/ P Pea	Inter-cropping		/	X	DAP 100	/	/	NA
	/		X	Sorghum/ Soybean (K)	Inter-cropping							
				Cowpea/ Sorghum (K)	Seq.		/	X	/	/	/	1300 NA
	/		X	Greengram-Cotton	Seq.	China Mung	/	X	/	/	/	1200 NA
Gabbur (Hubli)	/		X	Groundnut		GL-29	/	X	/	/	X	1560
			X	Safflower			/	X	/	/	/	NA
			X	Cowpea			/	X	/	/	/	NA
			X	Sorghum			/	X	/	/	/	NA
Somanhalli (Hirekerur)	/	0.4	X	Groundnut-Sorghum Safflower	Seq.		/	X	/	/	/	1100

APPENDIX - X4 ITEMWISE IMPLEMENTATION OF IVMT IN GULBARGA DIST.

IVMT site	Land survey	Slope	Grass waterway	Year and crop	Cropping system	Variety	BBF	Dry sowing	Fertiliser	Weeding interculture	Plant protection	Yield kg/ha
Karnagi (Yadgir)	/	0.4-0.6	X	P.Pea/ Groundnut	Inter cropping	GS-1 S206	/	X	DAP 62.5 kg	Weeding only	3 times spray	NA
Ourmitkal (Yadgir)	/	0.4	X	P.Pea/ Blackgram	Inter-cropping	GS-1 local	/	X		"	1 dusting 2 spray-ings	NA Failed
Patten (Gulbarga)	/		X	P.Pea	Seq.	GS-1	/	X	DAP 100-120	/	1 dusting 3 spray-ings	800-1000
Aland (Aland)	/		X	P.Pea/ Greengram	Inter-cropping	PT-2-21 China Mung	/	/	DAP 75	/	1 dusting 3 spray-ings	800-1000
Madagunaki (Aland)	/	0.4-0.9	X	P.pea	Seq.	PT-2-21	/	/	DAP 90	/	1 dusting 3 spray-ings	600
Parhatabad (Gulberga)	/		X	P.Pea	Seq.	GS-1	/	X /	DAP 95	/	3 spray-ings	NA