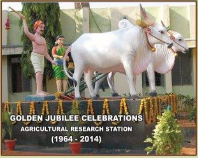

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ACHIEVEMENTS OF SOIL RESEARCH IN DRYLAND REGIONS OF ANDHRA PRADESH

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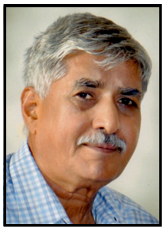

FOREWORD

The world population is expected to double within next three to four decades and rainfed agriculture is going to play a pivotal role in the years ahead. The agricultural growth in dryland is determined by the bio-physical and socio-economic factors and their interactions. Rainfed agriculture is diverse and risk prone mainly depending on rainfall. Location specific technologies are essential to attain sustainability in agriculture in these areas while the management of soil fertility and soil health is the key for the development of sustainable agriculture.

The All India Co-ordinated Research Project for Dryland Agriculture (AICRPDA) main centre, Ananthapuram was started in 1971 and has carried out commendable research work on dryland agriculture for the past four decades. This project has been carrying out location specific adaptive research on Long-term Integrated Nutrient Management and soil health management besides rain water management, soil and water conservation, crops and cropping systems, crop improvement, energy management, and alternate land use systems. This publication contains the essence of important technologies developed for profitable and sustainable rain fed farming including soil test based fertilizer application, recycling of organic wastes, balanced nutrition, micronutrient management, bio fertilizers, soil quality and soil health enhancement through integrated nutrient management, insitu and ex situ water conservation methods approach *etc.*

Focusing attention on soil fertility in relation to sustainable agriculture is the need of the day. I compliment all the scientists involved in bringing out this publication entitled *"Achievements of Soil Research in Dryland Regions of Andhra Pradesh"*. I am sure that this publication would form a valuable source of scientific information for scientists, extension workers, stake holders/farmers and all other engaged in practicing dryland agriculture to improve productivity in rainfed farming and enhance the livelihood security of farming community in the country.

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डॉ. सीएच. श्रीनिवास राव
निदेशक
Dr. CH. SRINIVASA RAO, FNAAS, FISSS
DIRECTOR

PREFACE

Rainfed farming is practiced on 80 M ha in India covering a wide range of soils and occupies a prominent place in rural livelihoods of Andhra Pradesh. Drought stress, uncertain and variable rainfall, low soil quality and emerging nutrient deficiencies are among principal constraints for enhancing and sustaining crop productivity in rainfed farming. Achieving food security for a rapidly expanding population would necessitate intensifying food production on existing crop lands through balanced nutrient supply input and organic matter recycling. With escalating costs of chemical fertilizers, such organic materials are a viable alternative source of plant nutrients for resource poor farmers.

Rainfed areas have diverse farming systems, different potential and constraints, which can only be addressed through development and application of location specific technologies. Both Agricultural Research Station, Anantapuram and the All India Coordinated Research Project for Dryland Agriculture (AICRPDA) jointly carried out location specific, adaptive soil research for four decades which resulted in development of improved technologies in the areas of rainfed cropping systems, soil and rain water conservation, integrated nutrient management, drought management, soil health, recycling of crop residues and so on. Some of these technologies have already formed a part of the packages of practices.

I compliment Dr. M.Vijay Sankar Babu and all the contributing scientists for their effort in compiling the publication entitled *"Achievements of Soil Research in Dry land Regions of Andhra Pradesh"*. I hope this publication will be quite useful to a wide spectrum of stakeholders like technical and administrative personnel of Central and State ministries dealing with dryland farming, extension officers, NGOs, farmers and research workers. The direct and indirect contributions from all those including farmers involved in developing, testing, demonstrations and popularizing these technologies are duly acknowledged.

(Ch.Srinivasa Rao) 14/11/14

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MESSAGE

Dryland agriculture occupies a prominent role in rural livelihoods mainly in scare rainfall and southern agro climatic zones in Andhra Pradesh. Efficient methods of soil and water conservation and soil fertility management become important areas of dryland agriculture research to achieve sustainability.

Since 1971, All India Co-ordination Research Project for Dryland Agriculture, Ananthapuram main centre has generated good number of technologies in the areas of soil health and nutrient management. These technologies have been demonstrated on the farmers' fields with their participation under the Operational Research Project for Dryland Agriculture and National Initiative on Climate Resilient Agriculture.

This book entitled *"Achievements of Soil Research in Dryland Regions of Andhra Pradesh"* includes research results of AICRPDA for the past forty years. I appreciate the sincere efforts of all the scientists who contributed for the development of technologies and congratulate them for bringing out the publication. I am confident the achievements made by AICRPDA, ARS, Ananthapuram will be useful for scientists, extension workers, farmers and all other engaged in the development of dryland agriculture.

I wish them all success in future research and development endeavor.

K. Raja Reddy

(K. RAJA REDDY)

Acknowledgements

All India Co-ordinated Research Project for Dryland Agriculture, Ananthapuram centre came into existence during 1971 under the joint auspicious of ICAR and Canadian International Development Agency (CIDA) to meet the Dryland research needs of the *Alfisols* regions of scare rainfall zone of Andhra Pradesh in particular and the country in general. During 1970, the approach has been sectorial, which gave way to system approach in 1980's to solve the location specific problems. Further, long-term experiments in major production systems including rain water management, integrated nutrient management, Water productive crops, energy management, cropping system, alternate land use system have been the key area of research for sustainable dryland agriculture and the findings are validated on large scale plot at farmer's field through Operation Research Project since 1984 and National Initiative on Climate Resilient Agriculture since 2010.

The forty years research efforts of the centre through large number of experiments have resulted in vast research data and number of technologies suited for rainfed *Alfisols* of scare rainfall zone of Andhra Pradesh. The results of research are documented as "Achievements of Soil Research in Dryland Regions of Andhra Pradesh". This book contains the salient findings of both on-station and on-farm results which are critically analyzed and interpreted with appropriate illustrations and data. We hope that this information will be useful and user friendly by a novice to the dryland agriculture and watershed management.

The editors express their profound gratitude to Dr. A. Padma Raju, Honorable Vice Chancellor, Dr. K. Raja Reddy, Director of Research, ANGRAU, Hyderabad and Dr. Y. Padmalatha, Associate Director of Research, Regional Agricultural Research, Nandyal for their encouragement, valuable guidance, professional and administrative support in bringing out this publication. Team is equally grateful to Dr. Ch. Srinivasa Rao, Project Co-ordinator & Director, G. Ravindra Chari, Principal Scientist, AICRP for Dryland Agriculture & team at CRIDA, Hyderabad and Dr. T. Yellamanda Reddy, Former Dean of Agriculture, ANGRAU, Hyderabad for their valuable suggestions which helped this publication to see the light of the day.

It is with deep sense of appreciation and gratitude we acknowledge the co-operation and support received directly or indirectly from the former Chief Scientists, Scientists, Research Associates and Supporting staff of AICRP Dryland Agriculture both main and ORP centres for their help in the preparation of this book.

Editors

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The global rainfed crop lands were estimated at 1.132 billion hectares at the end of the last millennium. This is 2.78 times the net irrigated areas (407 m ha) of the world. Rainfed agro-ecosystems occupy a considerable place in Indian agriculture too, covering 80 million ha, in arid, semi-arid and sub-humid climatic zones; constituting nearly 58% of the net cultivated area. Rainfed regions support 60% of livestock, 40% of human population and contribute 40% of food grains and several special attribute commodities. Rainfed agro ecologies are complex, diverse, fragile, risky, under invested and require regionally differentiated investments and management strategies. Achieving high production potential is difficult in these rainfed areas due to vagaries of rainfall.

1. Salient features of Agro eco system

Scarce rainfall zone comprises Anantapuram and Kurnool districts of Andhra Pradesh where average annual rainfall is very low coupled with low soil moisture storage capacity thus resulting in short crop growth period. The districts representing the scarce rainfall zone is shown in Fig.1

1.1 Establishment of the AICRP for Dryland Agriculture centre

The Agricultural Research Station, Anantapuram, one of the research stations of Acharya N.G. Ranga Agricultural University was originally started as "Soil Conservation Research Centre" during the year 1964 at Rekulakunta village, Bukkarayasamudram mandal of Anantapuram district. Indian Council of Agricultural Research has sanctioned All India Coordinated Research Project for Dryland Agriculture (AICRPDA) on 29^{th} September, 1971, to carry out multi disciplinary research work on all aspects of dryland farming to cater the needs of dryland farmers in the red soil areas of Rayalaseema region of Andhra Pradesh.

1.2 Brief details of the Agro-climatic Zone

All India Coordinated Research Project for Dryland Agriculture is situated in Rekulakunta village at 12 km away from Anantapuram 14° - 41' N latitude, 77° - 40' E longitude at an altitude of 350 m above MSL. Considering the infrastructural facilities available, Indian Council of Agricultural Research has sanctioned All India Coordinated Research Project for Dryland Agriculture on 29^{th} September, 1971, to carry out multi disciplinary research work on all aspects of dryland farming to cater to the needs of the dryland farmers in the red soil areas of Rayalaseema region. Anantapur district is situated in scarce rainfall zone of Andhra Pradesh and receives annual precipitation of 567 mm.

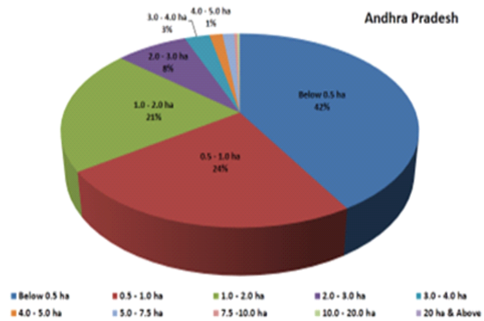
Fig.1 Districts representing scarce rainfall zone of Andhra Pradesh

1.2.1 Land holding size and operational holdings in Anantapur and Kurnool Districts

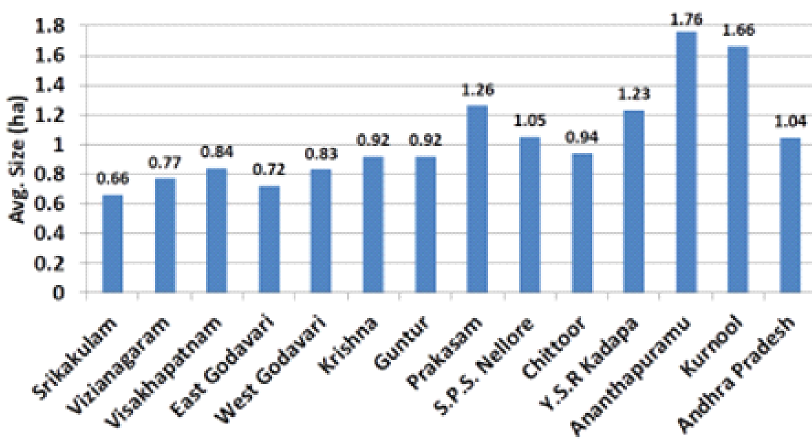
Table. 1 : Land holding size and operational holdings in Anantapur and Kurnool Districts

Category and Operational holding size	Anantapuram		Kurnool	
	No.	Area (ha)	No.	Area (ha)
Marginal (< 1 ha)	226564	126996	222336	125412
Small (1.0 to 2.0ha)	208267	305604	157681	225044
Semi medium (2.0 to 4.0 ha)	161888	411234	112333	304379
Medium (4.0 to 10 ha)	53083	307068	52275	302411
Large (10 and above)	7813	118785	7012	101371
Total	657615	1269688	551637	1058618

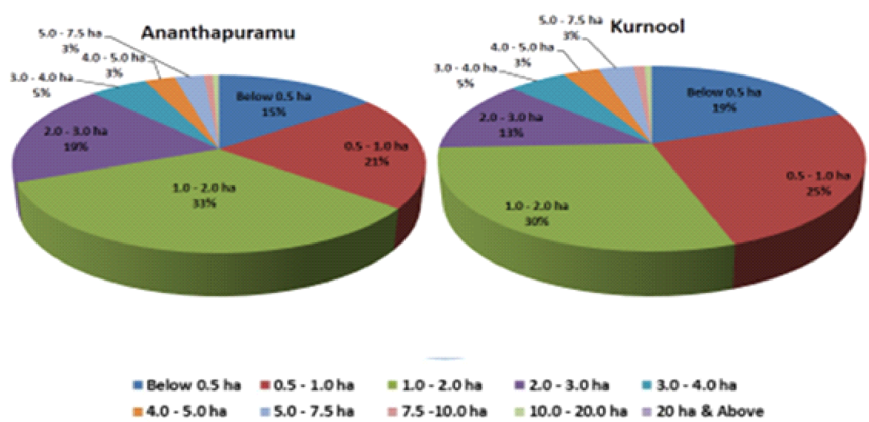
Source: Hand Book of Statistics – Anantapuram district, 2011
Hand Book of Statistics – Kurnool district, 2011



Graph.1 : Number of land holdings in Andhra Pradesh



Graph.2 : Size of land holdings in Andhra Pradesh



Graph.3 : Size of land holdings in Anantapur and Kurnool districts

The average land holding size in Anantapuram and Kurnool districts of scarce rainfall zone is higher than any other districts of Andhra Pradesh.

1.2.2 Soils of scarce rainfall zone of Andhra Pradesh

The soils of Anantapuram district are shallow in depth (10 – 15 cm), neutral in reaction, low in organic matter, medium to high in available phosphorus and available potassium contents. These soils are mostly granite genesis and coarse grained granites.In this district, red soils constitute 78% (13.16 lakh ha) of the area while black soils are predominant in 20% and other soils are in 2% area. The soils can be classified as sandy loams (31%), clay (24%) loamy sands (14%), sandy clay loams (13%) and rocky lands (12%) in texture.The topography is undulating and water storage capacity of these soils is only 40 mm/30 cm rooting depth.

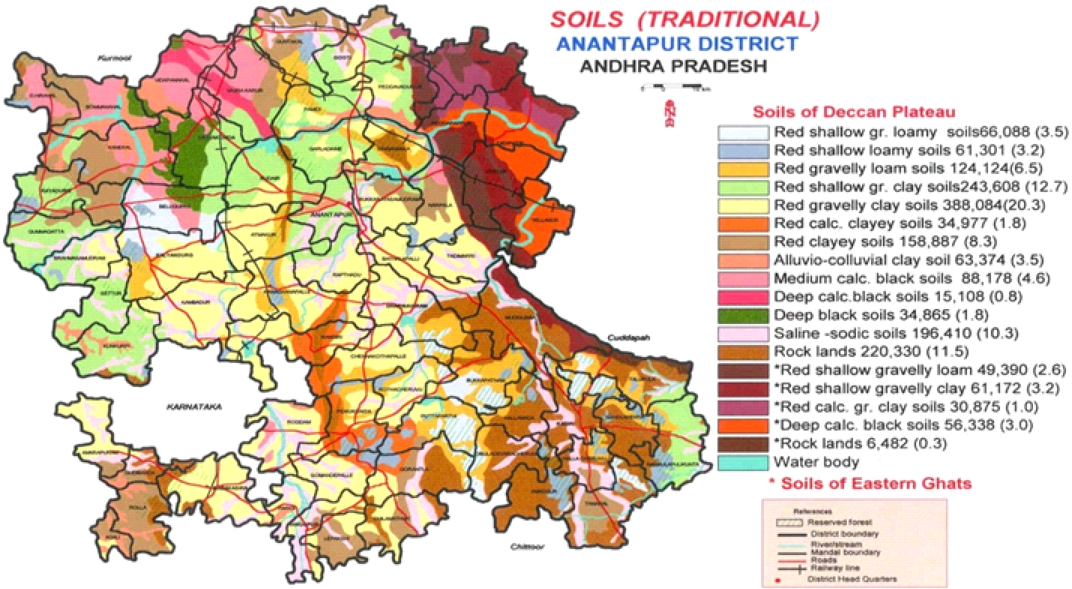


Fig: 2 Soil map (Traditional) Anantapuram district of Scarce rainfall zone

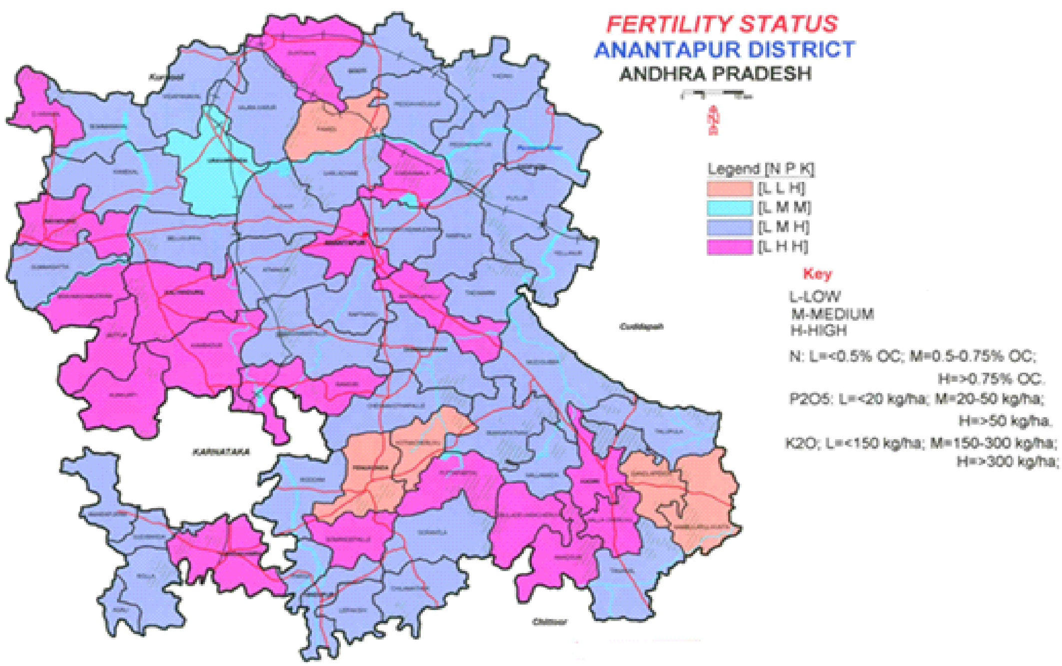
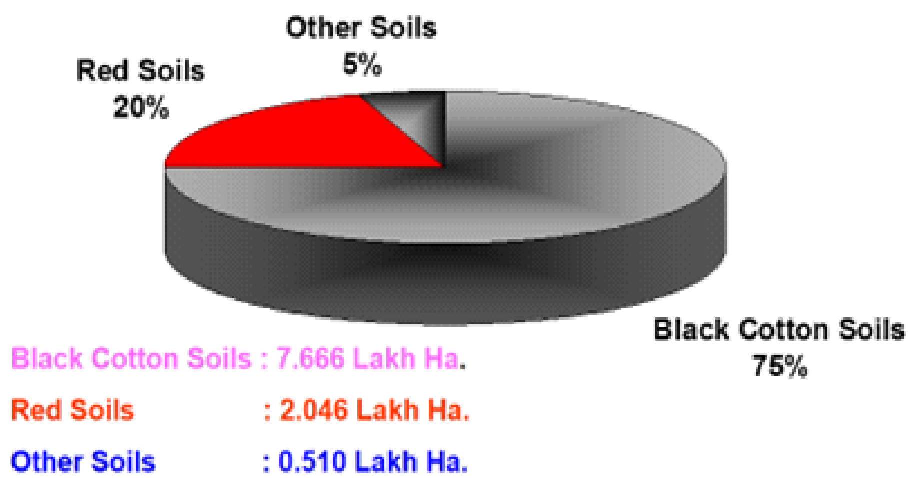


Fig. 3 : Soil Fertility map of Anantapuram district

The soils in Kurnool district are predominantly black cotton soils (75%) followed by red soils (20%) and remaining (5%) are others. The depth of soils varies from shallow (25-50 cm.) to very deep (>150 cm). Textural class of soils found in the District are 1) Loamy Sand 2) Sandy Loam 3) Sandy Clay Loam 4) Clay Loam 5) Silty Clay Loam 6) Silty Clay and 7) Clay. The available water capacity of the soils varies from very low (< 50 mm / meter of soil) to very high (> 200 mm / meter of soil.) The NPK status of the soils in the District is Low — Low – High except Yemmiganur (Low – Medium - High) & Pathikonda, Dornipadu, Gospadu, Rudravaram, Chagalamarri and Bandi Atmakur mandals (Low – Low – Medium).



Graph 4 : Soil types in Kurnool district of Scarce Rainfall zone

1.2.3 Crops and cropping systems

During *kharif*, normally, a single crop of sole groundnut or intercropped with redgram in proportions varying between 7 – 20 rows of the base crop is grown in an area of 7 – 8 lakh hectares in Anantapuram district. Other important crops are pearl millet, sorghum, setaria, pigeonpea and horsegram. In black soils, besides groundnut, crops like setaria, sorghum, bengalgram, coriander, safflower and sunflower are also cultivated. In irrigated areas, in black cotton soils, cotton and sunflower are also being cultivated.

Table 2 : Farming situations in Anantapuram district

S.No.	Name of the farming situation	Area (000'ha)
1.	Canal irrigated black soils	15.047
2.	Canal irrigated red soils	11.692
3.	Tank irrigated black soils	4.056
4.	Tank irrigated red soils	4.332
5.	Well irrigated black soils	18.153
6.	Well irrigated red soils	57.406
7.	Rain fed black soils	92.333
8.	Rainfed red soils	628.581
9.	Problematic soils	0.190

Table 3 Farming situations in Kurnool district

Farming Situation No.	Discription	Area 000'ha
1	KC Cannal-Red Soils	1.12
2	TBP-LLCRed Soils	7.66
3	TBP-HLCRed Soils	0.27
4	K.C Canal-Black soils	47.8
5	TBP-LLC Black soils	17.9
6	TBP-HLC Black soils	5.59
7	Problamatic soils	0.10
8	Tank Irrigation-Red Soils	6.21
9	Tank Irrigation-Black soils	12.44
10	Well Irrigation-Red soils	45.73
11	Well Irrigation-Black soils	46.98
12	Rain fed-red soils	253.75
13	Rainfed-Black soils	430.56
14	SRBC-Red soils	3.30.33
15	SRBC-Black soils	12.91
16	TGP-Red soils	1.4
17	TGP-Black soils	9.6

Table:4 Natural vegetation (Including area under horticulture)

Parameter	Kurnool	Anantapuram	Andhra Pradesh
Total geographical area (lakh ha)	17.658	19.13	275.045
Forest area (lakh ha)	3.407	1.97	62.104
Permanent pastures and other grazing lands (lakh ha)	0.036	0.089	5.69

Source: Hand Book of Statistics – Anantapur district, 2011
Hand Book of Statistics – Kurnool district, 2011

Table:5 Area of different horticulture crops in Kurnool and Anantapuram districts

Crop	Area in ha		
	Kurnool	Anantapur	Andhra Pradesh
Mango	12275	18794	475304
Banana	5765	5261	89802
Sweet orange	4450	50059	202050
Pomegranate	0	3663	6020
Papaya	300	7011	20045
Sapota	472	3951	12790
Muskmelon	—	6000	—
Grapes	0	350	1529
Acidlime	1088	14181	48778

Source: Hand Book of Statistics – Anantapur district, 2011
Hand Book of Statistics – Kurnool district, 2011

Table: 6 Cultivable area statistics in Andhra Pradesh (in lakh ha.)

S. No	District	Net sown area	Net irrigated area	Rainfed area	% Rainfed area
1	Srikakulam	3.21	1.80	1.41	44.08
2	Vizianagaram	3.01	1.30	1.71	56.94
3	Vishakhapatnam	3.08	0.85	2.23	72.41
4	East Godavari	4.32	2.70	1.62	37.55
5	West Godavari	4.75	3.60	1.15	24.22
6	Krishna	5.18	3.10	2.08	40.23
7	Guntur	6.16	3.80	2.36	38. 40
8	Prakasam	6.34	2.10	4.24	66.92
9	S.P.S.R.Nellore	3.45	2.55	0.90	26.17
10	Y.S.R.Kadapa	4.07	1.55	2.52	61.93
11	Chittoor	3.90	1.47	2.43	62.35
12	Kurnool	8.89	2.08	6.81	76.60
13	Anantapuram	10.83	1.18	9.65	89.11

Source: Agricultural Action Plan, Department of Agriculture – Anantapuram, 2010-11

Maximum area (89.11%) under rainfed farming is in Anantapuram district followed by Kurnool district (76.6%).

Table :7 Rainfed area and major rainfed crops in different agroclimatic zones of Andhra Pradesh

Name of the Agro climatic zone	Cultivable Area (Lakh ha)		Major rainfed crop (s)	Districts
	Total	Rainfed		
North Coastal Zone	11.94	5.30	Jowar, Bajra, Ragi, Mesta, Redgram, Horsegram, Sesame and Groundnut.	Srikakulam, Vijayanagaram and Vishakhapatnam
Godavari Zone	5.50	0.50	Blackgram, Groundnut and Redgram	East Godavari and West Godavari
Krishna Zone	25.00	15.00	Blackgram, Cotton, Chickpea, Greengram and Redgram	Krishna, Guntur and Prakasam
Southern Zone	11.20	7.84	Groundnut, Blackgram and Castor	Nellore, Chittoor and Kadapa
Scarce Rainfall Zone	28.73	19.10	Groundnut, Chickpea, Sorghum, Redgram and Cotton	Anantapur and Kurnool
High Altitude & Tribal Zone	3.46	2.52	Finger millet, Foxtail millet and Pigeonpea belts of	Hilly areas /Tribal E.Godavari, Vishakhapatnam, Vijayanagaram and Srikakulam

Source: Agricultural Action Plan, Department of Agriculture – Anantapuram , 2010-11

Among the different crops, groundnut is growing in majority of agro climatic zones of Andhra Pradesh.

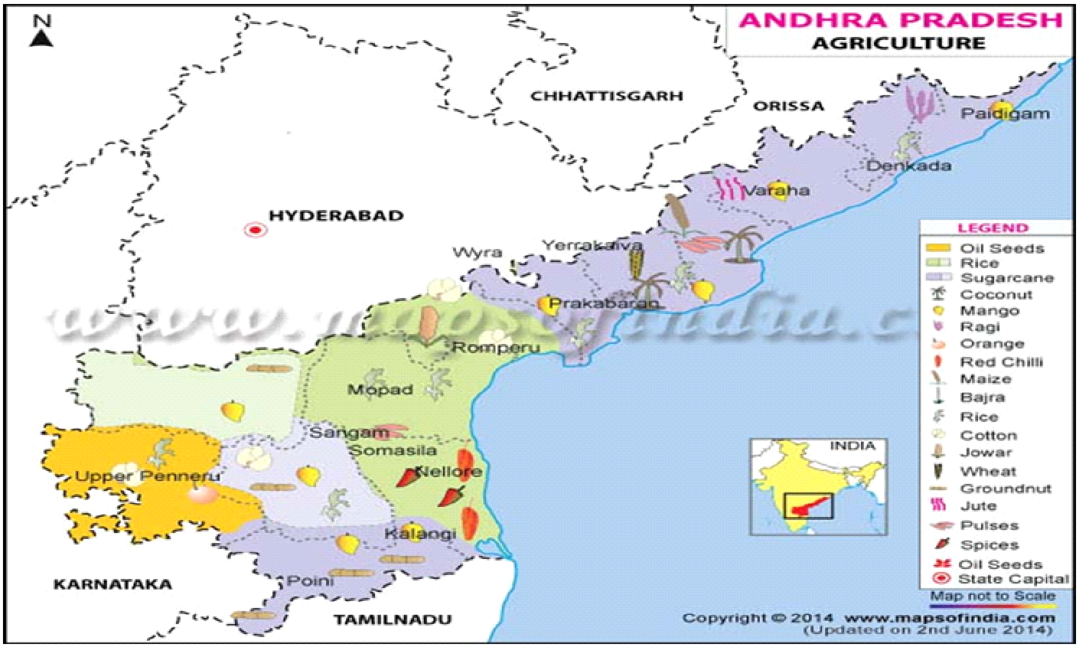


Fig. 4. Agricultural crops of Andhra Pradesh

The following are the agro climatic zones in Andhra Pradesh where dryland farming is predominant.

1. Scarce Rainfall zone
2. Southern Zone

2. Climate

2.1 Rainfall

Anantapuram is the rain shadow area of Andhra Pradesh with an average rainfall of 546mm. The normal rainfall for the South West monsoon period is 338mm which forms about 61.2% of the total rainfall for the year. The rainfall for North East monsoon period is 156mm, which forms 28.3% of annual rainfall (October to December). The remaining months of March, April and May are warm and dry. The normal daily maximum temperature ranges between 29°C and 42°C. The November, December and January are cooler months with minimum temperature around 17.2°C.The aridity index is-73.8, with an average 5runoff events per annum and PET is 2140 mm.

Kurnool district falls under scarce rainfall zone (VI) with rainfall ranging from 500 mm. to 750 mm. The Normal rainfall is 670 mm. Nearly 120% of rainfall is being received from South West Monsoon and 95% is received during North East Monsoon period. The most critical or potent among the various risks an average farmer faces during the farming season is the weather, more precisely, the amount of rainfall and its distribution over the crop cycle as the rainfall is mostly erratic, insufficient and unevenly distributed. Hence, drought or floods is a common phenomenon.

Table : 8 Variability in rainfall during the crop period in Anantapur district of Andhra Pradesh

Year	Rainfall during crop period (mm)	No. of rainy days	Onset of monsoon	Cessation of monsoon
2000	329.0	24	1st July	4th December
2001	659.6	33	3rd August	19th September
2002	303.2	23	4th August	10th November
2003	247.4	22	1st August	24th October
2004	327.8	20	14th July	27th October
2005	537.6	**38**	18th July	4th December
2006	239.6	21	**11th August**	18th November
2007	911.4	34	6th June	30th October
2008	444.8	33	6th June	29th November
2009	270.6	24	**Ist June**	29th October
2010	489.0	37	4 th June	10 th December
2011	317.7	20	1 st June	27th October
2012	331.2	24	16th Juje	18th October
2013	320.4	**14**	3rd June	19th October

Source: Agroclimatic Atlas of Andhra Pradesh, 2013

The normal onset of the monsoon is around June and could be delayed even upto end of August. The number of rainy days varies a minimum of 14 to a maximum of 38 days per anum. The onset of monsoon is highly varied starting right from 1st June to as late as 11th August. There is high coefficient of variation for the onset of monsoon which is typical of the district and is the major cause of uncertainty in farming.

Table: 9. Average monthly rainfall in Anantapuram and Kurnool districts of Andhra Pradesh.

Months	Average rainfall (mm)		Mean
	Anantapuram	Kurnool	
Jan	1	2	1.5
Feb	2	2	2
Mar	7	7	7
Apr	13	16	14.5
May	47	41	44
Jun	55	83	69
Jul	60	102	81
Aug	80	126	103
Sep	127	135	131
Oct	109	116	112.5
Nov	38	27	32.5
Dec	7	5	6

Source: Agroclimatic Atlas of Andhra Pradesh, 2013

September is the wettest month in both Anantapuram and Kurnool district of scarce rainfall zone of Andhra Pradesh (Table 9).

Table:10. Mean monthly distribution of rainy days (1971 to 2011) in Anantapuram and Kurnool districts of Andhra Pradesh.

Months	Average rainfall (mm)	
	Anantapuram	Kurnool
Jan	0	0
Feb	0	0
Mar	0	0
Apr	1	1
May	3	3
Jun	3	5
Jul	4	7
Aug	5	8
Sep	6	7
Oct	6	6
Nov	3	2
Dec	0	0

Source: Agroclimatic Atlas of Andhra Pradesh, 2013

Table:11 Mean annual and seasonal rainfall (mm) in Anantapuram and Kurnool districts of Andhra Pradesh.

Rainfall	Anantapuram	Kurnool	Mean
Annual	546	661	603.5
Southwest Monsoon	322	446	384
Northeast	154	147	150.5
Summer	68	63	65.5
Winter	3	4	3.5

Source: Agroclimatic Atlas of Andhra Pradesh, 2013

Table:12 Mean annual and seasonal rainy days in Anantapuram and Kurnool districts of Andhra Pradesh.

Rainy days	Anantapuram	Kurnool	Mean
Annual	32	38	35
Southwest Monsoon	18	26	22
Northeast	9	8	8.5
Summer	4	4	4
Winter	0	0	0

Source: Agroclimatic Atlas of Andhra Pradesh, 2013

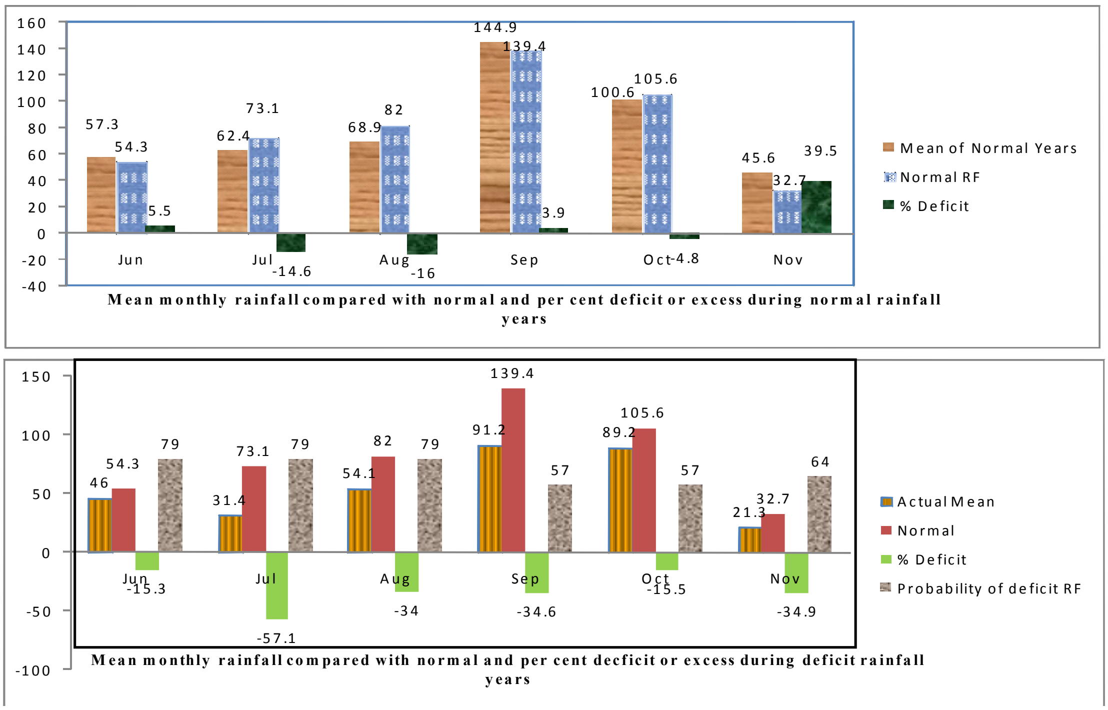
Table:13 Excess rainfall events (Rainfall > 100 mm) of Anantapuram District.

Year	Season	Date	Rainfall (mm)
1967	Northeast monsoon	10/3/1967	124
1974	Southwest monsoon	9/27/1974	130.2
1978	Southwest monsoon	9/27/1978	119
1987	Southwest monsoon	9/21/1987	102.8
1988	Southwest monsoon	8/29/1988	118.6
1989	Southwest monsoon	7/16/1989	120.8
1989	Southwest monsoon	7/17/1989	180
1995	Southwest monsoon	7/28/1995	146.4
1996	Southwest monsoon	6/9/1996	121.6
1998	Southwest monsoon	8/3/1998	128.4
1998	Southwest monsoon	8/20/1998	115.2
2007	Southwest monsoon	8/25/2007	110
2010	Southwest monsoon	7/11/2010	121.4

Source: Agroclimatic Atlas of Andhra Pradesh, 2013

Monthly rainfall pattern under normal and deficit years

Annual rainfall for 43 years was made into two homogeneous groups of normal rainfall years and deficit rainfall years to assess the monthly rainfall pattern during crop growth period. The graph indicates that during normal rainfall years all the months received normal rainfall (Fig.)



Graph 5 : Mean monthly rainfall compared with normal and percent deficit or excess during normal and deficit years

Length of Growing Period (LGP) During Normal, Excess and Deficit rainfall years

Length of growing period during normal and excessive rainfall years ranged from 16 to 17weeks with rainfall of 438 mm and 640 mm, respectively and LGP starts from 29th SMW and ends in 44th or 45th SMW. Duration of the crop season and amount of rainfall during normal and excess rainfall years was sufficient for taking up groundnut crop. During deficit rainfall years, crop growing period starts in 31 SMW and ends in 44 SMW with total duration of 14 weeks with the rainfall of 251mm which is not sufficient for groundnut crop. Hence, short duration, low water required contingent crops needed to be grown during deficit rainfall years.

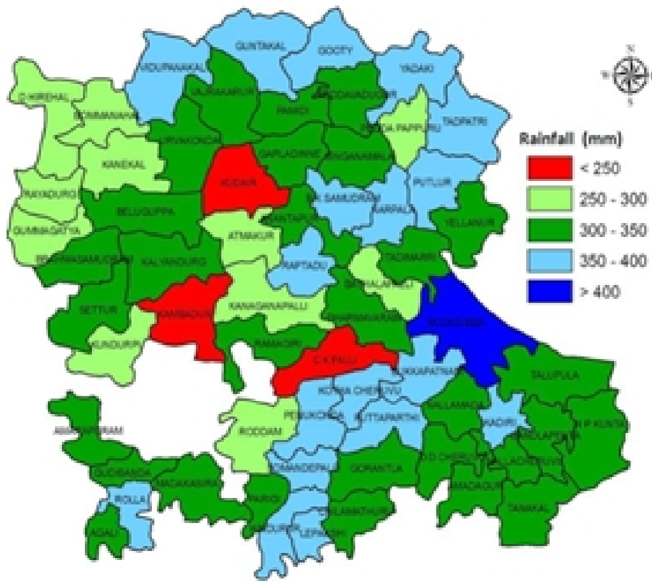


Fig. 5 : Mean rainfall during South-West monsoon period across various mandals of Anantapuram district

The length of growing period is variable across mandals spanning from less than 70 to 120 days.

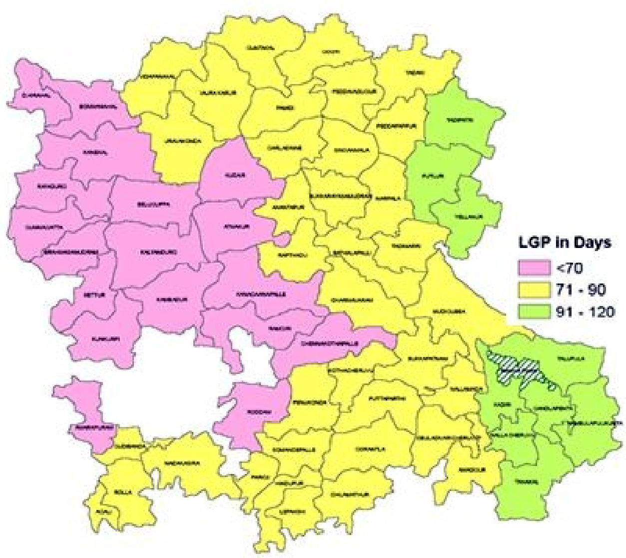


Fig. 6 : Length of growing period of Annatapuram district

Table : 14 Length of growing period during normal, excess and deficit rainfall years

Category of Rainfall during rainy Season	No. of Years	Mean Starting Week	Mean Ending Week	Mean Duration (Weeks)	Mean Rainfall during Crop Season (mm)
Normal	17 (16 – 22 July)	29 (5-11 November)	45	17	438
Excess	12 (16-22 July)	29 (29 Oct - 4 Nov)	44	16	640
Deficit	14	31 (30 July-5 Aug.)	44 (29 Oct - 4 Nov)	14	251

There is high spatial variability in annual rainfall in the district. While Kudair, Kambadur and C.K.Palli receive < 250mm mean rainfall during the South-West monsoon period, only Mudigubba mandal gets > 400mm rainfall.All other mandals receive between 250-400 mm rainfall during SW monsoon.

In nine mandals, namely Tadipatri, Yellanur, Putlur, Kadiri, Gandlapenta, Nallacheruvu, Tanakal, N.P.Kuntaand Talupula the LGP was maximum ranging from 90-120days. In 17 mandals viz. D.Hirehal, Bommanahal, Kanekal, Rayadurg, Beluguppa, Kudair, Atmakur, Kalyandurg, Gummagatta, Brahma sumudram, Settur, Kankurpi, Kanagalipalli, Ramagiri, C.K.Palle, Roddamand, Amarapuram have the LGP is lowest (< 70 days).The majority of the central region of the district comprising 37 mandals has an LGP of 70-90 days.

3. Salient Achievements

3.1 Rain water management and In situ moisture conservation

Rain water is dessipated as runoff, evaporation, transpiration and deep percolation. Research efforts are made to reduce these losses and techniques were developed to harvest runoff for efficient use for crop production. Soil and water conservation is important to maintain soil fertility and plant available soil water especially in dryland agriculture. Soil conservation practices like mulching, percolation pits found beneficial in harnessing the rain water effectively.

Effect of Mulching

Effect of bajra straw mulch on yield of pearl millet indicated that mulching increased the grain yield. Mulching reduced the weed population and conserved more moisture. Soil mulch (3-5 cm thick) along with bajra straw mulch (5 t ha^{-1}) significantly increased the grain yield as compared to no mulch. However, pearl millet straw mulch was not superior to soil mulch. Soil mulch can easily be developed in large areas with bullock drawn blade harrow. Nonetheless, the moisture use efficiency and hydraulic conductivity rates were increased in pearl millet straw mulch as against soil mulch (Table 15).

Table :15 Bajra yields as influenced by mulching

Treatments	Grain yield (Kg ha^{-1})				
	1971-72	1972-73	1973-74	1974-75	Mean
No mulch	1135	632	190	866	706
Soil mulch	-	-	340	1740	1040
Bajra straw mulch	1277	351	370	1412	853
S.Em$\pm$	53.5	-	17.7	720	-
C.D (0.05)	NS	-	54.0	223.0	-

Annual Report, ARS, Anantapuram, 1975

Reducing runoff

Research to stabilize the crop yields in drought years and to normal years was in progress at Agricultural Research Station since 1965. Quantification of soil and water losses was carried out for red soils of scarce rainfall area having 2-3% slope. On an average, five runoff incidents occurred in a year (three in September, one in July and one in October) and four tons of soil was lost per hectare per annum. These losses were severe when setaria was sown along the slope (Table 16) and low when groundnut was cultivated across the slope.

Table :16 Soil and water losses under different management practices

Treatment	Water loss (run off) (%)	Soil loss (t/ha)	Grain/pod yield (kg/ha)	Straw/haulm yield(kg/ha)
T_1 – Groundnut along the slope	12.1	4.1	890	1190
T_2 – Groundnut across the slope	10.4	2.4	950	1430
T_3 – Setaria along the slope	26.3	4.4	260	960
T_4 – Setaria across the slope	12.7	3.6	270	1100
Average rainfall during crop season (mm)	411			

Source: Annual Report, ARS,Anantapuram, 1975

Influence of coarse fraction of soil on growth and yield of rainfed groundnut

Pod yield decreased when soil coarse fraction was more than 50%. However, plant height, number of pods/plant and haulm yield was not influenced by soil coarse fraction. Growth and yield of groundnut was reduced when coarse fraction of the soil was more than 25% (Yellamanda Reddy *et.al.,* 2004).

Effect of dikes in *Alfisols* for increasing rain water productivity under groundnut based farming system

Dikes helps to conserve rain water in-situ effectively and thereby improve the available moisture to the crop. However, dikes formed after every 4 and 6 rows with dimensions of 1 m X 0.5 m X0.25 m with or without mulching with groundnut shells and also in paired row, groundnut crop did not increase the pod yield (Table 17).

Table:17 Effect of dikes in A*lfisols* for increasing rain water productivity on pod yileds of groundnut

Treatment	*Kharif* 2009 (kg ha^{-1})	*Kharif* 2009 (kg ha^{-1})	*Kharif* 2009 (kg ha^{-1})	Mean (kg ha^{-1})
Contro l(normal sowing)	288	1948	546	927
4 Rows 1 dike	334	2046	628	1002
6 Rows 1 dike	342	1974	527	947
4 Rows 1 dike with GNS mulching	301	1792	546	879
6 rows 1 dike with GNS mulching	367	2034	556	985
Paired row	757	1448	559	921
Paired row with earthing up	781	1428	539	916
Paired row with GNS mulching	767	1601	463	944
CD (0.05)	58.4	NS	124	NS

Source: AICRPDA Annual Report, ARS, Anantapuram,2011

Rainwater Management

One dike after every 4 rows with groundnut shell mulch

Paired row (20&40x10 cm) with groundnut shell mulch

Plate 1. Dikes and paired rows in *alfisols* for increasing rainwater productivity in groundnut

Cluster sowing and sowing geometry of groundnut for higher water use efficiency under rainfed conditions.

Cluster sowing did not influence the pod yields of groundnut (Table.18) significantly viz., 4 seeds sown in cluster with 40 cm intra row distance, 5 seeds with 50 cm and 6 seeds with 60 cm in *kharif* 2009, 2010 and 2011 , indicating that the cluster sowing in groundnut is not advantageous.

Table:18 Effect of cluster sowing and sowing geometry for higher water use efficiency on pod yields of groundnut under rainfed conditions.

Treatment	*Kharif* 2009 (kg ha^{-1})	*Kharif* 2009 (kg ha^{-1})	*Kharif* 2009 (kg ha^{-1})	Mean (kg ha^{-1})
Control (normal sowing)	393	1427	601	807
4 seeds cluster with 40cm	290	1205	609	701
5 seeds cluster with 50cm	318	1281	474	691
6 seeds cluster with 60cm	237	1098	562	632
4 seed cluster + decomposed FYM with 40cm	334	1429	588	784
5 seed cluster + decomposed FYM with 50cm	350	1484	518	783
6 seed cluster + decomposed FYM with 60cm	260	1196	454	637
CD (0.05)	NS	NS	NS	NS

Source: AICRPDA Annual Report, ARS, Anantapuram,2011

Experimental view

4 seed cluster with 40 cm intra row spacing

5 seed cluster with 50 cm intra row spacing

6 seed cluster with 60 cm intra row spacing

Plate 2. Cluster sowing and sowing geometry of groundnut for higher water use efficiency under rainfed conditions.

Water harvesting *insitu*

In order to overcome various drawbacks prevailed in contour bunding system, number of insitu water conservation practices in inter bunded area were tested. The results showed that forming compartmental bunds with 15 m length and 10 m width and forming conservation furrows at 2.4 m interval in pearl millet were found to improve the usefulnes of contour bunds while reducing the negative aspects of the bunds.

Field experiments conducted at Agricultural Research Station, Anantapuram on the effect of *in-situ* moisture conservation methods in inter bunded area on run off and groundnut yields revealed that it could be possible to reduce soil and water losses by adopting insitu conservation practices like conservation furrows at 3.6m interval across the slope (25-30 days after sowing) with the receipt of rains, coupled with compartmental bunding with 20 m length and 10 m width before germination of crop (Table19). The soil moisture availability increased considerably by adopting these practices, which lead to the increased groundnut yields.

Table: 19 Effect of *in-situ* moisture conservation methods on groundnut yields

Treatments	Yield kg ha^{-1}					
	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84
Sowing across the slope (check)	810	565	219	**Drought year**	510	1300
Coservation furrow at 1.8 m interval	—	543	233		509	1360
Conservation furrow at 2.4 m interval	890	—	270		544	1380
conservation furrow at 3.6 m interval	—	597	235		665	1460
Conservation furrow at 4.8 m interval	800	—	—		—	—
S Em±	0.3	—	—		0.35	0.33
CD 0.05	0.8	NS	NS		1.06	0.6

Source: Annual Report, ARS, Anantapuram,1984

When the technology on *in situ* moisture conservation practices was verified over farmers' fields (1995-98), contour cultivation + compartmental bunding resulted in 13% increased yield over farmers' practice of sowing across the slope only (Table 20).

Table : 20 Groundnut pod yield (kg ha^{-1}) as influenced by *in situ* moisture conservation practices

Treatment	1995	1996	1997	1998	Mean
1. Contour cultivation + compartmental bunding	1610	885	439	2143	1269
2. Farmers' practice (sowing across the slope only)	1415	863	188	1940	1102

Source: Annual Report, ARS, Anantapuram,1998

These practices are quite simple, require no input and can be implementable.

Intercropping of groundnut with redgram + Mixed pulses for moisture conservation and higher yields

In Anantapuram district, there is a practice of growing groundnut intercropped with redgram. However, the system does not prevent the runoff losses. By improving the existing intercropping system with the innovative practice of mixing redgram with other pulses or by practicing intercropping with cowpea alone reduced the runoff to a greater extent as this acted as a vegetative barrier. This practice also improved the total returns without involving any additional expenditure. In this direction, the experiments carried were significantly relevant and technologically feasible to the existing climatic conditions and poor economic status of farmer as the developed practice is of low input technology. **This intercropping system has gone as a recommendation from the university.**

Results of the experiments (1996 and 1997) revealed that intercropping of groundnut either with cowpea or mixed pulses (redgram + cowpea + horsegram) in 15 : 1 row ratio not only arrested the runoff, but also increased the total returns by 17.8 and 8.5 per cent respectively over sole crop of groundnut (Table 21). Results of the experiments under AICAR Project (1998 – 2001) also revealed that intercropping of groundnut with mixed pulses reduced the runoff and soil losses, thereby conserving more soil moisture. Groundnut pod was also high with the same system as compared to sole groundnut.

Ninenty percent of the farmers accepted this simple technology. Studies on adoption behaviour of dryland technology revealed that every year, about 1.0 lakh ha out of 8.5 lakh ha of groundnut area is being covered with this technology. It is being adopted by 20% of farmers in Pennar-Manirevu National Watershed area under ORP.

Table:21 Impact of different inter crops with groundnut on runoff and crop yields

Intercrop	Mean Runoff(%)	Pod yield (Kg ha^{-1})		Total Returns (Rs/ha)		% Increase Over control
		1996	1997	1996	1997	
Horsegram	23.4	532	193	11156	5327	0.6
Redgram	61.2	531	210	11067	5655	3.2
Cowpea	0.0	615	270	12683	6425	17.8
Mixed pulses	6.3	588	272	11909	5808	8.5
Pure crop	31.3	559	243	10857	5413	—

Padmalatha *et. al.,* 2001

Table:22 Effect of mulching and *in-situ* Rain Water Harvesting (RWH) through micro catchments on soil water dynamics and yield of groundnut

S.No.	Treatment	Pod Yield (kg ha^{-1})					
		2007 -08	2008 -09	2009- -10	Mean	Mean BC ratio of all products	Mean RWUE (kg/ha-mm)
No Mulch							
M_0T_1	Control	944	1202	662	936	1.85	2.16
M_0T_2	30cm apart 4 lines	949	1176	694	939	1.87	2.18
M_0T_3	30cm apart 6 lines	983	1444	677	1034	2.09	2.39
M_0T_4	45cm apart 4 lines	998	1204	706	969	1.91	2.24
M_0T_5	45cm apart 6 lines	1125	1205	709	1013	2.04	2.31
Mulch							
M_1T_1	Control	1096	1286	587	989	1.99	2.23
M_1T_2	30cm apart 4 lines	1175	1415	724	1104	2.23	2.52
M_1T_3	30cm apart 6 lines	1127	959	724	936	1.86	2.13
M_1T_4	45cm apart 4 lines	1062	1044	742	949	1.88	2.18
M_1T_5	45cm apart 6 lines	1081	1097	655	944	1.84	2.14
	CD (Main)	NS	NS	NS	NS	—	—
	CD (Sub)	NS	NS	NS	NS	—	—
	CD(M x S)	NS	306.5	NS	NS	—	—

Source: AICRPDA annual report, ARS, Anantapuram,2010

Mulching and in-situ Rain Water Harvesting (RWH) through micro- catchments on soil water dynamics and groundnut yields

In an another experiment, micro catchments were arranged after every four rows and every 6 rows of groundnut with 30cm and 45 cm apart in plots and under mulch treatment and same was adopted in without mulch treatments using 2.5 inch diameter with 30 cm depth during 2007-10.

Three years of experiment results (Table 22) on *in-situ* moisture conservation showed no significance among different treatments tried.

Micro catchments 30 cm for every 4 rows

Micro catchments 30cm every 6 rows

Microcatchments 45cm apart for every 4 rows

Micro catchments 45cm apart for every 6 rows

Plate 3. Mulching and in-situ Rain Water Harvesting (RWH) through micro-catchments on soil water dynamics and groundnut yields


Mulching on micro catchments


Plate 4. Mulching and in-situ Rain Water Harvesting (RWH) through micro-catchments on soil water dynamics and groundnut yields

Sand application to increase infiltration of rainwater

The intensity of rainfall in Anantapuram is high, causing severe soil erosion and runoff losses. On an average five runoff incidents are recorded during the season. The lands are sloppy and shallow in depth with moisture storage capacity of only 40mm/30cm soil depth with no carrying over capacity. The available soil moisture can be improved either by allowing more opportune time for rain water to infiltrate or by arresting runoff losses. This can be achieved by simple agronomic manipulations like application of sand so as to increase infiltration. In this direction, the experiments carried out on sand application are apt and scientifically relevant and technologically feasible to the existing situation.

Besides this hard setting sandy loam soils form the major chunk of groundnut growing soils in Anantapuram district, surface crusting is one of the important problems of the soils, limiting rain water infiltration, delayed and poor emergence of the crop. Pegging and pod development are also affected due to soil crustation, leading to reduced groundnut pod yields. Application of easily and cheaply available sand is an effective way of improving soil physical conditions, in turn leading to reduced runoff losses and higher soil moisture availability.

Application of sand to red soils:

Surface crusting of soil during kharif is the common phenomenon in red sandy loams of Anantapuram. Farmers used to apply sand with a thougtht that it enhances the yield of groundnut. In order to study the advantages of sand application systematically, studies were conducted during 1987 to 1990. Sand @ 40 t ha^{-1} applied at the time of preparatory cultivation and mixed with soil decreased the crust strength of top 2-5 cm layer by 18 to 40%. The soil infiltration rate increased by 78% (Table 23). As a result, pod yield of groundnut increased by 1 to 57% over years. The cumulative effect of sand application was also observed upto 4 years.

Table : 23 Effect sand application on groundnut yields

Sand applied (t ha^{-1})	Direct effect			Cumulative effect		
	Crust strength (kg cm^{-1})	Infiltration rate (mm hr^{-1})	Pod yield (kg ha^{-1})	Pod yield (kg ha^{-1})		
				2^{nd} year	3^{rd} year	4^{th} year
0	0.71	26.1	2000	1093	1093	1093
20	0.58	31.3	2160	1150	1300	1350
40	0.51	38.7	2300	1230	1310	1400

Munaswamy *et.al.,* 1995

Results revealed that the soil water in the profile was high during critical dry spells when sand was applied @ 40 t ha^{-1} once in four years, due to more infiltration of rain water. Crust strength and soil resistance were low with the application of sand. Besides improvement in soil physical condition, groundnut pod yields were found to increase upto 150 kg ha^{-1}. **This technology has gone as recommendation from the University for hard setting sandy loam groundnut growing soils.** Some of the farmers are also practising the application of sand to their fields.

Intensive cropping system

Experiments to find out suitable crops with higher water use efficiency were conducted for three years and the data indicated that bajra variety HB-3 and Setaria variety N-1 are most suitable for the shallow red soils of this tract (Table 24).

Table:24 Efficient crops and varieties for shallow red soils

Particulars	Pearl millet			*Setaria*		
	1971	1972	1973	1971	1972	1973
Grain yield (kg ha^{-1})	460	430	652	782	680	817
Moisture use efficiency (kg cm^{-1})	-	46.7	31.3	-	42.1	32.6

Source: Annual Report, ARS, Anantapuram,1973-74

3.2 Tillage and nutrient management for resource conservation , soil health and crop yield

3.2.1 Studies on various tillage practices

Proper tillage is necessary for good root penetration, crop growth, moisture conservation pest and weed management. Hitherto local practice by "country plough" and "chekkala guntaka" followed by blade harrow is adopted for land preparation in the area.

Monetary returns were increased by 25% in pearlmillet and sunflower by ploughing once with a chisel plough upto a depth of 30 cm (Table 25). Deep tillage (30 cm) with tractor drawn disc plough induced greater spread and penetration of roots and enhanced the yields of groundnut, castor and pearlmillet by 35%, 36% and 34% respectively.

Table:25 Effect of tillage on yield of different crops

Crop	Grain or pod yield (kg ha^{-1})			
	Main effect		Residual effect	
	Shallow tillage	Deep tillage	Shallow tillage	Deep tillage
Groundnut	627	840	1330	1420
Pearl millet	820	1100	20	30
Castor	740	1010	1280	1510

Source: Annual Report, ARS, Anantapuram,1992-93

Root penetration studies (Table 26) further indicated that mixing surface soil with sub soil is advantageous . However tillage with sub soiler was not helpful.

Table:26 Effect of tillage on root spread (cm) of different crops

Crop	Spread of roots (cm)			
	Shallow tillage		Deep tillage	
	Vertical	Horizontal	Vertical	Horizontal
Groundnut	19.1	15.6	25.0	22.3
Pearl millet	21.6	12.5	31.5	21.0
Setaria	17.6	9.4	24.2	17.9

Source: Annual Report, ARS, Anantapuram,1992-93

Table :27 Effect of tillage on soil physical properties

Tillage	Water intake rate (Gallons hr^{-1})	Hydraulic conductivity (cm hr^{-1})	Water holding capacity (%)
Shallow	3.2 – 4.5	3.2 – 4.2	16.0 – 16.5
Deep	4.8 – 6.3	4.8 – 5.8	17.2 – 18.4

Source: Annual Report, ARS, Anantapuram,1992-93

Water intake rate, water holding capacity, hydraulic conductivity and root spread also increased due to deep ploughing (Table 27). Keeping in view of the many advantages including cost of effectiveness and residual effect, deep ploughing once in 3 years where soil depth is 20 cm or more is recommended . The benefit of deep tillage was further improved by deep placement of phosphetic fertilizer. Deep tillage after broadcasting of P fertilizer was equally effective in improving productivity of pearlmillet.

Primary tillage using "chekkala guntaka" (a local tillage implement) reduced the soil resistance by 73% over no primary tillage when compared to 60% by blade harrow and 68% tiller + blade harrow resulting in higher pod yield of groundnut. Roots of groundnut were evenly, distributed upto 15 cm depth when land was prepared with "chekkala guntaka".

3.2.2 Tillage and nutrient management for resource conservation and improving soil quality

In order to study the long term impact of low till system on soil quality and groundnut productivity, an experiment was conducted during *kharif* 2000 to 2004 at Agricultural Research Station,Anantapuram .

Table:28 Pod yield of groundnut as influenced by tillage and nutrient management

Treatments	Pod yield (kg ha^{-1})					
	2000	2001	2002	2003	2004	Mean
Main treatments (tillage)						
Conventional tillage	1524	1294	653	431	1197	1019
Low tillage	1402	1433	692	382	947	971
Low tillage - herbicide	1400	1335	764	375	868	948
CD (0.05)	NS	NS	66	NS	NS	NS
Sub treatments (Nutrition)						
100% organic source	1383	1370	695	485	913	969
50% organic + 50% inorganic	1362	1373	651	359	1008	951
100% inorganic	1582	1319	662	344	1091	999
CD (0.05)	121	NS	NS	69.4	91.2	NS

Vijay sankar babu *et.al.,*(2007)

Table: 29 Status of available nutrients and organic carbon content of soil as influenced by tillage and nutrient management

Treatment	Available nutrients (kg ha^{-1})				Organic carbon (%)	
	Phosphorus		Potassium			
Tillage	2000	2004	2000	2004	2000	2004
T_1 : Conventional tillage	101	106	131	236	0.25	0.32
T_2 : Low tillage	108	109	102	272	0.26	0.38
T_3 : Low tillage + herbicides	79	104	141	264	0.22	0.35
Nutrition						
F_1 : 100% organics	75	54	118	303	0.32	0.43
F_2 : 50% org + 50% inorganics	102	123	141	279	0.17	0.37
F_3 : 100% inorganics	13	142	114	185	0.19	0.25
Initial values	46.9		83.4		0.20	

Vijay sankar babu *et.al.,*(2007)

The results revealed that tillage has no influence on yield and yield attributes of groundnut. However, the nutrient source had found to influence the pod yield. Groundnut pod yield is significantly high when 100 % recommended dose of nutrients were applied through organic manures (Table.28) . The nutrient source was found significant on pod yield of groundnut for three years out of five years of experimentation. The mean pod yield of groundnut was high (999 kg ha^{-1}) with inorganic source of nutrients only.

Organic carbon content built up (0.20 to 0.43%) in the soil was observed when 100% recommended dose applied through organic source (Table 29). However available potassium was comparatively more in this treatment when compared to other nutritional treatments. There was increasing trend of available phosphorus from 100% organic source (48 kg P_2O_5 ha^{-1}) to 100% inorganic source (219 kg P_2O_5 ha^{-1}) of nutrient supply.

During the most of the crop period, the available soil water (mm/30 cm depth) was however high in low tillage followed by conventional tillage. Similar trend was observed with either 100% nutrients through organic source or 50% organics + 50% inorganic source of nutrient supply. The maximum water holding capacity was high both of conventional tillage (32.8 %) and 100% recommended dose of nutrients were applied through organic source (32.9%). Soil bulk density was not influenced either by tillage practice (ranging between 1.48 to 1.51 Mg m^{-3}) or nutrient source (1.47 to 1.51 Mg m^{-3}).

Yield and yield attributes of groundnut as influenced by different soil densities in the pod zone

At average bulk density of 1.4 Mg m^{-3} to 1.6 Mg m^{-3}, groundnut performed better because of relative ease in peg penetration and pod development in the soil. Significantly higher pod yields were obtained from plots compacted with FYM when compared to plots compacted with groundnut shells (Annual Report, AICRPDA, ARS, Anantapuram, 2010).

3.3 Fertilizer use in dry lands

3.3.1 Delineation of soil fertility status

The results of long term manurial trials carried out at Agricultural Research Station, Anantapuram revealed that there is need to review nutrient recommendations, particularly zinc. Soil conditions are getting deteriorated owing to run off, erosion and non use of organic manures. Basic information on these aspects and regular monitoring of nutrient status of the soils and changes in physical properties are very much essential for making fertilizer recommendations and other management practices. Ten bench mark locations for regular monitoring are selected representing rainfed situation under groundnut cropping in Anantapuram district. Soil samples and relevant data pertaining to crop yield, constraints and perceptions of farmers about crop production, management practices followed etc., are documented during summer season.

Initially (1996), bulk density of ten bench mark locations of groundnut growing soils of Anantapuram district, ranged from 1.4 Mg m^{-3} to 1.9 Mg m^{-3}. Water holding capacity ranged from 26.9 % to 57% and the infiltration rates ranged from 3.6 – 36 mm hr^{-1}. During 2005, the infiltration rates ranged from 6-30 cm hr^{-1} and maximum water holding capacity (%) ranged between 25.3 and 44.5 in the benchmark sites in the district. The soils are slightly acidic to alkaline in reaction. Electrical conductivity of surface soils ranging from 0.017 to 0.109 dSm^{-1} , Organic carbon content of surface soils (0-15cm) ranged from 0.24 to 0.60% and sub surface (15-30cm) soils it was 0.30 to 0.90% . The available nitrogen for surface soils ranged from 100 to 151kg ha^{-1} and it was 113 to 188 kg ha^{-1} for sub surface soils. The available phosphorus content ranged from 7 to 43 kg ha^{-1} and from 7 to 22 kg ha^{-1} respectively for surface and sub surface soils. Soil available K ranged from 94 to 343 kg ha^{-1} for surface soil and 78 to 220 kg ha^{-1} for sub surface soils of bench mark sites and was depicted in graphs 1 to 4.

A comparison of soil chemical parameters between base year 1999 and 2006 year (Table 30) indicated that there was slight shift in soil reaction (10.4%) towards acidity. There is decrease in organic carbon content (8.6%) and there was slight reduction (2.3%) in available K, but for 41.2% decrease was noticed in available P in surface soil.

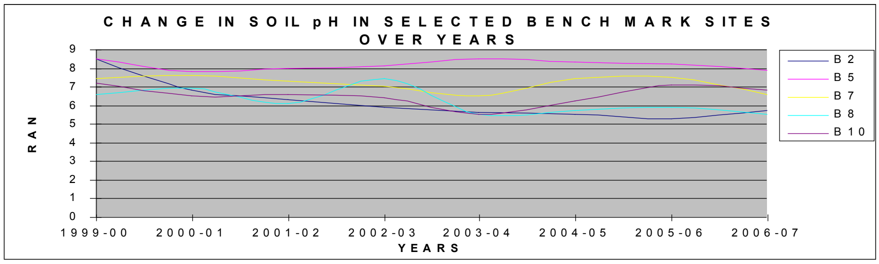
Table :30 Change in soil properties of benchmark locations over years

Soil parameter	1999			2006		%shift
	Depth (cm)	Range	Mean	Range	Mean	
pH	0-15	6.6-8.5	—	5.17-7.92	—	-10.4
EC (dSm^{-1})	0-15	0.08-0.38	0.23	0.017 -0.109	0.063	-72.6
OC (%)	0-15	0.10-0.81	0.46	0.24 - 0.60	0.42	-8.6
Phosphorus (kg ha^{-1})	0-15	9-76	42.5	7.0-43.0	25.0	-41.2
Potassium (kg ha^{-1})	0-15	88-340	214	94-343	219	-2.3

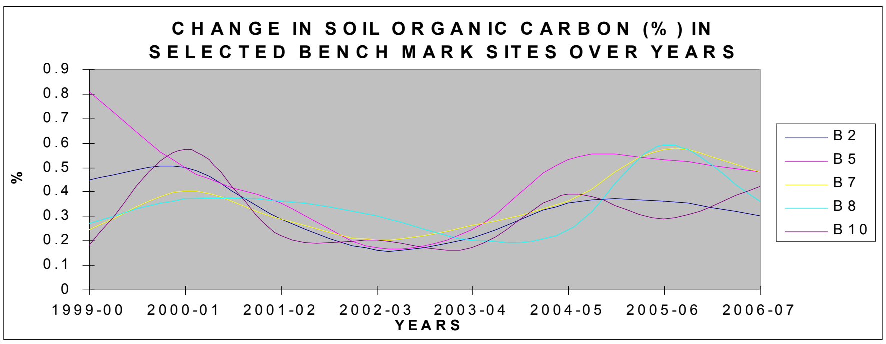
Source: Annual Report, ARS,Anantapuram, 2006-07

Index: B2: Kadiri, B5: Miduthur (Gooty), B7: Renumakulapalli (Uravakonda), B8: N.Gundlapalli (Kalyanadurg), B10: Venkatapuram (Anantapuram)

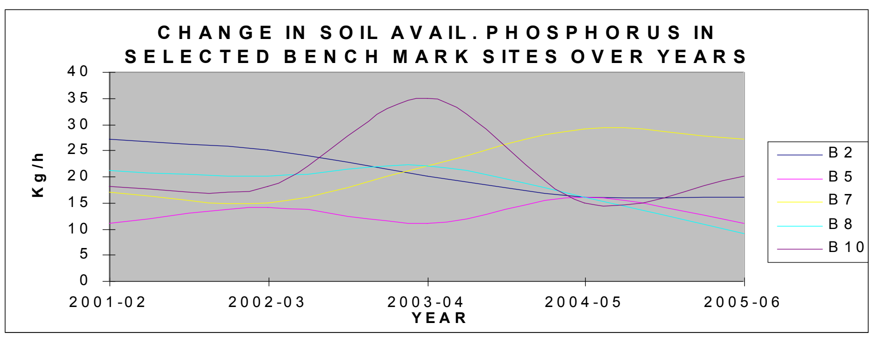
Source: Annual Report, ARS, Anantapuram, 2006-07



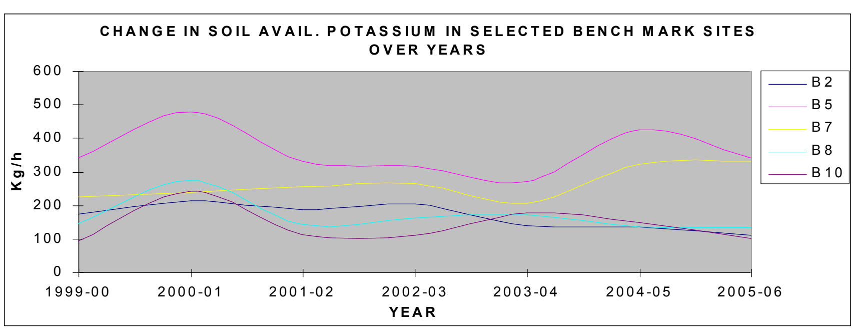
Graph. 6 Change in soil pH in benchmark sites over the years



Graph. 7 Change in soil Organic carbon (%) in benchmark sites over the years



Graph. 8 Change in soil avail.Phosphorus in benchmark sites over the years



Graph. 9 Change in soil avail.Potassium in benchmark sites over the years

Survey for fertility status of chickpea growing soils

In black soils of Anantapuram district, about 49000 ha area is under chickpea cultivation with varying fertilizer practices and yield levels ranging between 5 – 12 q ha^{-1} (Annual report, ARS, Anantapuram 2000). Several fertility problems in chickpea, growing in black soils have emerged needing attention. One of the major constrain limiting crop production in black soils of Andhra Pradesh is low fertility status. In Anantapuram district, at present blanket dose of fertilizers are being applied to chickpea without considering the soil fertility status. Hence a survey was conducted to study the nutrient status of chickpea growing Vertisols of Anantapuram district for better fertility management and crop production.

Surface (30 cm depth) soil samples were collected from 46 locations in chickpea cultivated areas during 2001 – 2002, covering 11 mandals, viz., Uravakonda, Vidapanakal, Guntakal, Vajrakarur, Yadiki, Gooty, Kalyandurg, Beluguppa, Kanekal, Bommanahal and Tadipatri of Anantapuram district (Andhra Pradesh) (Table 31). The soil samples were analysed for pH, Ec, N, P, K and micronutrients.

Existing fertilizer practices by dryland farmers to chickpea

- 43.8 % of the farmers are applying 100 % recommended dose of nutrients except S
- 27.94 % of the farmers are applying < 25 % recommended dose of excepts S
- 47.8 % of the farmers are using only DAP as fertilizer
- 52.2 % of the farmers are using only 14-35-14 as fertilizer
- 30 % of the farmers are integrated both FYM and DAP/14-35-14 and interestingly no farmer is applying directly S as fertilizer

Soil pH ranged from 7.4 to 8.7, EC from 0.12 to 0.49 dSm^{-1} , organic carbon from 0.04 to 0.5, 93.5 per cent. The soils were low in organic carbon and only 6.5 per cent soils were medium in organic carbon content (Table 31). The mean available nitrogen, phosphorus and potassium status ranging from 124.7 to 163.0, 30.7 to 102.3 and 290.5 to 358.5 kg ha^{-1} respectively. Despite of cultivation of chickpea for last 15 – 20 years the available nitrogen status was low in all the soils. Available phosphorus content ranging from 13.4 to 185.5 kg ha^{-1} with low, medium and high in 28.3, 15.2 and 56.5 per cent soils respectively. Soils with high available phosphorus might be due to continuous application of phosphotic fertilizers. Available potassium content of soil samples ranging from 186 to 587 kg ha^{-1}. Mean soil available potassium is high in 82.6 and 17.4 per cent soils were medium. Highest mean available N, P and K status were observed in Bommanahal, Guntakal and Tadipatri mandals respectively, whereas, lowest mean available N, P and K status were observed in Vajrakarur, Tadipatri and Beluguppa mandals respectively.

Table 31 Macronutrient status (kg ha^{-1}) and micronutrients status (ppm) of chickpea grown *Vertisols* in Anantapuram district

S. No.	Name of the Mandal	Nitrogen	Phosphorus	Potassium	Zinc	Iron	Manga nese	Copper
1	Uravakonda	149.7±12.2	66.9±5.2	231.7± 49.5	0.46± 0.55	1.92± 0.14	3.33± 0.44	1.10± 0.19
2	Vidapanakal	145.5±18.0	75.4±5.3	269.9± 45.0	0.25± 0.05	1.44± 0.23	3.72± 0.25	0.97± 0.10
3	Guntakal	148.5±7.5	102.3±14.6	255.9± 40.6	0.42± 0.07	1.76± 0.09	3.80± 0.40	1.10± 0.17
4	Vajrakarur	124.7±5.2	60.3±20.5	281.6± 83.3	0.29± 83.3	1.85± 0.29	4.13± 0.38	1.06± 0.11
5	Yadiki	135.6±0	41.7±36.8	304.7± 32.5	0.32± 0	20.2± 0.14	6.91± 1.06	11.03± 0.54
6	Gooty	129.7	51.5	272.8	0.28	1.98	6.02	1.08
7	Kalyandurg	125.3±6.5	69.1±9.3	287.5± 466.6	0.56± 0.71	1.50± 0.07	4.65± 0.58	1.24± 0.14
8	Beluguppa	149.1±19.2	61.8±27.1	216.5± 101.9	0.26± 0.16	1.42± 0.29	5.73± 2.02	0.94± 0.36
9	Kanekal	145.7±11.2	32.8±6.9	368.5± 109.2	0.18± 0.14	1.45± 0.35	4.05± 0.61	0.78± 0.25
10	Bommanahal	163.0±7.1	37.5±7.8	281.5± 45.2	0.13± 0.04	0.61± 0.15	3.95± 1.06	0.73± 0.25
11	Tadipatri	151.3±20.0	30.7±5.3	363.6± 88.1	0.27± 0.12	0.81± 0.08	6.64± 0.60	1.30± 0.43
	Mean	42.5±9.72	57.3±12.6	284± 58.3	0.3± 0.18	1.51± 0.17	4.82± 0.67	1.03± 0.22

Vijay Sankar Babu *et.al.,* 2006

The mean available Zinc, manganese and copper status of soils ranged from 0.13 to 0.56, 0.61 to 2.02, 3.33 to 6.91 and 0.73 to 1.30 mg kg^{-1} respectively (Table 32). Highest mean Zn, Fe, Mn and Cu were observed in Kalyandurg, Yadiki and Tadipatri mandals. Whereas, lowest mean Zn, Fe, Cu and Mn were observed in Bommanahal and Uravakonda mandals. Mean available zinc content was below the critical limit of 0.75 mg kg^{-1} in all mandals. Available iron content ranged in between 0.61 to 2.02 mg kg^{-1} and all the mandals have available Fe content below the critical limit of 4.5 mg kg^{-1}. The available manganese content varied between 3.33 to 6.91 mg kg^{-1} and mean available manganese content was above the critical limit of 3 mg kg^{-1} in all the 11 mandals. The available copper ranged from 0.73 to 1.30 mg kg^{-1}. All soils were above the critical limit of 0.2 mg kg^{-1}. All soils were deficient in zinc and iron. The manganese and copper content was sufficient in all soil samples.

Table 32 Nutrient status of chickpea grown soils in different mandals of Anantapuram district

Parameter	Range	Mean	Per cent		
			Low	Medium	High
pH	7.4-8.7	8.1	—-	—-	—-
Ec (dsm^{-1})	0.12-0.49	0.27	—-	—-	—-
OC (%)	0.04-0.5	0.29	93.5	6.5	—-
N (kg ha^{-1})	112.5-177.2	141.7	100	—-	—-
P_2O_5 (kg ha^{-1})	13.4-185.5	77.8	28.3	15.2	56.5
K_2O (kg ha^{-1})	186-587.6	373.6	—-	82.6	17.4
				Deficient	Sufficient
Zn (mg kg^{-1})	0.1-1.72	0.32		100	—-
Iron (mg kg^{-1})	0.44-3.52	1.53		100	—-
Mn (mg kg^{-1})	2.14-20.4	4.30		—-	100
Cu (mg kg^{-1})	0.5-1.84	1.04		—-	100

Vijay Sankar Babu *et.al.,* 2006

The study revealed that 93.5 per cent soils were low in organic carbon, all the soils were low in available N, 28.3 per cent soils were low in available P_2O_5 and 82.5 per cent soils were medium in available K_2O. With regard to micronutrients, all soils were deficient in Zn and Fe and sufficient in Mn and Cu in chickpea growing Vertisols of Anantapuram district.

Soil depth and fertility status of soils of Agricultural Research Station, Anantapuram

The Agricultural Research Station farm is spread over 110 ha. Soils are sandy loam in texture and classified as typic haplustalfs. The mean rainfall is 652 mm. 85 representative surface soil samples were collected from 36 fields of Agricultural research station, Anantapur am during summer 2001 when the fields were fallow. The number of samples collected from each field would vary according to depth categorised.

Based on the soil depth recorded, the soils of the ARS Anantapuram are categorised into four depth viz., very shallow (<25 cm), shallow (26-50 cm), medium deep (51-75 cm) and deep soils (>75 cm). Hence, the nutritional status of the fields according to the depth category is discussed. Most of the soils fall under the category of shallow (65.8%) followed by medium deep (22.35%), very deep (9.4%), and very shallow (2.35%).

About 2.35 per cent of the area falls under very shallow soils category. The soils are moderately acidic (pH-5.4) in nature and low in available nitrogen (143 kg ha^{-1}) and available K_2O (110 kg ha^{-1}).However, available phosphorus is very high ranging from 62-149 kg ha^{-1}. All the cationic micronutrients are above critical level except Zn. Fifty per cent of the samples collected from this category of lands are low in available Zn.

Nearly 66 per cent of the area falls in shallow soils category from where 56 samples were collected. Most of the soils are slightly acidic to near neutral in reaction with pH ranging from 4.9-9.1 with a mean of 6.1.the soils are low in available nitrogen (114 kg ha^{-1}) ranging from 82-163 kg ha^{-1}. The available phosphorus P_2O_5 ranged from 5.1-200 kg ha^{-1} with a mean of 65 kg ha^{-1}. About 16.4 per cent of samples fall under low P_2O_5 category, 18.2 per cent fall under medium P_2O_5 category. Remaining 65.4 per cent samples are high in available P_2O_5. The soils are also low in potassium with available K_2O ranging from 93-127 kg ha^{-1} (mean of 110 kg ha^{-1}). Out of total samples collected, 89.3 per cent samples fall under low K_2O status. The available micronutrients are above critical level except Zn, which is found sufficient in only 42.9 per cent samples are below critical level.

About 22.4 per cent of area falls under medium deep soils from where 19 samples were collected. Most of the soils are slightly acidic in nature with a mean pH of 6.3 (ranging from 5.1-8.2). All the fields are low in available N (range 82-127 kg ha^{-1}). The mean available P_2O_5 is 60 kg ha^{-1} ranging from 13-179 kg ha^{-1}. Out of total samples, 5.6 per cent are medium and 72.2 per cent samples are high in available P_2O_5. Majority of the soils are high in this category (94.4%) are low in available K_2O with a mean of 98 kg/ha (ranging from 59-163 kg ha^{-1}). Micronutrients availability is above critical level except Zn in which 41.2 per cent samples are below critical level.

Only 9.4 per cent of soils fall under deep soils category. Soils are slightly acidic in reaction with a mean pH of 6.6 (ranging 5.8-8.2). the available N is slightly high as compared to shallow soils and medium deep soils with a mean of 120 kg ha^{-1} (ranging from 85 – 181 kg ha^{-1}). Whereas, available P_2O_5 is high (34 kg ha^{-1}), but it is comparatively low to previous depth ranging from 5.1 – 113 kg ha^{-1}. Out of total samples, 22.2 per cent low in P_2O_5 content, 55.6 per cent are medium and remaining 22.2 per cent are high in available phosphorus. The available K_2O is high in this category of soils as compared to previous categories. However, 66.7 per cent of samples are in low in K_2O status and 33.3 per cent samples are medium in range. In respect to micronutrients, all are above critical levels except Zn. Out of total samples, 44.4 per cent have Zn above critical level.

As all the soils are low in available N, and above critical levels in respect of Fe, Mn, and Cu, the fertility maps for these nutrients are not presented. These will be useful for determining the fertilizer dose for rain-fed groundnut as this is the major crop grown on this farm. Irrespective of the soil depth i.e shallow or deep, available N is low. The available P_2O_5 is high in shallow soils and the availability gradually decreased in the lands with increase in the soil depth. Whereas, incase of available K_2O, the reverse trend is observed and the availability is gradually decreased in soil depth. In respect of available Zn, Fe and Mn soil depth is found to have no influence whereas deep soils are found deficient in copper.

3.4 Nutrient Management

3.4.1 Fertilizer requirement of different crops

Among the several biotic stresses, low fertility of soils is responsible for low yields. Fertilizer use is also very low in drylands obviously due to risk factors involved. But it is the fertilizer component that gives maximum benefit to dryland farmers. In order to obtain better fertilizer use efficiency and reduce the input cost on fertilizer, experiments were conducted to determine the optimum dose, time and method of application for different crops, crop sequences and intercropping systems.

In 1970s and 1980s pearl millet, setaria, redgram, groundnut, castor, cowpea etc were important crops of the district. Nutrient requirement, method and time of application was worked out for these crops, nitrogen @ 80 kg ha^{-1} to pearl millet was found remunerative based on cost benefit ratio when applied in two equal splits as basal and top dressing at 30 days after sowing by placement at 5cm depth. Flowering was also found early when N was applied at sowing besides giving significantly higher yields. Application of fertilizer in set line was found superior followed by drilling by the side of seed furrows in pearl millet and greengram. Since soils are low in available potassium, application of potassium @ 50 kg ha^{-1} to these soils having available K_2O less than 150 kg ha^{-1} found to increase the yield by 31% in pearl millet 17% in cowpea, 32% in groundnut and 550% in sunflower and 16% in setaria. Moisture use efficiency was high when K_2O was applied at 100 kg ha^{-1}. Crops though did not show zinc deficiency particularly the groundnut, hidden hunger of zinc was brought to light. The results revealed that pearl millet and groundnut were highly responsive to $ZnSO_4$ when applied at the rate of 50 kg ha^{-1} . However poor response to zinc application was observed in setaria and sunflower (Table 33).

Table:33 Moisture use efficiency of different crops influenced by potash and zinc application

Crop	Moisture use efficiency (kg cm^{-1}) water used				
	K_2O levels kg ha^{-1}			$ZnSO_4$ levels	
	0	50	100	0	50
Pearl miller	49.3	89.7	99.04	64.33	89.78
Groundnut	13.82	14.42	18.03	10.11	14.72
Sunflower	9.82	18.41	23.4	17.75	17.71
Setaria	49.3	89.97	99.04	—-	——

Source: Annual Report, ARS, Anantapuram,1973-74

As photosynthetic rate in grain legumes drops rapidly at flowering, supplementing of N through foliar sprays to increase the photosynthetic activity. Spraying of 0.5% increased the yield of green gram and cowpea, likewise foliar sprays of urea @ 10 kg ha^{-1} (2%) or DAP 2% on groundnut immediately after cessation of prolonged dryspell found to increase the pod yield significantly.

Nitrogen application significantly increased the grain yields of in bajra (Table 34) both in good and drought years of rainfall. Though a maximum grain yield as well as net realization were obtained by 120 kg ha^{-1}, the yields did not differ significantly over 80 kg N ha^{-1} and it was remunerative both in good and drought years to apply only 80 kg N ha^{-1} from the point of view of cost benefit ratio (Table 35). Placement of fertilizer 10 cm deep was on par with 5 cm deep placement but inferior to the best two methods application. Split application and placement at 5 cm below the seed were as good as broadcast.

Table :34 Yield of bajra (kg ha^{-1}) as influenced by N levels and application methods (1971-72 to 1973-74)

Methods of application	Levels of N (kg ha^{-1})				
	0	40	80	120	Mean (kg ha^{-1})
1. Broadcast	496	734	1042	1204	869
2. Placement 10 cm deep below the seed	384	730	966	980	765
3. Placement 5 cm deep below the seed	350	846	940	1197	841
4. Split application at knee high stage as top dressing	343	944	1076	1170	883
Mean	394	813	1006	1138	

Source: Annual Report, ARS, Anantapuram,1973-74

Table : 35 Yield of bajra and net profit as influenced by N levels

N level	Mean grain yield(kg ha^{-1})	Gross value of Produce (Rs./ha)	Net income (Rs./ha)
0	394	354	—-
40	813	731	631
80	1016	905	705
120	1138	1024	724

Source: Annual Report, ARS, Anantapuram,1974-75

Table 36. Effect of different levels of phosphorus on the pod yield of groundnut

Treatments	**Pod yield (kg ha^{-1})**		**Yield difference**
	1999	**2000**	
T_1 : Control (No P)	1530	1292	—-
T_2 : 20 kg P_2O_5 ha^{-1}	1616	1177	439
T_3 : 40 kg P_2O_5 ha^{-1}	1526	1313	213
T_4 : 60 kg P_2O_5 ha^{-1}	1702	1104	598
T_5 : 80 kg P_2O_5 ha^{-1}	1645	1118	527
CD	NS	NS	—-

Source: Annual Report,AICRPDA, ARS, Anantapuram,2000-01

Application of 40 kg P_2O_5 ha^{-1} is hold good (Table 36) as there is detrimental effect by application of higher or lower doses of P

Response of crops to Potash application

Application of potash at 50 kg ha^{-1} significantly increased the yields in sunflower, groundnut, bajra and setaria. But no significant difference in yield was observed in any of these crops when the potash application was increased from 50 kg to 100 kg ha^{-1} (Table 37).

Table :37 Response of crops to Potash application

Crop	Yield (kg ha^{-1})								
	1971-72			1972-73			1973-74		
	Potash Levels			Potash Levels			Potash Levels		
	K_0	K_{50}	K_{100}	K_0	K_{50}	K_{100}	K_0	K_{50}	K_{100}
Bajra	840	790	780	1160	1520	1580	631	890	950
Setaria	830	860	840	250	290	350	210	328	333
Groundnut	420	440	450	390	420	410	880	1270	1310
Cowpea	420	430	450	170	180	200	—-	—-	—-
Sunflower	—-	—-	—-	330	500	580	580	860	800
S.E ±	Not significant				0.66		Significant		
C.D					1.83				

Source: Annual Report, ARS, Anantapuram,1973-74

Table:38 Nutrient requirement different crops under dryland conditions of Anantapuram

Crop	Nutrient requirement (kg ha^{-1})		
	N	P_2O_5	K_2O
Groundnut	20	40	40
Mesta	40	0	0
Cowpea	20	40	0
Castor	40	80	0
Pearl millet	80	40	0
Styloxanthus hemata	0	50 to 100	0

Source: Annual Report, ARS, Anantapuram,1975-76

The results from various experiments conducted to fix the nutrient requirements different crops revealed that 20-40-40 N-P_2O_5-K_2O kg ha^{-1} will be optimum for groundnut (Table 38).

Sources and methods of fertilizer application

Application of fertilizer in setline proved superior to broadcasting in pearl millet and greengram. Among other methods of application, drilling by the side of seed while sowing gave higher yields. Among different sources of phosphorus Diammonium Phosphate (DAP) and single superphosphate (SSP) were found superior and equally good in increasing the pod yield of groundnut (Table 39).

Table:39 Effect of different sources of phosphorus on yield of groundnut

Source of P	Pod yield of groundnut Kg ha^{-1} (Mean of 3 years)		% increase	
	TMV-2		J11	J11
Control	1210	1230	28.8	23.3
SSP	1616	1640	26.4	33.3
DAP	1580	1604	29.6	39.8
DAP + Cats	1620	1720	7.2	5.7
Mussoriphos	1340	1300		

Source: Annual Report, ARS, Anantapuram,1974-75

The results from various experiments conducted to fix the nutrient requirements different crops revealed that 20-40-40 N-P_2O_5-K_2O kg ha^{-1} will be optimum for groundnut (Table 40).

Table:40 Nutrient requirement different crops under dryland conditions of Anantapuram

Crop	Nutrient requirement (kg ha^{-1})		
	N	P_2O_5	K_2O
Groundnut	20	40	40
Mesta	40	0	0
Cowpea	20	40	0
Castor	40	80	0
Pearl millet	80	40	0
Styloxanthus hemata	0	50 to 100	0

Source: Annual Report, ARS, Anantapuram,1974-75

Mussoriphos was not found as an effective source of P. Application of DAP with or without addition of Ca and S was found equally good in case of TMV-2 where as application of DAP with Ca and S was found beneficial to J-11. Highest pod and haulm yields were obtained with the application of 14-35-14 @ kg ha^{-1} which was significantly superior over DAP application @ 100 kg ha^{-1} and 150 kg ha^{-1}. Pod and haulm yields decreased with the increased dose of DAP from 100 to 150 kg ha^{-1}. Application of FYM along with chemical fertilizers slightly improved the pod yield.

Studies on the impact of farmers way of fertilizer use on the sustainability of groundnut productivity and properties of soils

Highest pod and haulm yields were obtained with the application of 14-35-14 @ 100 kg ha^{-1} which was significantly superior over DAP application @ 100 kg ha^{-1} and 150 kg ha^{-1}. Pod and haulm yields were lowered with the increased dose of DAP from 100 to 150 kg ha^{-1}. Application of FYM along with chemical fertilizers slightly improved the pod yield (Table 41).

Table 41 Impact of farmers' way of fertilizer use on pod yield of groundnut over years

Treatment	Pod yield (kg ha^{-1})					
	1996	1997	1998	1999	2000	Mean
T_1 : DAP @ 100 kg ha^{-1}	633	628	1596	1106	847	962
T_2 : 14-35-14 @ 100 kg ha^{-1}	630	758	1321	1161	972	968
T_3 : 28-258-0 @ 100 kg ha^{-1}	815	613	1609	1546	942	1105
T_4 : DAP @ 100 kg + FYM @ 5 t ha^{-1}	770	686	1716	1423	1134	1146
T_5 : 14-35-14 @ 100 kg + FYM 5 t ha^{-1}	796	761	1343	1501	1181	1116
T_6 : 28-28-0 @ 100 kg + FYM @ 5 t ha^{-1}	844	686	1769	1394	1051	1149
CD	128	NS	268	207	200	—

Source: Annual Report,AICRPDA, ARS,Anantapuram, 2001

Table 42 Impact of farmers' way of fertilizer use on pod yield of groundnut over years

Treatment	5 years mean pod yield	Infiltration rate	Maximum water holding capacity
Chemical fertilizer (mean of 3 treatments)	1011	11.8	29.7
Chemical fertilizers + FYM (mean of 3 treatments)	1137	13.5	32.4

Source: Annual Report,AICRPDA, ARS, Anantapuram, 2001

In all the farmers way of fertilizer applications, chemical fertlizers along with FYM @ 5 t ha^{-1} (Table 41 & 42) recorded not only higher pod yields but also increased infiltration rate and water holding capacity.

Frontline demonstrations on soil test crop response by targeted yield approach

Front line demonstrations (Tables 43,44) conducyed during rabi season for targeted pod yield based on soil test values revealed that adjustment of soil test crop response equations for yield targets in groundnut is feasible upto 25 q ha^{-1} beyond that the equations are not working. Soil test crop response equations always not possible to apply in the farmers' fields.

Table 43 Initial soil test values of four FLD's

S.No.	Farmers' name	Village	Soil available nutrients (kg ha^{-1})		
			N	P_2O_5	K_2O
1.	Ashok Kumar	B.K.Samudram	256	75	241
2.	K. Lakshmi Reddy	Venkatapuram	136	83	102
3.	B. Balanagireddy	Venkatapuram	138	78	71
4.	Ramanjaneyulu	Sanjeevapuram	136	85	68

Source: Annual Report, ARS,Anantapuram, 2002

Fertilizer adjustment equations

FN = 2.12 T – 0.14 SN. Where T = Yield target in q ha^{-1}

FP_2O_5 = 2.40 T – 1.72 SP Fn, FP_2O_5 + FK_2O = Fertilizers to be applied

FK_2O = 1.84 T – 0.09 SK SN, SP & SK = soil available N, P and K

Table 44 Effect of soil test based fertilizer application on pod yield of groundnut in four FLD's during *rabi* 2001

Name of the farmer/ village	Fertilizers applied (kg ha^{-1})			Pod yield
	Urea	SSP	MOP	(kg ha^{-1})
Ashok Kumar, B.K.Samudram				
T_1 : Farmers practice	50	300	50	950
T_2 : RFD	66	252	70	1500
T_3 : ST based for 25 q ha^{-1} target	37	Nil	41	2187
T_4 : ST based for 30 q ha^{-1} target	60	Nil	56	2625

K. Lakshmi Reddy, Venkatapuram				
T_1 : Farmers practice	60	250	50	2100
T_2 : RFD	66	252	70	1900
T_3 : ST based for 25 q ha^{-1} target	73	Nil	61	2050
T_4 : ST based for 30 q ha^{-1} target	97	Nil	78	1800
D. Balanagi Reddy, Venkatapuram				
T_1 : Farmers practice	50	150	50	1970
T_2 : RFD	66	252	70	2200
T_3 : ST based for 25 q ha^{-1} target	73	Nil	66	1950
T_4 : ST based for 30 q ha^{-1} target	97	Nil	81	1770
Ramanjaneyulu, Sanjeevapuram				
T_1 : Farmers practice	50	250	50	2202
T_2 : RFD	66	252	70	2261
T_3 : ST based for 25 q ha^{-1} target	73	Nil	66	2548
T_4 : ST based for 30 q ha^{-1} target	97	Nil	82	2250

Source: Annual Report, ARS, Anantapuram, 2002

3.4.2 Fertilizer management in cropping system

Fertilizer requirement for different crop sequences and intercropping systems were worked out so as to obtain maximum returns. Among the intercropping systems, groundnut + redgram and pearlmillet + redgram are important.

Recommended fertilizer dose for groundnut (20-40-40, N.P_2O_5.& K_2O kg ha^{-1}) was itself found sufficient for intercropping system of groundnut- redgram (5:1 or 15:1) for obtaining maximum monitory returns. Response curves for the component crops were developed for applied phosphorus. The response of pulse crop (redgram) to P was linear upto 40 kg P_2O_5 kg ha^{-1} whereas it was good for N upto 20 kg and marginal to K application. However in pearl millet + redgram (3:1) intercropping system, fertilizer nitrogen twice to the normal dose (80 kg ha^{-1}) gave maximum yield and returns.

Pearlmillet as succeeding crop to groundnut (Table 45) showed linear response to applied P irrespective of fertilization with full dose of phosphorus (40 kg P_2O_5 ha^{-1}) to previous crop as high amout of sesquioxides in the soil curtail the availability of added phosphorus to a large extent.

Table:45 Response to P application in groundnut + pearlmillet cropping system

P_2O_5 applied (kg ha^{-1})		Mean yield in Kg ha^{-1} (Average of 2 years)	
1st year	2nd year	1st year groundnut	2nd year rotation pearl millet
80	0	1305	1473
40	40	1247	2047
60	0	1319	1783
40	30	1348	2053
40	0	1254	1841
40	20	1229	2055
CD	(5%)	NS	272

Source: Annual Report,1987-88, ARS,Anantapuram

The possibility of taking a pulse crop before the main crop was found feasible. Greengram as a green manure crop followed by groundnut gave higher monitory returns under normal fertilization (20-40-40, N, P_2O_5& K_2O kg ha^{-1}) followed by greengram + bajra.

There was no response of groundnut to applied gypsum as a source of sulphur when the initial level of sulphate sulphur in the soil is 9.8 ppm and above.

3.4.3 Reccycling of farm residues

An experiment was conducted during the year 2002 and 2003 at Agricultural Research Station, Anantapuram on recycling of different farm wastes in to valuable vermi compost. The pits of sizes 100 cm x 100 cm x 60 cm were prepared with Kadapa slabs. Sand was spread at the bottom to drain out the excess water. Five pits were used for this study. Selected farm waste like redgram stalks, glyricidia loppings, papaya leaf litter and problematic weeds like parthenium and celosia @ 75% by weight along with FYM as starter material @ 25% by weight were added to all pits and also equal number of earthworms (650) were applied to each pit by maintaining 40 to 50% moisture in the pits with good quality of water. The parthenium and celosia weeds, papaya leaf litter and glyricidia loppings were collected from surrounding fields and premises of Agricultural Research Station, but redgram stalks were collected from the previous year crop and decomposed well was used for the purpose. The gestation time was calculated by noting the date of entry of worms into the pit and date of removal of prepared compost from the pit. Similarly, the earthworm multiplication rate was calculated. Nutrient composition of different materials before application to the compost pit and also compost obtained from the same materials were analysed by using standard methods. The prepared vermin compost was applied to the field of groundnut as test crop and assessed the weed infestation of the materials used to produce vermin compost. The chemical properties of soil before and after harvest of crop were estimated by using standard methods.

A significant increase of potassium over initial values recorded in the compost prepared with papaya leaf litter (0.31 to 0.99%), glyricidia (0.24 to 0.85%) and redgram stalks (0.18 to 1.34%) only but not with celosia and parthenium. The other macronutrients *viz.,* available nitrogen and phosphorus contents were drastically reduced in the compost prepared with farm wastes and weeds over initial content of the same materials. In all the treatments, there was a tremendous increase in the organic carbon level due to release of CO_2 farm decaying organic matter by the activity of microorganisms.

The results revealed that the gestation time taken for completion of compost was 70 – 75 days in the case of compost prepared with papaya leaf litter, glyricidia loppings and parthenium but with celosia and redgram stalks, it was little bit more i.e., 85 days due to hardiness of the material. The multiplication rate of earthworms was more in papaya leaf litter (1006), glyricidia (1110), parthenium (760) and redgram stalks (1054) and drastic reduction in worms content with celosial weed compost (580) over initial population (650).

The pH of the soil showed a decreasing trend when compared to the initial soil. This decrease of pH may be due to the pressure of humic, fulvic acids produced alongwith CO2 from the decaying organic matter by the activity of microorganisms, and significant increase in electrical conductivity in all the treatments may be due to mineralization of organic substances through better aeration and enhancement of microbial activity. There was a very less weed infestation (2%) from the vermin compost prepared from the problematic weeds of celosia and Parthenium. The available nitrogen, potassium and organic carbon content of the soil was increased significantly over initial values in all the treatments except the available phosphorus i.e., decreased from initial value. This might be due to the more utilization of phosphorus by the crop.

The results of the study revealed that in view of the multifunctional effects of vermi compost on growth, quality and yield of crop and also plays vital role in eradication of pollution hazards with huge quantities of domestic, agricultural and rural industrial organic wastes includes problematic weed populations from the agricultural fields and surrounding areas can be recycled by the effective and fast decomposition through vermin composting (Vijay Sankar Babu *et. al.,* 2008).

Influence of Organic farming on yield and soil properties of rainfed groundnut (*Arachis hypogea*)grown in alfisols of Andhra Pradesh, India

In an ongoing long term field experiment, the influence of organic farming onproductivityand soil properties of rainfed groundnut was studied for the past 12 years at Agricultural Research Station, Anantapur. The experiment was initiated during kharif 2002 comprising only two treatments viz, organic and conventional for the clear comparison of organic and conventional farming in rainfed agro-ecosystem. In the organic treatment the nutrient management through the application of FYM and seed treatment with biofertilizers, pest management by cultural, mechanical and biological methods whereas in the conventional treatment the use of recommended dose of fertilizers and need based chemical pest management was followed.Over a period of 12 years the influence of organic farming on groundnut pod yield revealed wide yield variation ranging from 278 to 1220 kg ha^{-1} in the organic farming and 207 to 1446 kg ha^{-1} in the conventional farming. The mean yield was 580 kg ha^{-1} in the organic farming and 681 kg ha^{-1} in the conventional farming. The protein content in groundnut kernels of organic farming was 36.7% and it was 34.1% in conventional farming. After 12 years the organic treatment recorded the soil pH 6.9 over initial value of 5.3 revealing that, in the organically managed plot the pH is moving towards neutral than that of conventional (5.2). The initialorganic carbon (0.45%)over the 12 years increased to 0.53 % in the organic farming and decreased to 0.32% in the conventional farming. However, no definite trend was observed with respect to available N, P_2O_5andK_2O. Overall the organic treatment performed better pertaining to soil propertiesandyield attributes showing the increasing trend.

Evaluation of different sources of bio-fertilizers in combination with inorganic and organic manures

The differences among various treatments were found significant with regard to dry matter at harvest and pod yield. Highest DMP was with N-P-K followed by Rhizobium + N-P-K+FYM. Pod yields were highest with N-P-K+FYM combination. However, in terms of total biological yields it was highest with Rhizobium + PSB+N-P-K followed by Rhizobium + N-P-K+FYM. In 1997-98, application of NPK or FYM or Rhizobium either alone or in combination increased the yields of groundnut significantly over control. However, the differences within these treatments were not significant. Application of biofertilizer (i.e. Rhizobium + PSB) along with inorganic and organic manures resulted in the highest yield (692 kg ha^{-1}) i.e. an increase of 87% over control. Dry matter accumulation, growth and yield attributes were better when biofertilizer, inorganic and organic manures were applied together.

3.4.4 Balanced nutrition

Response of groundnut varieties to soil and foliar application of iron compounds.

Spraying of Annabhedi (Ferrous sulphate) was found effective and significantly increased the pod yield to the tune of 11% in TMV-2. Foliar spray of $FeSO_4$ (0.2%) was more effective in correcting early chlorosis and gave increased yields. The increase in yields depends on the extent of intensity of chlorosis. The variety TMV-2 responded more to foliar spray of $FeSO_4$ than J-11.

Effect of balanced nutrition on rainfed groundnut productivity and soil properties

RFD N & K along with zinc sulphate @25 kg ha^{-1} + boron @ 10kg ha^{-1}, recorded significantly higher yield (534 kg ha^{-1}) during 2009-10 and was on par with RFD N,P and K, RFD N & K and RFD N and K + Zinc Sulphate @ 25 kg ha^{-1} treatments. However lower groundnut pod yields were recorded in control where no fertilizer were applied (Table 46).

Application of recommended doses of N and K along with zinc and boron recorded higher groundnut pod yields and this was closely followed by application of recommended dose of N and K. However treatment with recommended N and K recorded higher benefit cost ratio. Soil available phosphorus content decreased in all the treatments from initial level (174kg ha^{-1}).There is a slight increase in available potassium content, where as slight decrease in available nitrogen content over initial levels are noticed (Table 47).

Table: 46 Effect of balanced nutrition on rainfed groundnut productivity

S. No.	Treatments	Pod Yield (kg ha^{-1})					
		2007-08	2008-09	2009-10	Mean	Mean BC ratio	Mean RWUE (Kg/ha-mm)
1	Control (No fertilizers)	732	1473	362	684	1.81	1.96
2	RFD N & K only	882	1540	428	767	1.99	2.15
3	T_2 + Boron @ 10 kg/ha	788	1602	367	737	1.86	2.09
4	T_2 + Zn @ 25 kg/ha	965	1425	420	745	1.88	2.07
5	T_2+Zn +B	803	1551	534	769	1.87	2.24
6	Recommended NPK	878	1356	489	725	1.77	2.07
	CD (0.05)	NS	NS	135	—	—	—

Source: Annual Report, AICRPDA,ARS,Anantapuram, 2009-10

Table:47 Physico-chemical characteristics of soils as influenced by balanced nutrition in groundnut during 2007-2009 (mean values)

	Treatment	pH	EC (dSm^{-1})	Available nutrients (kg ha^{-1})		
				N	P_2O_5	K_2O
T_1	Control (No fertilizers)	5.57	0.02	101	90	112
T_2	RFD N& K only	5.53	0.027	96	98	124
T_3	T_2 + B @ 10 kg/ha	5.42	0.023	100	110	134
T_4	T_2 + Zn @ 25 kg/ha	5.46	0.027	108	106	144
T_5	T_2 + Zn + B	5.47	0.026	87	112	135
T_6	Recommended NPK	5.60	0.029	100	134	134
	Initial valves	5.8	0.03	113	174	121

Source: Annual Report, AICRPDA,ARS,Anantapuram, 2009-10

Nutrient response of horse gram under contingent situations for higher biomass production

Horse gram yield (seed and bhusa) grown as contingent situations, was not significantly influenced by the nutrient management practices (Annual Report, ARS,Anantapuram,2001).

Micro nutrients

Occurrence of iron chlorosis in groundnut in certain areas in alfisols under rainfed conditions was noticed under moisture stress conditions and found relieved from it with the receipt of rainfall. The decrease in yield due to iron chlorosis was more than 50% depending upon time of occurrence and its intensity. Iron deficiency in groundnut can be corrected by foliar spray of 0.2% ferrous sulphate (Table 48).

Table:48 Studies on the response of crops to application of Zinc Sulphate

Crops	Grain yield (kg ha^{-1})					
	Zinc sulphate @ 50 kg/ha			No Zinc sulphate		
	1971-72	1972-73	1973-74	1971-72	1972-73	1973-74
Bajra	778	1570	950	635	1291	800
Setaria	776	440	240	746	425	200
Groundnut	390	395	—-	353	313	—-
Cowpea	385	321	132	308	249	115
Sunflower	—-	440	—-	—-	425	—-
S.E	32.14	4.2	0.28	32.14	4.2	0.28
C.D	67.85	117.0	102	67.85	117	102

Source: Annual Report, ARS, Anantapuram, 1974-75

There was significant difference in grain yield of bajra, setaria, groundnut, cowpea and sunflower due to application of Zinc sulphate @ 50 kg ha^{-1}.

Table:49 Effect of $ZnSO_4$ applications on pod yield of groundnut

Treatment	**Pod yield (kg ha^{-1})**						
	1998 R	**1999 K**	**1999 R**	**2000 K**	**2000 R**	**2001 K**	**Mean**
Control	1122	891	2163	1010	1415	810	1235
25 kg $ZnSO_4$/ha/S	1372	1013	2529	1090	1890	888	1464
50 kg $ZnSO_4$/ha/S	1330	1100	2637	1225	1500	608	1400
50 kg $ZnSO_4$/ha/2S	1417	1077	2545	1372	1583	841	1473
50 kg $ZnSO_4$/ha/3S	1351	1032	2276	1154	1668	659	1357
0.2% $ZnSO_4$ spray at 35 & 45 DAS	1309	1227	2927	1308	2151	851	1629
CD (0.005)	NS	NS	283	NS	314	181	—-

Source: Annual Report, ARS, Anantapuram, 1974-75

Application of zinc @ 25 kg zinc sulphate/ha/season or 50 kg zinc sulphate ha^{-1} per 2seasons is giving similar yields (Table 49). Spraying of 0.2% zinc sulphate @ 35 & 45 DAS is more beneficial than the soil application.

3.4.5 Site specific nutrient management

Need driven fertilizer application in rainfed groundnut for higher net returns

In Anantapuram district, there is a practice of application of diammonium phosphate, a high analysis 'P' fertilizer (18 – 46 – 0) to groundnut in Anantapuram District. A systematic soil survey for nutrient status of farmers' fields of Anantapuram district. It revealed that there was phosphorus build up to the tune of 30% and depletion of available potassium upto 25%. Soil test based fertilizer application concept was developed for groundnut crop in scarce rainfall zone to reduce cost of cultivation. Phosphorus and potassium fertilizers were applied in full dose if soil test values were low and half of the recommended dose if soil test values were medium and no fertilizer if the soils contain high value of P and K.

Soil test based fertilizer application was also tried in farmers' fields and technology was found feasible and profitable when tested in Pennar-Manirevu National Watershed, Narasapuram National Watershed and K.Agraharam Watershed areas under Operational Research Project (Table 50 & 51).

Table:50 Pod and haulm yield (kg ha^{-1}) as influenced by soil test based fertilizer application in Narasapuram National Watershed area

Treatment	2003-04		2004-05		2005-06		Mean	
	Pod	Haulm	Pod	Haulm	Pod	Haulm	Pod (kg ha^{-1})	Haulm (kg ha^{-1})
Soil test based fertilizer application	501	923	1237	1983	1050	1992	929	1633
Farmers Practice	456	838	1078	1718	888	1861	807	1472

Source: Annual Report, AICRPDA,ORP, 2005-06

Table:51 Economics with soil test based fertilizer applications in groundnut in Narasapuram National watershed area

Treatment	Gross Returns (Rs./ ha)	Net Return (Rs./ ha)	Benefit Cost Ratio
Soil test based fertilizer application	14540	7323	1.98
Farmers Practice	12554	5391	1.73

Source: Annual Report, AICRPDA,ORP, 2005-06

Pod yield of groundnut was increased by 5 to 22% due to soil test based fertilizer application in different on-farm demonstrations. A saving of Rs.555 to 995/ha was realized in soil test based fertilizer application alone besides increasing pod yield of groundnut. The finding has contributed to the overall reduction in use of unnecessary fertilizers and there by the cost to be incurred on the fertilizer input.

The technology was approved in Zonal Research Extension Advisory Council meetings, held in the state during *kharif*-2003 and the department of agriculture is advised to follow the technology and recommendation being given in soil health cards. Soil health cards to be issued to the farmers based on soil analytical data are also changed accordingly.

Integrated nutrient supply system for rainfed semi-arid tropics

In castor – castor rotation and castor in castor-groundnut rotation, seed yield of castor were significantly influenced by the treatments. In castor – castor rotation, highest seed yields was recorded in 25% N as glyricidia +75% N inorganic (365 kg ha^{-1}) followed by 100% N as inorganic form (318 kg ha^{-1}) (Annual Report, ARS,Anantapuram, 2004) .

Table: 52 Yield and nutrient status as influenced by sheep penning in rainfed groundnut

Treatments	**Yield (Kg ha^{-1})**		**Available Nutrient Status (Kg ha^{-1})**		
	Pod	**Haulm**	**N**	**P_2O_5**	**K_2O**
Main plots					
Control	1267	1615	61	75	109
Sheep penning	1518	2408	72	93	351
Sheep manure	1528	1918	70	83	121
FYM	1425	1759	70	80	111
CD (P=0.05)	185	343	NS	NS	43
Sub plots					
Control	1408	1912	59	75	164
50 % FYM	1433	1934	62	79	168
50% RDF	1469	1922	62	87	171
50 % FYM+50%RDF	1429	1930	71	89	188
CD (P=0.05)	NS	NS	NS	NS	20

Sahadeva Reddy *et.al.,* 2012

Integrated groundnut based farming systems:

A field experiment was conducted during *kharif* 2009 and 2010 to validate the effect of sheep penning (ITK) on the soil and crop productivity in rainfed *alfisols* of Scarce Rainfall Zone of Andhra Pradesh. Sheep penning resulted increased pod and haulm yields by 20 and 50 per cent respectively compare to control (Table 52).

Sheep penning increased the available nitrogen and phosphorous in soil compared to control. K_2O content in sheep penning was increased by 222 per cent when compare to control. Integrated farming of rainfed groundnut with sheep and overnight sheep penning in the field enhance the yield and available nutrient status in soils.

3.5 Long Term Integrated Nutrient Management for Groundnut

A long-term experiment was initiated in the 1985 rainy season (June–October) at the Agricultural Research Station, Anantapuram, Andhra Pradesh, India under the All-India Coordinated Research Project for Dryland Agriculture (AICRPDA). Experimental soil is classified as Rhodostalfs (Voyalpadu series). The landscape is characterized by mild slope (<1%) with soils low in organic carbon (C) and available nitrogen (N), medium in phosphorus pentoxide (P_2O_5; 20 kg ha^{-1}) and dipotassium oxide (K_2O; 155 kg ha^{-1}), and sandy loam in texture (Table 1). Groundnut crop (variety: TMV-2) was grown during the rainy season (June–October) during the 28-year period (1985–2013).

Table 53

Initial properties of soil in permanent manorial experimental site

Value	
Soil taxonomy	Alfisol
Soil series	Voyalpadu
Soil texture	Sandy loam
pH (1:2 soil/water)	6.6
EC (dS m^{-1})	0.15
Organic carbon (%)	0.25
Available N (kg ha^{-1})	139
Available P (kg ha^{-1})	20
Available K (kg ha^{-1})	155

Plate 5: Longterm INM Experimental plot at ARS, Anantapuram

Fig:6 Experimental field view of Permanent mannurial trial at ARS,Anantapuram

Long-term usage of organic amendments such as groundnut shells and FYM along with inorganic fertilizers enriched the exchangeable as well as nonexchangeable K forms in K-deficient Alfisol soil profile. All the nutrient-management options maintained available K near to initial K levels, whereas there was a negative balance in control plots. Potassium release rates from soil were increased under treatments involving addition of organic mat- ter along with inorganic fertilizers (integration of organic and inorganic sources of K). Parabolic diffusion and first-order kinetic equations explained well the K release from the soil without being affected by the differential manuring. Present results caution that continu- ous cropping, in absence of K inputs, adversely affects the K supply and that continuous use of locally available organic manures such as groundnut shells can maintain the soil K supply. Therefore, depending upon locally available organic resources such as groundnut shells or FYM along with 50% recommended levels of inorganic fertilizers could supply to the level of maintenance dose of K to sustain the long-term productivity of soils.

Amount and distribution of rainfall during critical growth stages was more important to agronomic yield than total and seasonal rainfall. Thus, the amount of rainfall received during pegging stage (r = 0.47; P \ 0.05) and pod formation stage (r = 0.50; P \ 0.05) was significantly correlated with the mean pod yields. Whereas, use of diverse fertility management practices improved nutrient status in soil profiles (N, P, K, S, Ca, Mg, Zn, Fe, Mn and B) after 29 years of cropping, yet soil available N, K and B remained below the critical limits. Long-term cultivation also caused deficiency of S, Zn and B, which limited the groundnut productivity.

The objective of the experiment was to study the long term effects of recycling of farm wastes and organic manure along with or with out inorganic fertilizers on soil properties. The nutrient depletion pattern studies was initiated during kharif 1993.

The tretments are

T1 : Control

T2 : Rec. Fertilizer dose (20-40-40 N-P_2O_5-K_2O Kg ha^{-1})

T3 : Half Fertilizer Rec. dose (10-20-20 N-P_2O_5-K_2O Kg ha^{-1})

T4 : GNS (4 t ha^{-1})

T5 : FYM (4 t ha^{-1})

T6 : GNS (4 t ha^{-1}) + (10-20-20 N-P_2O_5-K_2O Kg ha^{-1})

T7 : FYM (4 t ha^{-1}) + (10-20-20 N-P_2O_5-K_2O Kg ha^{-1})

T8 : T2 + Zn SO_4@50 kg ha^{-1} Once in 3 years

T9 : FYM (5 t ha^{-1})

Table:54 Effect of long-term integrated nutrient management on groundnut pod yields (kg ha^{-1}) since 1985

Treatment /Year	Pod yield (kg ha^{-1})									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	CD
1985	1186	1367	1288	1187	1058	1077	1197	1309	991	84
1986	902	1055	943	1300	1138	1233	960	1072	945	204
1987	1364	1467	1428	1518	1240	1478	1447	1473	1161	NS
1988	1480	1786	1920	1605	1915	1741	1912	2040	1977	280
1989	1156	1446	1385	1129	1516	1152	1541	1453	1508	215
1990	1099	1264	1316	1348	1290	1218	1315	1238	1302	NS
1991	381	608	547	507	569	524	491	432	424	NS
1992	1016	1250	1143	1207	1130	1250	1352	1280	1141	NS
1993	493	745	724	634	662	642	716	733	626	NS
1994	469	658	568	633	625	757	708	642	601	130
1995	760	1111	984	799	926	1004	994	1131	946	84
1996	563	632	625	688	660	701	701	694	653	NS
1997	241	410	347	333	320	338	336	297	329	66
1998	966	1250	1112	1013	1088	1256	1182	1329	1087	NS
1999	823	1265	1080	957	1018	1152	1337	1348	988	123
2000	613	658	740	575	740	636	792	694	679	NS
2001	1034	1085	1188	888	1148	942	1302	930	1151	201
2002	451	363	391	498	410	522	456	415	460	NS
2003	441	385	366	577	414	588	328	401	267	89
2004	955	1546	1342	1196	1433	1419	1295	1370	1380	204
2005	728	820	893	901	1009	659	1123	861	986	195
2006	237	235	247	226	219	193	171	226	205	175
2007	719	988	680	719	938	708	1194	805	1198	247
2008	953	913	949	803	950	818	818	895	1076	181
2009	251	606	506	383	543	441	602	621	568	112
2010	820	1588	1089	1132	1429	1264	1733	1122	1674	390
2011	346	619	513	553	527	541	644	640	609	74
2012	439	748	637	618	641	634	784	726	693	180
2013	328	427	397	358	394	318	410	404	358	NS
MEAN	732	941	874	837	895	869	960	917	896	

Source: Annual Report, AICRPDA, ARS,Anantapuram- 2013-14

Table: 55 Depletion effect on pod yield (kg ha^{-1}) of groundnut since 1993

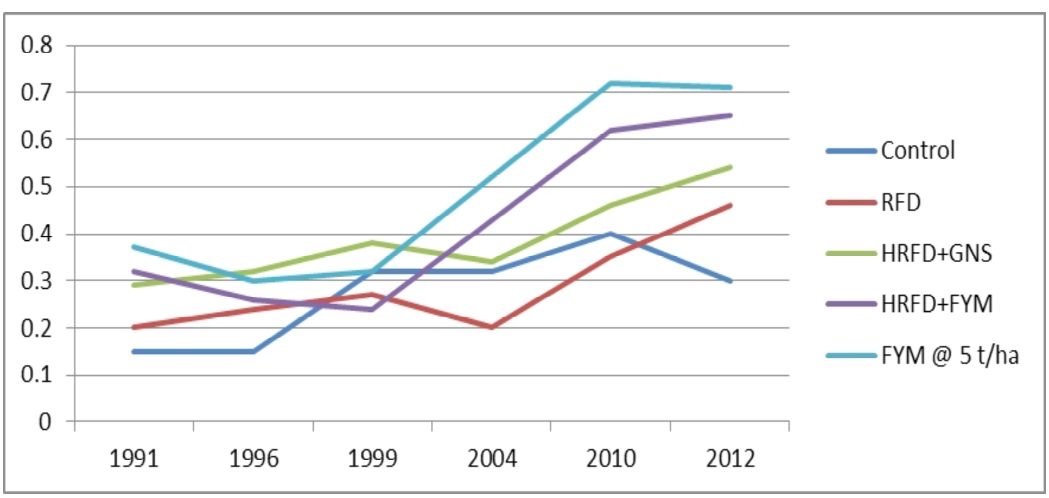
Treatment /Year	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	CD
1993	493	675	708	494	552	543	407	465	551	NS
1994	469	601	535	634	601	693	650	617	551	94
1995	760	975	858	838	877	897	906	916	867	105
1996	563	597	556	583	611	639	646	611	555	NS
1997	241	271	273	262	285	290	287	276	287	NS
1998	966	1065	1039	920	996	1088	1052	978	1019	NS
1999	823	1121	1019	980	1018	1049	1173	1060	1029	155
2000	613	622	643	591	638	658	751	664	715	NS
2001	1034	1069	988	1064	1114	1047	1225	1018	985	NS
2002	451	371	397	375	420	351	357	273	348	NS
2003	441	530	404	379	425	387	448	540	304	107
2004	955	1211	1084	1100	1213	1124	1160	1209	1185	NS
2005	728	750	739	851	918	781	771	813	958	122
2006	237	217	213	216	189	198	204	201	209	NS
2007	719	717	558	865	1063	806	861	671	269	242
2008	953	951	919	934	956	822	989	864	962	79.7
2009	251	262	262	436	328	302	217	191	274	135
2010	820	1005	929	967	1111	886	884	970	1258	353
2011	346	416	383	458	432	404	434	442	501	127
2012	439	517	431	483	493	444	488	523	601	132
2013	328	352	364	341	386	316	357	353	341	NS
MEAN	601	681	633	656	696	654	679	650	656	

Source: Annual Report, AICRPDA, ARS,Anantapuram- 2013-14

Soil enzyme dehydrogenase activity was highest with use of FYM followed by groundnut shells indicating that soil biological activity was also improved with the recycling of farm organics.

Influence of longterm recycling of farm organics on soil properties

Soil pH of the surface layer was slightly acidic under 100 % NPK and the control plots, and was close to being neutral in soil receiving 50 %NPK+ GNS or 50 % NPK+ FYM (INM treatments) and 100 % organic treatments (Table 56). In general, soil pH increased with depth of the profile in all treatments. The minimum EC of soil was observed in the control treatment ranging from 0.023 to 0.061 dS m^{-1} and the maximum of 0.070 to 0.123 dS m^{-1} in the 100 % NPK treatment. Furthermore, the EC was lower in the surface (0–0.2 m) compared with that in the sub surface layers (0.2–0.4 m). The concentration of SOC in the profile improved significantly in all fertilizer and manurial treatments as compared to those in the control. Higher SOC concentration (5.8–6.2 g kg^{-1}) was observed in the treatments having receiving organics in the form of either FYM or GNS (Srinivasarao *et al.* 2012). The lime content was lower (0.18 %) in the surface layer (0–0.2 m) of the 100 % NPK than that in all other treatments. The lime content increased with increase in soil depth up to 0.8 m in all INM treatments (50 % NPK + GNS/FYM) followed by a decrease with increase in soil depth. In contrast, the lime content increased with increase in depth down to 1.0 m in the control. Applications of fertilizers or manure increased CEC especially in the 0–0.2 m layer. The average CEC for the profile ranged from 14.0 to 17.5 cmol kg^{-1} for the control compared



Graph : 10 Effect of INM on Organic carbon content (%) over years

Table 56 Soil properties of Alfisol profile after 20 years of continuous cropping, fertilization and manuring (Mean ± standard deviation)

Treatment	Soil pH (1:2)	EC (dS m^{-1})	SOC (g kg^{-1})	$CaCO_3$ (%)	CEC (Cmol (+) kg^{-1})
Soil depth 0–0.2 mControl	6.1 ± 0.02^{Cc}	0.023 ± 0.001^{Cc}	3.1 ± 0.14^{Ca}	0.26 ± 0.03^{Ce}	14.7 ± 0.3^{Db}
100 % RDF	6.2 ± 0.03^{Cc}	0.061 ± 0.002^{Bc}	4.0 ± 0.18^{Ba}	0.18 ± 0.02^{De}	16.5 ± 0.3^{Cc}
50 % RDF + 4 Mg ha^{-1} GNS	6.8 ± 0.03^{Bc}	0.073 ± 0.003^{Ab}	6.2 ± 0.29^{Aa}	0.35 ± 0.03^{Bc}	18.2 ± 0.4^{Ab}
50 % RDF + 4 Mg ha^{-1} FYM	7.4 ± 0.04^{Aa}	0.061 ± 0.002^{Bb}	5.9 ± 0.27^{Aa}	0.41 ± 0.02^{Ad}	18.8 ± 0.4^{Ac}
5 Mg ha^{-1} FYM	7.2 ± 0.03^{Ab}	0.060 ± 0.002^{Bc}	5.8 ± 0.26^{Aa}	0.41 ± 0.04^{Ac}	17.4 ± 0.3^{Bb}
Soil depth 0.2–0.4 mControl	6.8 ± 0.02^{Cb}	0.037 ± 0.001^{Db}	2.6 ± 0.12^{Cb}	0.59 ± 0.03^{Dc}	17.3 ± 0.3^{Da}
100 % RDF	7.0 ± 0.03^{Bb}	0.121 ± 0.005^{Aa}	3.2 ± 0.14^{Bb}	0.80 ± 0.05^{Cb}	18.1 ± 0.4^{Cb}
50 % RDF + 4 Mg ha^{-1} GNS	7.1 ± 0.04^{Bb}	0.108 ± 0.004^{Ba}	4.6 ± 0.22^{Ab}	0.89 ± 0.05^{Ba}	18.8 ± 0.4^{Bb}
50 % RDF + 4 Mg ha^{-1} FYM	7.4 ± 0.06^{Aa}	0.104 ± 0.004^{Ba}	4.3 ± 0.20^{Ab}	0.98 ± 0.06^{Aa}	18.8 ± 0.4^{Bc}
5 Mg ha^{-1} FYM	7.3 ± 0.04^{Ab}	0.098 ± 0.004^{Ca}	3.9 ± 0.20^{Ab}	0.98 ± 0.04^{Aa}	19.5 ± 0.4^{Aa}
Soil depth 0.4–0.6 mControl	7.3 ± 0.05^{Ba}	0.040 ± 0.002^{Eb}	2.6 ± 0.12^{Bb}	0.38 ± 0.02^{Cd}	17.5 ± 0.4^{Ca}
100 % RDF	7.2 ± 0.03^{Ba}	0.123 ± 0.005^{Aa}	2.6 ± 0.12^{Bc}	0.53 ± 0.03^{Bc}	20.5 ± 0.4^{Aa}
50 % RDF + 4 Mg ha^{-1} GNS	7.6 ± 0.07^{Aa}	0.068 ± 0.003^{Db}	3.0 ± 0.15^{Ac}	0.85 ± 0.04^{Ab}	20.6 ± 0.4^{Aa}
50 % RDF + 4 Mg ha^{-1} FYM	7.4 ± 0.05^{Aa}	0.095 ± 0.004^{Ba}	2.7 ± 0.12^{Bc}	0.85 ± 0.04^{Ab}	20.8 ± 0.4^{Aa}
5 Mg ha^{-1} FYM	7.4 ± 0.06^{Ab}	0.085 ± 0.003^{Cb}	2.9 ± 0.13^{Ac}	0.84 ± 0.05^{Ab}	19.5 ± 0.4^{Ba}
Soil depth 0.6–0.8 mControl	7.3 ± 0.07^{Ba}	0.035 ± 0.001^{Db}	1.9 ± 0.09^{Bc}	0.71 ± 0.03^{Bb}	14.0 ± 0.3^{Dc}
100 % RDF	7.2 ± 0.04^{Ba}	0.070 ± 0.003^{Bb}	1.9 ± 0.09^{Bd}	0.91 ± 0.05^{Aa}	16.5 ± 0.3^{Cc}
50 % RDF + 4 Mg ha^{-1} GNS	7.6 ± 0.06^{Aa}	0.044 ± 0.002^{Cc}	1.9 ± 0.09^{Bd}	0.91 ± 0.04^{Aa}	17.1 ± 0.3^{Bc}
50 % RDF + 4 Mg ha^{-1} FYM	7.6 ± 0.06^{Aa}	0.099 ± 0.004^{Aa}	2.1 ± 0.11^{Ad}	0.95 ± 0.06^{Aa}	19.5 ± 0.4^{Ab}
5 Mg ha^{-1} FYM	7.5 ± 0.05^{Aa}	0.065 ± 0.003^{Bc}	1.9 ± 0.09^{Bd}	0.93 ± 0.03^{Aa}	17.5 ± 0.4^{Bb}
Soil depth 0.8- 1.0 mControl	7.5 ± 0.03^{Aa}	0.061 ± 0.002^{Ca}	1.5 ± 0.07^{Bd}	0.87 ± 0.04^{Aa}	10.7 ± 0.2^{Cd}
100 % RDF	7.4 ± 0.05^{Ba}	0.073 ± 0.003^{Ab}	1.5 ± 0.07^{Be}	0.38 ± 0.02^{Cd}	15.7 ± 0.3^{Bd}
50 % RDF + 4 Mg ha^{-1} GNS	7.5 ± 0.06^{Aa}	0.044 ± 0.002^{Dc}	1.6 ± 0.07^{Be}	0.40 ± 0.02^{Cc}	15.6 ± 0.3^{Bd}
50 % RDF + 4 Mg ha^{-1} FYM	7.6 ± 0.02^{Aa}	0.070 ± 0.003^{Bb}	1.8 ± 0.08^{Ad}	0.47 ± 0.03^{Bc}	15.8 ± 0.3^{Bd}
5 Mg ha^{-1} FYM	7.7 ± 0.04^{Aa}	0.076 ± 0.003^{Ab}	1.7 ± 0.08^{Bd}	0.44 ± 0.02^{Bc}	16.1 ± 0.3^{Ac}

Different capital and small letters denotes significant difference of treatment and depth at P = 0.05 according to Duncan Multiple Range Test (DMRT) for separation of means

Srinivasarao *et.al.,* 2012

Micronutrients in soil profile influenced by INM

With continuous cropping, soils were deficient in available Zn (critical limit 0.75 mg kg^{-1}) regardless of the fertility management treatment (Table 57). The concentration of available Zn (mg kg^{-1}) in 0–0.2 m layer, ranged from 0.52 (control) to 0.72 (50 % NPK + 4 Mg ha^{-1} FYM). The concentration (mg kg^{-1}) of available Zn ranged from 0.40 to 0.52 for the control to 0.52–0.72 for 50 % NPK + 4 Mg ha^{-1} FYM in the profile. The concentration of available Fe was similar among all treat- ments. In general, however, there was a trend of somewhat higher concentration of available Fe in treatments receiving organics than control and 100 % NPK treatment. The concentration (mg kg^{-1}) of available Fe ranged in the profile from 4.1 to 9.2 compared with 5.3 to 10.6 for 50 % NPK + 4 Mg FYM ha^{-1}. The concentration of available Fe was adequate in soils under all the treatments. There was a general trend of a slight increase in concentration of available Mn in soil receiving the INM treatments compared with those under control and 100 % NPK. The concentration (mg kg^{-1}) of available Mn ranged from 4.3 to 13.8 in control to 7.0–16.5 in 50 % NPK ? 4 Mg ha^{-1} FYM across the profile. The highest concentration of available Mn in the entire profile was observed in soils receiving 100 % organic treatment. Overall, however, the concentration of available Mn in soils was adequate in all treatments. The concentration of available Cu was similar among all treatments. In general, there was a trend of somewhat lower concentration of available Cu in soil profiles receiving the NPK treatment. Nonetheless, the concentration of Cu was adequate in soil layers of all treatments. In contrast, the concentration of available B was deficient in all treatments. Furthermore, even the continuous addition of organic manures (e.g., GNS and FYM for 20 years) only marginally improved the status of available B in soil. Therefore, the concentrations of available B (mg kg^{-1}) were low and ranged across the profile from 0.04 to 0.19 in control to, 0.06–0.21 in 100 % NPK treatment compared with the critical limit of 0.58. The maximum concentration of available B in the top soil was observed in 50 % NPK + 4 Mg ha^{-1} FYM followed by that in the 100 % organic (5 Mg ha^{-1} FYM) and 50 %NPK + 4 Mg ha^{-1} GNS.

Table 57 Available micronutrient status in Alfisol profile after 20 years continuous cropping, fertilization and manuring (Mean ± standard deviation)

Treatment	Av. Zn	Av. Fe	Av. Cu	Av. Mn	Av. B
				mg kg^{-1}	
Soil depth 0–0.2 mControl	0.52 ± 0.04^{Ca}	9.2 ± 0.60^{Ba}	1.02 ± 0.07^{Ba}	13.8 ± 0.97^{Ca}	0.13 ± 0.01^{Eb}
100 % RDF	0.57 ± 0.04^{Ba}	9.5 ± 0.70^{Ba}	0.94 ± 0.06^{Ca}	13.9 ± 0.91^{Ca}	0.18 ± 0.01^{Db}
50 % RDF + 4 Mg ha^{-1} GNS	0.58 ± 0.04^{Bb}	10.2 ± 0.71^{Aa}	1.02 ± 0.07^{Ba}	15.1 ± 1.06^{Ba}	0.24 ± 0.01^{Cb}
50 % RDF + 4 Mg ha^{-1} FYM	0.72 ± 0.05^{Aa}	10.6 ± 0.74^{Aa}	1.08 ± 0.08^{Aa}	16.5 ± 1.16^{Aa}	0.35 ± 0.02^{Aa}
5 Mg ha^{-1} FYM	0.70 ± 0.05^{Aa}	10.4 ± 0.73^{Aa}	1.04 ± 0.07^{Aa}	15.7 ± 1.10^{Ba}	0.29 ± 0.02^{Ba}
Soil depth 0.2–0.4 mControl	0.50 ± 0.04^{Ea}	7.6 ± 0.53^{Bb}	0.88 ± 0.06^{Cb}	10.4 ± 0.73^{Cb}	0.19 ± 0.01^{Ba}
100 % RDF	0.55 ± 0.04^{Ca}	7.8 ± 0.55^{Bb}	0.88 ± 0.06^{Cb}	10.6 ± 0.74^{Cb}	0.21 ± 0.01^{Ba}
50 % RDF + 4 Mg ha^{-1} GNS	0.62 ± 0.04^{Ba}	8.8 ± 0.62^{Ab}	0.94 ± 0.07^{Bb}	13.1 ± 0.92^{Bb}	0.28 ± 0.02^{Aa}
50 % RDF + 4 Mg ha^{-1} FYM	0.65 ± 0.05^{Ab}	9.0 ± 0.63^{Ab}	1.04 ± 0.07^{Ab}	14.4 ± 1.01^{Ab}	0.28 ± 0.02^{Ab}
5 Mg ha^{-1} FYM	0.46 ± 0.03^{De}	9.2 ± 0.64^{Ab}	1.02 ± 0.07^{Aa}	12.6 ± 0.88^{Bb}	0.27 ± 0.02^{Aa}
Soil depth 0.4–0.6 mControl	0.46 ± 0.03^{Db}	5.7 ± 0.40^{Cc}	0.81 ± 0.05^{Cc}	8.3 ± 0.58^{Dc}	0.09 ± 0.01^{Ac}
100 % RDF	0.50 ± 0.04^{Cb}	6.0 ± 0.42^{Cc}	0.80 ± 0.05^{Cc}	8.4 ± 0.59^{Cc}	0.09 ± 0.01^{Ac}
50 % RDF + 4 Mg ha^{-1} GNS	0.52 ± 0.04^{Cc}	7.6 ± 0.53^{Bc}	0.86 ± 0.06^{Bc}	10.3 ± 0.72^{Bc}	0.11 ± 0.01^{Ac}
50 % RDF + 4 Mg ha^{-1} FYM	0.63 ± 0.04^{Ab}	8.3 ± 0.58^{Ac}	0.89 ± 0.06^{Ac}	12.2 ± 0.85^{Ac}	0.11 ± 0.01^{Ac}
5 Mg ha^{-1} FYM	0.55 ± 0.04^{Bc}	8.3 ± 0.59^{Ac}	0.91 ± 0.05^{Ab}	9.1 ± 0.64^{Cc}	0.10 ± 0.01^{Ab}
Soil depth 0.6–0.8 mControl	0.42 ± 0.03^{Cc}	4.5 ± 0.32^{Bd}	0.46 ± 0.03^{Cd}	4.8 ± 0.34^{Cd}	0.07 ± 0.01^{Ac}
100 % RDF	0.51 ± 0.04^{Bb}	4.8 ± 0.34^{Bd}	0.46 ± 0.03^{Cd}	7.6 ± 0.53^{Ad}	0.08 ± 0.01^{Ac}
50 % RDF + 4 Mg ha^{-1} GNS	0.50 ± 0.04^{Bc}	5.6 ± 0.39^{Ad}	0.52 ± 0.04^{Bd}	6.8 ± 0.48^{Bd}	0.09 ± 0.01^{Ac}
50 % RDF + 4 Mg ha^{-1} FYM	0.61 ± 0.04^{Ac}	5.5 ± 0.40^{Ad}	0.64 ± 0.04^{Ad}	7.5 ± 0.53^{Ad}	0.08 ± 0.01^{Ad}
5 Mg ha^{-1} FYM	0.60 ± 0.04^{Ab}	5.7 ± 0.40^{Ae}	0.67 ± 0.05^{Ac}	5.4 ± 0.38^{Cd}	0.08 ± 0.01^{Ab}
Soil depth 0.8–1.0 mControl	0.40 ± 0.03^{Dc}	4.1 ± 0.29^{Ce}	0.24 ± 0.02^{Ce}	4.3 ± 0.30^{Be}	0.04 ± 0.01^{Bd}
100 % RDF	0.44 ± 0.03^{Cc}	4.1 ± 0.29^{Ce}	0.26 ± 0.02^{Ce}	7.2 ± 0.50^{Ae}	0.06 ± 0.01^{Ad}
50 % RDF + 4 Mg ha^{-1} GNS	0.48 ± 0.03^{Bd}	5.6 ± 0.39^{Bd}	0.27 ± 0.02^{Ce}	6.6 ± 0.46^{Ad}	0.08 ± 0.01^{Ad}
50 % RDF + 4 Mg ha^{-1} FYM	0.52 ± 0.04^{Ad}	5.3 ± 0.37^{Bd}	0.33 ± 0.02^{Be}	7.0 ± 0.49^{Ae}	0.08 ± 0.01^{Ad}
5 Mg ha^{-1} FYM	0.51 ± 0.04^{Ad}	6.1 ± 0.43^{Ad}	0.42 ± 0.03^{Ad}	4.9 ± 0.34^{Be}	0.08 ± 0.01^{Ab}

Different capital and small letters denotes significant difference of treatment and depth at P = 0.05 according to Duncan Multiple Range Test (DMRT) for separation of means

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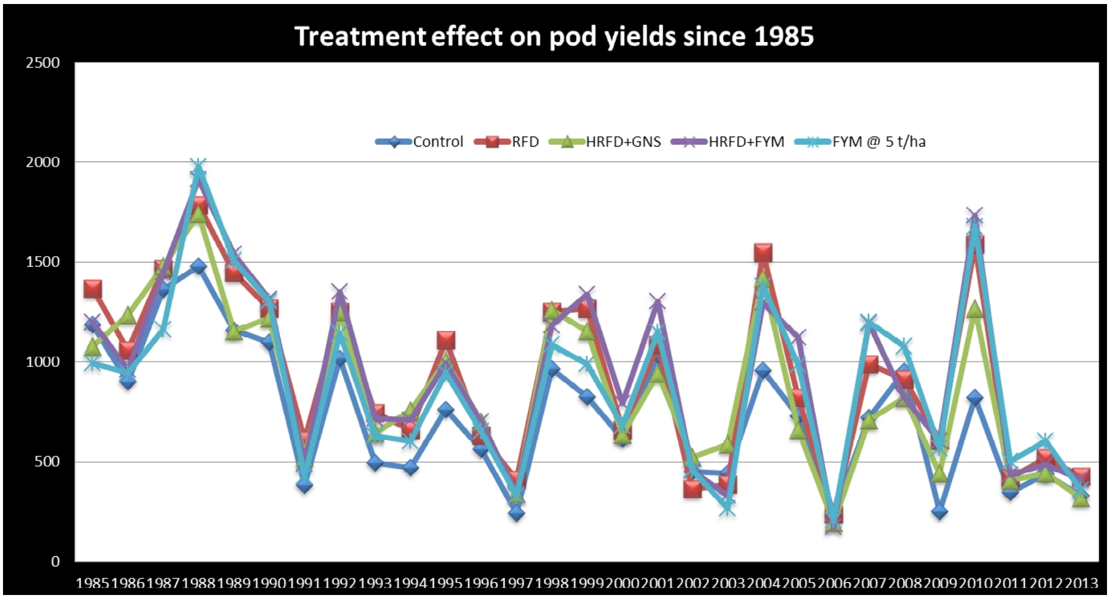
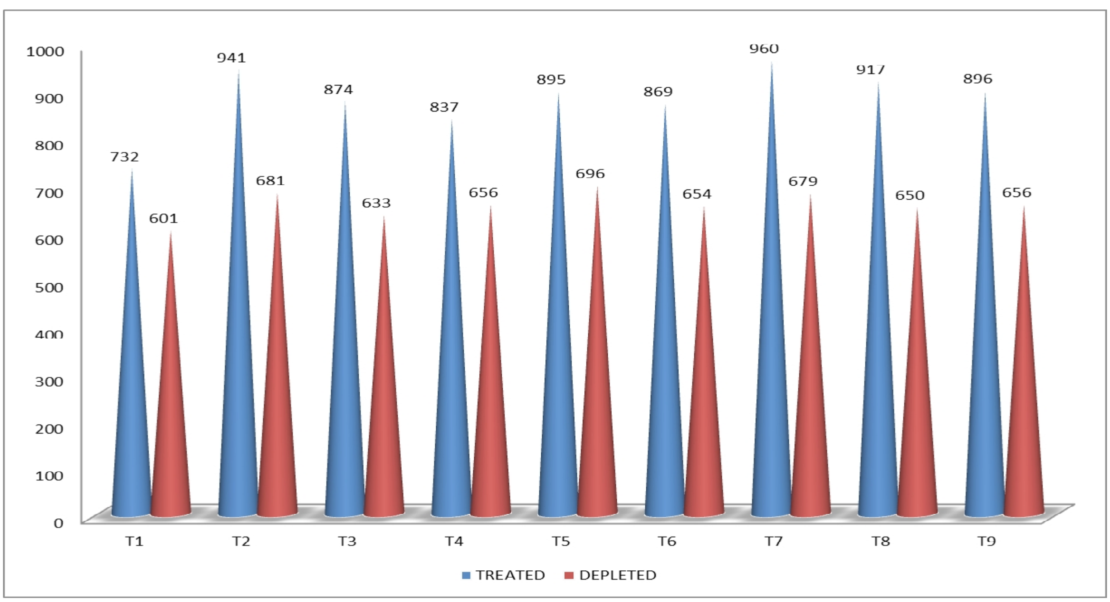
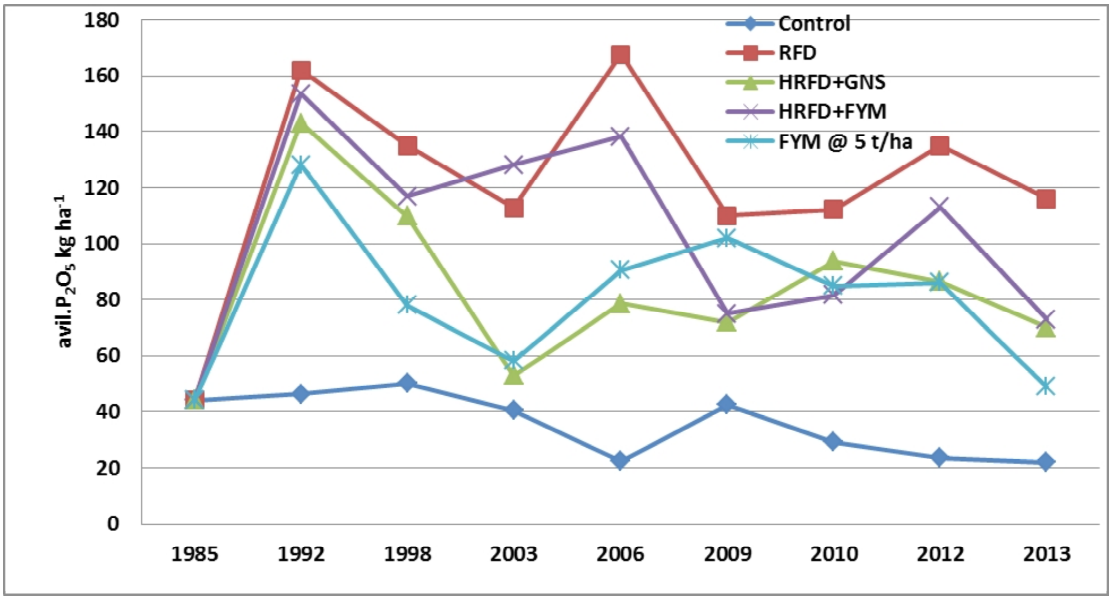


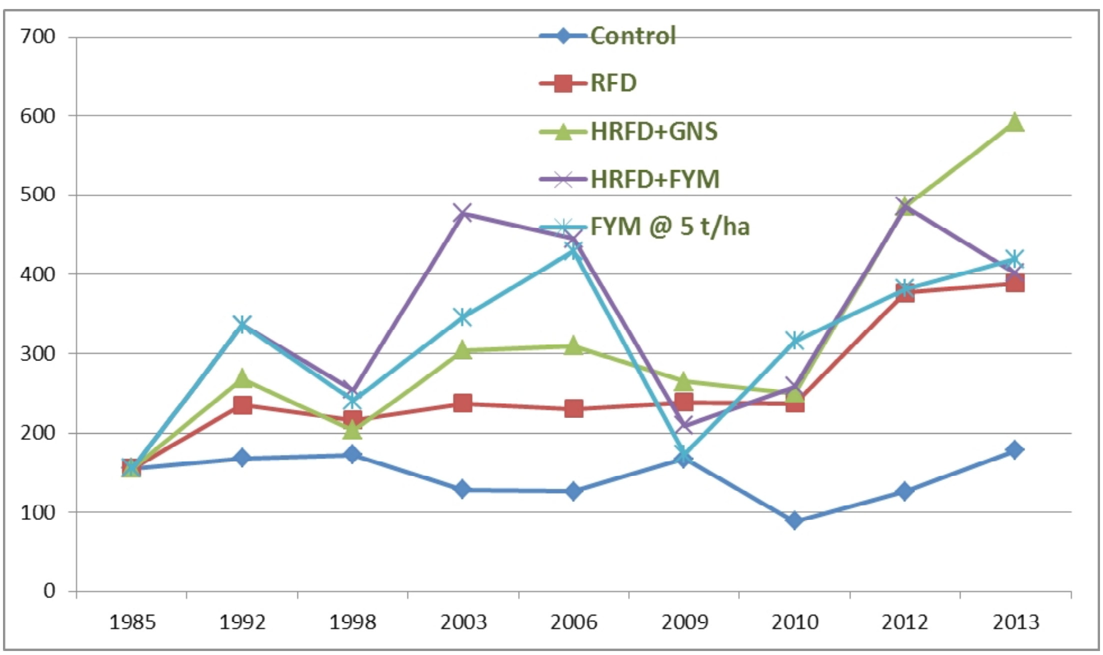
Graph : 11 : Effect of long term Integrated Nutrient Management on pod yield(kg ha^{-1}) of groundnut since 1985



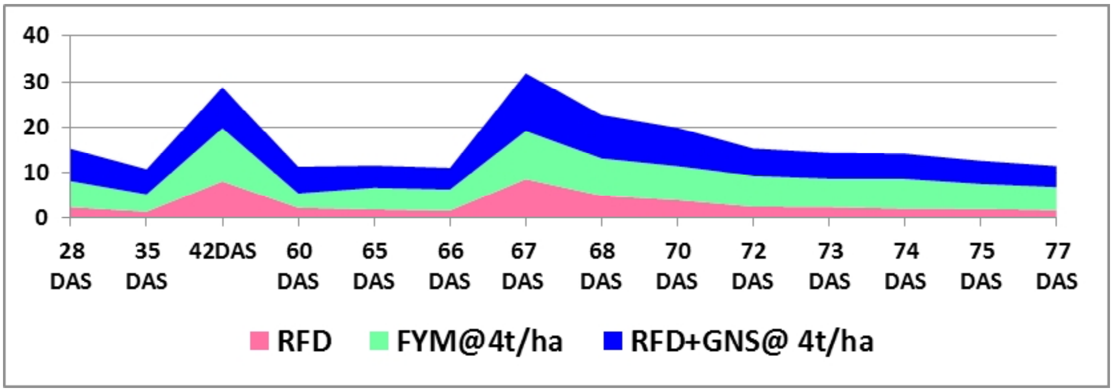
Graph :12 Effect of long term Integrated Nutrient Management on groundnut pod yield (kg ha^{-1}) since 1985 (29 yrs) & (21 yrs)



Graph : 13 Effect of INM on Available P_2O_5 content (kg ha^{-1}) over years



Graph : 14 Effect of INM on Available K_2O content (Kg ha^{-1}) over years



Graph :15 : Moisture content (% volume) during crop growth period in RFD, FYM @ 4t ha^{-1} and RFD+GNS@ 4t ha^{-1}

Results:

- Pod yield over control was influenced by all the treatments in majority of the years (20 out of 29 years) of experimentation.
- Mean differential yield was at par in both RFD (941 kg ha^{-1}) and HRFD + FYM @ 4 t ha^{-1} (960 kg ha^{-1}). However control (732 kg ha^{-1}) recorded lowest mean pod yield.
- Uniform distribution of rainfall during the crop growth period in critical stages is very important rather than the total rainfall
- After non application of fertilizers and manures for the past 21 years all the treatments regestered yields more or less equal to that of control.
- The initial available P_2O_5 of 44.2 kg ha^{-1} reduced to 22 kg ha^{-1} and 126 kg ha^{-1} respectively in the control over 29years
- The initial available phosphorous content increased in treatments received with only inorganics alone compared to other treatments, whereas available potassium content increased over initial values in treatments received with organics or organics in combination with inorganics, over control.
- An attempt was made through ICAR, New Delhi funded National Agricultural Technology Project (NATP) on "*Assessment and improvement of soil quality and resilience for rainfed production system*" to develop soil quality index under rainfed groundnut productivity system revealed that integrated use of both organic (FYM @ 4 t ha^{-1}) and inorganics (10-20-20 N, P_2O_5, K_2O kg ha^{-1}) fertilizer emerged as best practice and found to be not only sustain but also upgrade the soil quality index and significantly correlated with groundnut pod yield.

- Application of chemical fertilizers based on soil test values was evolved from this experiment. Application of full recommended fertilizer dose (20 N, 40 P_2O_5 and 40 kg ha^{-1} K_2O) applied when the soil test values for NPK were low and half the recommended fertilizer dose (20 N, 20 P_2O_5 and 20 K_2O kg ha^{-1}) is sufficient when P and K are medium in range. However application of P and K are not required when the soil test values are high.
- So keeping in view of soil nutrient status, the treatment Half Recommended Fertilizer Dose (10-20-20 N, P_2O_5, K_2O kg ha^{-1}) along with Farm Yard Manure @ 4 t ha^{-1} is giving at par yields compared to full recommended dose of fertilizers which not only giving sustainable yields but also enhancing the soil health.

Table 58 Effect of long-term groundnut cropping, fertilization and soil amendments on balance of major nutrients (in surface 0- 0.2 m soil depth)

Treatments	Initial nutrient status (1985) (kg ha^{-1})	Applied nutrients	Crop removal	Nutrient status at 2004	Balance
N					
Control1	39	0	334	74.5	-195
100 % RDF	139	400	464	141.7	75
50 % RDF + 4 Mg ha^{-1} GNS	139	1000	523	141.3	616
50 % RDF + 4 Mg ha^{-1} FYM	139	800	534	132.7	405
5Mg ha^{-1} FYM	139	750	462	138.5	427
Control	20	0	109	19.8	-89
100 % RDF	20	800	165	28.9	655
50 % RDF +4 Mg ha^{-1} GNS	20	600	210	25.4	410
50 % RDF + 4 Mg ha^{-1} FYM	20	560	202	30.6	378
5Mg ha^{-1} FYM	20	200	169	23.4	51
Control1	55	0	348	82.9	-193
100 % RDF	155	800	519	160.5	436
50 % RDF + 4 Mg ha^{-1} GNS	155	1280	598	118.7	837
50 % RDF + 4 Mg ha^{-1} FYM	155	800	597	156.8	358
5Mg ha^{-1} FYM	155	500	536	148.5	119

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Nutrient input, output and balances, computed for major nutrients over the 20 years of cropping, are presented in Table58. Higher amounts of nutrients (N, P, K) were added through combination of chemical fertilizers and organics.The highest amount of N (1,000 kg ha^{-1}) and K(1,280 kg ha^{-1}) were added in 50%RDF+ 4 Mg ha^{-1} GNS treatment, but higher amount of P(800 kg ha^{-1}) was added in100% RDF treatment in 20 years. Higher removal of N, P, K was observed in all INM treatments (e.g., 50 % RDF+ 4 Mg ha^{-1}GNS : 523, 210 and 598 kg ha^{-1} of N, P, K) and 50% RDF+4 Mg ha^{-1} FYM (534,202 and 597 kg ha^{-1}of N, P, K) followed by that in the100% organic (462,169 and 536 kg ha^{-1} of N, P, K) and the least in the control (334, 109 and 348 kg ha^{-1} of N, P, K). With exception of the control, there was a positive balance of N, P and K in 100% NPK, INM and 100% organic treatments. In control, negative balance of N(- 195 kg ha^{-1}), P(- 89 kg ha^{-1}) and K (- 193 kg ha^{-1}) were observed. The highest positive balance of N (616 kg ha^{-1}) and K (837 kg ha^{-1}) were observed in50% RDF+4 Mg ha^{-1} GNS treatment, whereas, that of P (655 kg ha^{-1}) was observed in 100% RDF treatment over 20years.

Soil test based fertilizer application to groundnut increased the economic returns and reduced the cost of cultivation.

- In Anantapuram district, there is a practice of application of diammonium phosphate, a high analysis 'P' fertilizer (18-46-0) to groundnut crop. This practice resulted in built up of reliable phosphorus.
- In addition, depletion of potassium was also observed. Soil test based fertilizer application, i.e., half the recommended dose of fertilizer to medium P and K soils and full recommended dose to low P and K soils and no application of fertilizers to high P and K soils, has been developed and tested. (Table 58) Pod yield of groundnut increased by 5 to 22% due to soil test based fertilizer application. A saving of Rs. 555 to 995/ha was realized due to soil test based fertilizer application alone besides increase in pod yield of groundnut. Hence, soil test based fertilizer application to groundnut crop not only reduces its cost of cultivation, but also improves the net returns per unit area.

Table 59. Fertilizer recommendation for rainfed groundnut grown in alfisols of Anantapuram based on soil test values

Nutrient	Soil test value (kg ha^{-1})	Dose to be applied (kg ha^{-1})
Phosphorus (P_2O_5)		
Low	< 20	40
Medium	20 – 50	20
High	> 50	Nil
Potassium (K_2O)		
Low	< 150	40
Medium	150 – 300	20
High	> 300	Nil

Achieving food security for a rapidly expanding population in the tropics would necessitate intensifying food production on existing crop lands through enhanced nutrient input and recycling. Growing of legumes and using locally available organics (e.g., FYM, crop residues / byproducts) can improve soil fertility and enhance crop nutrition. Although the benefits of using FYM are widely recognized, its availability is becoming a constraint because of the declining livestock population and alternative uses of dung as a fuel. Performance of GNS is equally good as FYM in terms of increasing yield and improving soil fertility. So it can be a viable alternative as soil amendment/organic nutrient source for improving soil fertility. Benefits of improved soil fertility with nutrient management can only be harnessed when proper distribution of rainfall is received during the growing season, or the drought stress is alleviated with application of supplementary irrigation. Less removal of nutrients because of low crop yield under harsh climatic conditions leads to higher than expected nutrient balance. But, considering nutrient status in 2004, there is a disparity between the current availability and estimated nutrient balance for most of the nutrients studied depicting the other fraction (difference of estimated and present nutrient status) as unavailable or fixed or lost. Hence, there is need for a comprehensive study of all the possible nutrient fluxes (input and output) for ideal nutrient balance study. The P buildup in all the treatments except control, suggests the possibility of reduction of P dose or skipping P application in alternate year. As P response was not found in desired magnitude, P fraction studies can be conducted to get better idea of what could be the possible reason for P buildup.

4. Externally funded projects

4.1. NATP MM on Land Use Planning

Mission Mode project "Landuse planning for management of Agricultural Resources" was taken up during the year 2001 - 2004, with the main objective to develop strategies and options for rational and scientific land use plans at watershed level integrating geo referenced bio-physical information on land and socio-economic attributes for maximum and sustained production in rainfed Agro Eco-system. Agricultural Research Station, ANGRAU, Anantapuram was selected as one of the centres and Nallakonda watershed in B.K.Samudram mandal of Anantapuram district was taken for this purpose.

Extensive traverse of the watershed was carried out as the first step to identify field boundaries and study external land features. Based on the recorded observations, the soils were grouped into eleven different soil series. Texture of most of the soils is varying from loamy sand to sandy loam with 1 to 3% slope, and moderately eroded classified under Rhodustalfs.

The physiographic position is Deccan Plateau, soils are derived from granite, gneiss and coarse grained granites, occasionally influenced by dolamite dykes with undulated topography and the elevation is 350 m above MSL. The present land use mainly under rainfed agriculture and the dominant annual crop is groundnut. The depth of the soils varies considerably from extremely shallow to very deep with well drainage. The surface and sub-surface gravelliness is dominant in the watershed. The watershed soil was neutral to alkaline in reaction, low in available nitrogen and phosphorus and sufficient in zinc, magnesium and copper. The interpretative grouping of the soil series into land capability classes yielded two classes viz., III and IV and the land irrigability classes yielded three classes II, III and IV where the major limitations were climate, soil and erosion

Majority of the farmers are of marginal to semi-medium and the main source of getting inputs were through private lenders. Regarding gender issues 61.4% of women farmers were involved in decision making in agriculture, 88.8% in livestock management and almost 90% in household activities.

On-farm trials conducted to study the influence of soil depth and soil test based fertilizer application on growth and yield of rainfed groundnut with the objectives viz., to reduce the cost of cultivation and to increase the yield of rainfed groundnut.

The results will be revealed that from two years pooled analysis data; the plant height, pod yield and haulm yield were higher in medium and deep depth soils than shallow soils. The growth and yield difference between medium (326 kg ha^{-1}) and deep soils are marginal. The lack of response beyond 50 cm of soil depth during the two years of experimentation might be due to very low rainfall received. With regard to the plant nutrition the difference in plant height, pod yield and haulm yield between farmers' method of application and soil test based application was marginal, though the yields were not increased due to soil test based fertilizer application. There was substantial reduction in the expenditure on fertilizers (Rs.2517/ha). It might be due to build up of phosphorus in the soils due to the continuous application of DAP by the farmers and further application of phosphorus did not give any excess yield from the results. Among different technological interventions tried at the watershed level in the farmers' fields, soil test based fertilizer is beneficial over farmers' way of fertilizer application in reduction of cost of cultivation of groundnut intercropped with redgram. Soils having depth more than 25 cm are suitable for successful rising of groundnut under scarce rainfall conditions cost of cultivation.

4.2. NATP – RRPS – 20 ASSESSMENT AND IMPROVEMENT OF SOIL QUALITY AND RESILIENCE FOR RAINFED PRODUCTION SYSTEM

The project "Assessment and improvement of soil quality and resilience for rainfed production system" was taken up during the year 2000 -2004, with the main objective to identify and measure the indicators for assessing soil quality and resilience under longterm manorial trial with different management practices. Agricultural Research Station, Anantapuram was selected as one of the centres for this purpose as long term manorial trial on rainfed groundnut production system was in progress at this research station since 1985.

Five treatments were chosen on going LT experiment to meet the above objective and extensive data base was generated during the project period for the proposed five models treatments viz., T1 : to T5. In addition to this five treatments soil samples were also collected from a fallow field (near the experimental site) where no cultivation was practiced over a period of last 30 years. Attributes of soil quality were chosen based on scientific principles and personnel judgments. Most of the chosen attributes suchas physical (BD, IR, WHC), chemical (pH, OC, available major secondary and micro nutrients). Biological (microbial biomass carbon, dehydragenese enzyme activity) and food quality (shelling percentage and oil content of groundnut) were analysed.

Efforts were made to calculate SQI for all the treatments through two methods – conventional and statistical giving appropriate weightages through different parameters using personal judgment. Through conventional method such index was calculated using the parameters from the fallow as the base line to judge whether there was any aggredation/degradation in soil quality because of as they figured in all the years, MBC, organic carbon and available N were also found to be good indicators as they figure in two out of four years. There was a good correlation existed between OC and available N, OC and MBC. Based on the easiness of the analysis of soil parameters OC may be considered as the one of the parameters that can be taken into account ignoring available N and MBC.

Among the different interventions over the years HRFD along with FYM (4 t ha^{-1}) application found to be the best management practice, since, SQI was high in all the years. This is also found to be highly correlated with groundnut pod yields.

Overall results indicated that integrated application of half recommended dose NPK (10-20-20 N, P_2O_5, K_2O kg/ha) along with FYM @ 4 mt/ha could not only sustain but also aggrade soil quality over the fallow land as well as other soil management interventions. Application of only chemical or organic manures caused not degradation in soil quality.

Impact

1. SQI is an important tool for identifying the best soil management practice by taking easily analysable parameters into account which has been developed and assessed for rainfed groundnut production system.
2. Minimum data set was arrived based on the impact and contribution of each parameter
3. Out of 22 parameters, the most important soil contribution viz., available K, P, OC, MBC are found to contribute mostly towards SQI.
4. Among different interventions, integrated use of both organic (FYM 4 t/ha) and inorganic (10 – 20 – 20 N, P_2O_5, K_2O kg/ha) fertilizer found to not only sustain but also aggraded the soil quality
5. In all the years, Soil Quality Index is correlated with pod yield of groundnut Where as, Sustainable Yield Index is correlated with pod yield during 2000 – 2001 and 2003 – 2004.

4.3 ACIAR project

Indicators and soil management options for sustainable agriculture under rainfed situation of Anantapuram

In India about 166 million ha of land is subjected to land degradation. Erosion by water is the single most important mechanism affecting an area of 87 million ha. Efficient use of incident rainfall is the key to maximise production. Large increases and bring sustainability in production are possible using optimum management practices. Anantapuram District consists of 80% of red sandy loam soils (Alfisols) characterised by low supplying capacity of plant available water, shallowness (10 to 20 cm deep), surface stoniness and low nutrient capacity. The lands are sloppy, undulated with rock out crops and often subject soil erosion resulting in poor yields year after year. The soil physical characteristics increase the impact of poor seasonal conditions. Land management in this situation should aim to ensure that soil physical properties at the start of the wet season favours effective water entry and storage, easy seed bed preparation and low risk crop establishment. In essence, infiltration is the key process. Activities such as mulching and reduced tillage intensity increase the water entry, enhance soil structure and contribute to soil conservation . Formation of dead furrows reduces run off losses. Knowing of perceptions of farmers about sustainability is important in choosing various management options for conducting research and extension of the results. This paper presents about the perceptions of farmers about sustainability and the results of soil management research carried out during 1997 at Agricultural Research Station, Anantapuram. This study was done to evaluate soil management options and improve long term sustainability and productivity of rained lands of Anantapuram.

In recent, there is an emphasis on the involvement of farmers and other community members to collect data on the subject and their awareness for choosing various management for conducting research options and interpretation of results later on. In this process, group meetings among farmers with mixed gathering and action learning excersises with rainfall simulator with different soil management practices were carried out at Pampanur village. Field level experiments were also conducted at Agricultural Research Station, Anantapuram with different land management practices.

Rainfall simulation carried out in farmers field resulted in a thought provoking discussion on management practices for control of soil and water loss. Influence of method of cultivation and use of organic manures on soil and water loss was shown to them with the help of rainfall simulator.

Application of organic manure (FYM) and formation of dead furrows or land cover with Glyricidia loppings not only reduced the soil loss but also resulted in increased crop yield. As per the farmers perceptions, arable farming with good yields and increased productivity are the indicators of sustainability. Research results indicated that addition of organics (either addition of FYM or plant loppings) paves way for sustainability. However the availability of organic matter in large quantities is a question mark owing to climatic situation of Anantapuram and farming practices of the farmers. There is need to bring more and more area in each village under social forestry and planting of lands and waste lands with tree species viz., pongamia, subabul, sissoo, glyricidia which are suitable for lopping purpose (personal communication). Farmers should be encouraged to grow such tree species on their farm bunds and in waste lands as agroforestry. This may aid in bringing sustainability in agriculture.

4.4 DFID – NRSP Project R 8192 Enabling rural poor for better livelihoods through improved natural resource management in SAT India

- Governing and implementation body like salahasamithi (village advisory council) should be constituted in each village to implement any project activity successfully
- Farmers participation in planning and implementation of project activities is very important
- Gender issues should be focused in all social interventions

- Survival of forest plantations will be more on the trench cum bund compared to contour bunding since, contour bunds constructed across the slope and trench cum bunds constructed around the field where water stagnation is more
- Constructing of line farm ponds and utilization of stored water to the crop (groundnut) to give one supplementalirrigation during critical stages will enhance the crop from complete failure.
- Making of diversion channels for rejuvenation of old wells and abandoned wells is very cheaper and very effective.
- Majority of CPR's are in ill or in bad management position (encroached by neighbouring land owners)
- Ownership of community will ensure better management of CPRs.
- Application of fertilizer should be based on soil test values, so that 25 – 50% of recommended dose of fertilizer can be saved
- To reduce the cost of cultivation usage of shriveled and small seeds for groundnut sowing is giving similar returns so that of bold seeds
- Usage of improved tools and agricultural implements (mechanical seed drill, threshers etc) will save the time and cost of production
- Mixed farming (agriculture + sheep rearing) is found beneficial rather than agriculture alone
- Raising of fodder (CO – 1) in 10 cents area will provide sufficient nutritional fodder to the livestock of the farming community
- For betterment of livelihoods of landless poor sheep component, vermi composting, kitchen garden, backyard poultry were found successful
- Sheep (rams) rearing is very easy and maintenance cost is very low and it is very much beneficial for landless poor farmers.
- Sheep as livelihood intervention to the landless poor is affordable since market accessibility is not a problem.

5. Publications

5.1 Research papers

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Vijay Sankar Babu M., M. Balaji Naik..and Dr.V.Munaswamy ,2012, NADEP method of composting

5.5 BOOK CHAPTERS

C BOOK CHAPTERS/COMPLILATION/ COMPLETION REPORTS ETC...

1	T. Yellamanda Reddy, M Vijay Sankar Babu, N.B. Ghodke, M.Girish, T.Vijay Bhaskar Reddy, C. Radha kumari and K.V. Subramanayam	2006	Role of PRA in planning of watershed development activities	Book chapter	Impact Assessment of Watershed Development.*Issues, Methods and Experiments*	326-337Cost: Rs.695/-	Published by Associated Publishing Company, P.B.No.2679, Karolbagh, New Delhi
2	Biswapathi Mandal… and M Vijay Sankar Babu	2004	Assessment and improvement of soil quality and resilience for rainfed production system	Completion Report (2000-04)	NATP, RRPS-20	100 pages	BCKV, Kalyani, West Bengal
3	B.Ravindranatha Reddy, Y. Padmalatha, B. Sahadeva Reddy, M. Vijay Sai Reddy, M. Vijay Sankar Babu, ….and B. Vathsala	2010	Highlights of Research in Dryland Agriculture (1971-2009)	Compilation	All India Coordinated Research Project for Dryland Agriculture (AICRPDA)	Pages 1-140	AICRPDA Main Centre and ORP, ARS, Anantapuram
4	B.Ravindranatha Reddy, Y. Padmalatha, B. Sahadeva Reddy, M. Vijay Sai Reddy, M. Vijay Sankar Babu, …and B. Vathsala	2010	ITKs of Dryland Agriculture in Anantapuram District	Book chapter	All India Coordinated Research Project for Dryland Agriculture (AICRPDA)	Pages. 1 - 14	AICRPDA Main Centre and ORP, ARS, Anantapuram
5	B.Ravindranatha Reddy, Y. Padmalatha, B. Sahadeva Reddy, M. Vijay Sai Reddy, M. Vijay Sankar Babu, …and B. Vathsala	2010	Contingency Crop Planning for Scarce Rainfall Zone	Book chapter	All India Coordinated Research Project for Dryland Agriculture (AICRPDA)	Pages. 1 - 50	AICRPDA Main Centre and ORP, ARS, Anantapuram
6	M. Vijay Sankar Babu, M.Madhan Mohan and Dr A Pratap Kumar Reddy	2013	Integrated nutrient management for rainfed crops with special emphasis to groundnut	Training manual chapter	Training programme on technologies for sustainability in dryland agriculture –ARS, Anantapuram	<u>Pages : 68-75</u>	ARS, Anantapuram
7	M. Vijay Sankar Babu, Ramasubbaiah, Srihari and Sahadeva Reddy	2014	Soil health and nutrient management – Importance of soil and water testing	Training mannual	Training and awareness programmes to the farmers under RKVY	<u>44 Pages</u>	ARS, Anantapuram

6. Awards/ Recognition

Team Awards

Year	Name of Award	Organization	Recipients	Work
2004	**Vasantharao Naik Award**	**ICAR**	Dr. T. Yellamanda Reddy Dr. D. Balaguravaiah Dr. Y. Padmalatha	Dryland Agriculture
2009	**ChoudaryDevilal Outstanding AICRPDA Award**	**ICAR**	AICRPDA staff	Dryland Agriculture

Honors & Awards to the individuals

Year	Name of Award	Organization	Name of Recipient	Work
2001	A.V.Krishnaiah Memorial Award	ANGRAU	Dr. D. Balaguravaiah	Significant contributions in Agricultural Research
2010	UAS (B) Award of Gold medal	UAS, Bangalore	Dr.M.Vijay Sankar Babu	Ph.D work
2014	Rythubanbhu Best Scientist Award	Best Publications Hyderabad	Dr.M.Vijay Sankar Babu	Significant work on creating awareness to farmers on micro nutrients

7. List of Contributors

S.N	Name of the sanctioned post	1971-72	1972-73	1973-74	1974-75
1.	Chief Scientist	Dr.G.VenkataNadhachary	Dr.G.VenkataNadhachary	Dr.G.VenkataNadhachary	Dr.G.VenkataNadhachary
2	Soil Physicist	Dr.D.Subbarami Reddy	Dr.D.Subbarami Reddy	Dr.D.Subbarami Reddy	Dr.D.Subbarami Reddy

S.N	Name of the sanctioned post	1975-76	1976-77	1977-78	1978-79
1.	Chief Scientist	Dr.G.VenkataNadhachary	Dr.G.VenkataNadhachary	Dr.G.VenkataNadhachary	Dr.G.VenkataNadhachary
2	Soil Physicist	Dr.D.Subbarami Reddy	Dr.A.PadmaRaju From 01.06.76	Dr.A.PadmaRaju	Dr.A.Padmaraju

S.N	Name of the sanctioned post	1979-80	1980-81	1981-82	1982-83
1.	Chief Scientist	Dr.G.VenkataNadhachary	Dr. G.VenkataNadha chary	V.S.R.Anjineyulu (From 01.05.1981) I/c	K.Venkataraju (From 14-09-82)
2	Soil Physicist	Dr.A.Padmaraju	Dr.A.Padmaraju (To 05.06.79) Dr.G.Venkatanadhachari (06.06.79 to 04.02.81) I/c S.RiazuddinAhammed (From 05.02.81)	S.RiazuddinAhammed (05.02.81 to 16.12.81) G.I.Lazarus (From 17.12.81)	S.RiazuddinAhammed

S.N	Name of the sanctioned post	1983-84	1984-85	1985-86	1986-87
1.	Chief Scientist	K.Venkataraju	K.Venkataraju	K.Venkataraju	K.Venkataraju
2	Soil Physicist	G.I.Lazarus (i/c)	G.I.Lazarus (i/c)	G.I.Lazarus (i/c)	G.I.Lazarus (i/c)

S.N	Name of the sanctioned post	1987-88	1988-89	1989 – 90	1990 - 91
1.	Chief Scientist	Dr.K.Venkataraju	Dr.K.Venkataraju	Dr.K.Venkataraju	Dr.K.Venkataraju
2	Soil Physicist	G.I.Lazarus (i/c)	G.I.Lazarus (i/c)	G.I.Lazarus (i/c)	G.I.Lazarus (i/c)

S.N	Name of the sanctioned post	1991 – 92	1992 – 93	1993 – 94	1994- 95
1.	Chief Scientist	Dr.K.Venkataraju	Dr.B.Sreenivas (i/c)	Dr.B.Sreenivas (From 5.2.1994)	Dr.B.Sreenivas
2	Soil Physicist	Sri.V.Munaswamy	Sri.V.Munaswamy	Dr.D.Balaguravaiah (From 30.3.1994)	Dr.D.Balaguravaiah

S.N	Name of the sanctioned post	1995 – 96	1996 -97	1997 – 1998	1998-99
1.	Chief Scientist	Dr.B.Sreenivas	Dr.B.Sreenivas	Dr.T.Yellamanda Reddy (From 25.9.1997)	Dr.T.Yellamanda Reddy
2	Soil Physicist	Dr.D.Balaguravaiah	Dr.D.Balaguravaiah	Dr.D.Balaguravaiah	Dr.D.Balaguravaiah

S.N	Name of the sanctioned post	1999 -2000	2000 - 01	2001 - 02	2002 - 03
1.	Chief Scientist	Dr.T.Yellamanda Reddy	Dr.T.Yellamanda Reddy	Dr.T.Yellamanda Reddy	Dr.T.Yellamanda Reddy
2	Soil Physicist	Dr.D.Balaguravaiah	Dr.D.Balaguravaiah	Dr.D.Balaguravaiah	Dr.D.Balaguravaiah

S.N	Name of the sanctioned post	2003 – 04	2004 – 05	2005 – 06	2006 - 07
1.	Chief Scientist	Dr.T.Yellamanda Reddy	Dr.T.Yellamanda Reddy	Dr.T.Yellamanda Reddy	Dr.K.Veerabhadra Rao(From 9.12.2006)
2	Soil Physicist	Sri. M.VijayaSankar Babu (i/c)	Sri. M. VijayaSankar Babu (i/c)	Dr.K.Veerabhadra Rao(From 9.12.2006)	Dr.K.Veerabhadra Rao

S.N	Name of the sanctioned post	2007 - 08	2008 - 09	2009 - 10
1.	Chief Scientist	Dr.K.Veerabhadra Rao	Dr.B.Ravindranatha Reddy(From 27.8.2008)	Dr.B.Ravindranatha Reddy
2	Soil Physicist	Dr.K.Veerabhadra Rao	Dr.K.Veerabhadra Rao	Vacant

S.N	Name of the sanctioned post	2010-11	2011-12	2012-13	2013-14
1.	Chief Scientist	Dr.B.Ravindranatha Reddy	Dr. V. Munaswamy (From 12-12-2011)	Dr. V. Munaswamy (Up to 1-10-2012) Dr .A.Pratap Kumar Reddy (From 5-10-2012)	Dr.B.Sahadeva Reddy (From 2-06-2013)
2	Soil Physicist	Dr. M. VijayaSankar Babu(From 30-7-2010)	Dr. M. VijayaSankar Babu	Dr. M. VijayaSankar Babu	Dr. M. VijayaSankar Babu

దిగుబడులు పెంచుకోనేందుకు భూసార పరీక్షలు తప్పనిసరి

-భూసార పరిరక్షణ విభాగం సీనియర్ శాస్త్రవేత్త డాక్టర్ విజయశంకర్‌బాబు

-భూసార పరీక్ష, నేల ఆరోగ్యం-ఎరువులు యాజమాన్యంపై రైతులకు అవగాహన

ఉరవకొండ, ఏప్రిల్ 10 ప్రభాతవార్త

దిగుబడులు పెంచుకోనేందుకుగాను రైతులు తప్పనిసరిగా ప్రతి యేడాది మార్చి, ఏప్రిల్, మే నెలల్లో భూసార పరీక్షలు చేయించుకోవాలని అనంతపురం రేకులకుంట వ్యవసాయ పరిశోధనా స్థానం భూసార పరిరక్షణ విభాగం సీనియర్ శాస్త్రవేత్త డాక్టర్ విజయశంకర్‌బాబు సూచించారు. గురువారం ఉదయం పట్టణంలోని స్థానిక వ్యవసాయ మార్కెట్‌యార్డులో రాష్ట్రీయ కృషి వికాస్ యోజన కేంద్రం ఆధ్వర్యంలో "భూసార పరీక్షలు, నేల ఆరోగ్యం-ఎరువులు, యాజమాన్య పద్ధతులు" అనే అంశంపై రైతులకు అవగాహన సదస్సు జరుగగా ఆయనతోపాటు వ్యవసాయశాఖ ఉరవకొండ సహాయ సంచాలకులు మోహన్ విజయ్‌కుమార్, ఉరవకొండ ఏఓ రామసురేష్ బాబు, గుంతకల్లు ఏఈఓ షేక్షావలి పాల్గొన్నారు. ఈ సందర్భంగా శాస్త్రవేత్త మాట్లాడుతూ భూముల్లో భాస్వరం నిల్వలు పెరిగిపోవడంచేత రైతులకు పెట్టుబడి ఖర్చులు పెరిగిపోతున్నాయన్నారు. పెట్టుబడి ఖర్చులను తగ్గించుకోవ డానికి రైతులు మట్టి పరీక్షలు చేయించుకొని దానికి అనుగుణంగా పోషకాలు సరైన మోతాదులో ఉన్నాయా లేదో తెలుసుకొని నేలకు పోషకాలు అందించాలన్నారు. దీనిమూలంగా పెట్టుబడి ఖర్చులు తగ్గడమే కాకుండా దిగుబడులను పెంచుకోవచ్చని సూచించారు. నేల ఆరోగ్యం కాపాడుకోవడానికి తప్పనిసరిగా సేంద్రియ ఎరువులు వాడాలని, దిగుబడులు పెరుగడానికి రసాయన ఎరువులను వినియోగించాలన్నారు. దిగుబడులు పెంచుకోవడంతోపాటు నేల ఆరోగ్యం కాపాడుకోవడానికి తప్పనిసరిగా సేంద్రియ, రసాయన ఎరువులను కలిపి వాడుకోవాలని సూచించారు. అనంతరం రైతులకు ప్రశంసాపత్రాలు అందించారు. ఈ కార్యక్రమంలో ఏఈఓలు రామన్న, మహాలక్ష్మి, భరత్, జానమ్మ, వెంకటరమణ, ప్రణీత తదితరులు, మూడు మండలాల రైతులు పాల్గొన్నారు.

అవగాహన సదస్సులో ప్రసంగిస్తున్న సీనియర్ శాస్త్రవేత్త డాక్టర్ విజయశంకర్‌బాబు - హాజరైన సబ్ డివిజన్‌లోని రైతులు

భూసార పరీక్షలు చేయించడం ద్వారా

వృథా పెట్టుబడిని నివారించుకోండి

– రైతులకు అవగాహన శిబిరంలో ఏఆర్ఎస్ శాస్త్రవేత్త పిలుపు

రాయదుర్గంటౌన్, ఏప్రిల్ 4 ప్రభాతవార్త

భూసారపరీక్షలు చేయించుకోవడం ద్వారా వృథా పెట్టుబడిని నివారించుకోవాలని వ్యవసాయ పరిశోధన స్థానం సీనియర్ సైంటిస్ట్ విజయశంకర్‌బాబు రైతులకు పిలుపునిచ్చారు. శుక్రవారం రాయదుర్గం ఏడీఏ కార్యాలయం వద్ద ఏడీఏ ఎం రవి అధ్యక్షతన రైతులకు ఒకరోజు శిక్షణ, అవగాహన కార్యక్రమాన్ని నిర్వహించారు. ఈ సందర్భంగా విజయశంకర్ బాబు మాట్లాడుతూ నేల స్వభావం, అందులో సహజసిద్ధంగా ఉన్న ఎరువుల గురించి తెలియకుండా వృథాగా ఎరువులు వాడటం వల్ల పెట్టుబడి పెరిగిపోవడంతో పాటు పంటకు కూడ నష్టం వాటిల్లే ప్రమాదం ఉందన్నారు. నత్రజని, భాస్వరం, పొటాషియం ఎరువుల ప్రాధాన్యత గురించి వివరించారు. నత్రజని ఎరువులు పైపాటిగా వాడితే వాటికి ఆవిరి అయ్యే గుణం ఉంటుందన్నారు. ఒకేసారి వాడకుండా రెండు, మూడు దఫాలుగా నేలలో వేయాలన్నారు. భాస్వరం జడత్వం ఎక్కువగా ఉంటుందని, ఎక్కువగా వాడనవసరం లేదన్నారు. భాస్వరం పెరిగితే జింక్‌లోపం ఏర్పడుతుందన్నారు. సహజసిద్ధంగా ఉండే జింక్ సరిపోతుందని, అయితే భాస్వరం పెరిగిపోతే జింక్‌ను కూడ వేసుకోవాల్సిన పరిస్థితి వస్తుందన్నారు. పొటాషియం లోపం ఉంటే గింజ బరువు తగ్గుతుందని, ధాన్యం నిల్వ సామర్థ్యం కూడ తగ్గుతుందన్నారు. కాబట్టి నేలలో నత్రజని, పొటాషియం, భాస్వరం ఎంత మోతాదులో ఉందో పరీక్ష చేయించుకుంటే ఏ ఎరువులు, ఎంత మోతాదులో వాడితే సరిపోతుందో తెలియచేస్తామన్నారు. పండ్లతోటల్లో ఎక్కువగా పూతరాలడం, కాయలు చీట్లిపోవడం జరుగుతుందని, బోరాన్‌లోపం వల్ల ఈ విధంగా జరుగుతుందన్నారు. ఏడీఏ ఎం రవి మాట్లాడుతూ శాస్త్రవేత్త వివరించిన మేరకు రైతులు భూసార పరీక్షలు చేయించి లాభం పొందాలని కోరారు. భూసార పరీక్షలకు మట్టిని ఏ విధంగా సేకరించాలో వివరించారు. మట్టిని సేకరించే పద్ధతులు పాటించకపోతే నష్టపోతారని తెలిపారు. సమావేశంలో వ్యవసాయాధికారులు వై శ్రీనివాసులు, ఎం నిర్మల్‌కుమార్, జీ శ్రీనివాసరావు, ఎం అహమ్మద్‌బాష, రైతులు పాల్గొన్నారు.

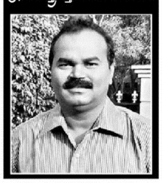
సమావేశంలో ప్రసంగిస్తున్న శాస్త్రవేత్త విజయశంకర్‌బాబు

అనంతపురం శనివారం 05, ఏప్రిల్ 2014 **13**

సూటి ఎరువుల వాడకం మంచిది

బుక్కరాయసముద్రం, న్యూస్‌టుడే: ఖరీఫ్ సీజన్లో వరి, వేరుసెనగ, ఇతర పంటలను సాగుచేస్తున్న రైతులు తమ భూముల్లో అన్ని రసాయనిక మిశ్రమ ఎరువులు కన్నా సూటి ఎరువులు వాడకం మంచిదని ఆచార్య ఎన్.జి. రంగా వ్యవసాయ పరిశోధనాస్థానం రేకులకుంట భూసార విభాగ శాస్త్రవేత్త విజయశంకర్‌బాబు పేర్కొన్నారు. సూటి ఎరువులైన నత్రజని (యూరియా) ఇందులో 46 శాతం నైట్రోజన్ ఉంటుందని తెలియజేశారు. భాస్వరం (సింగిల్ సూపర్ ఫాస్ఫేట్) 16 నుంచి 20 శాతం వరకు ఉంటుందని వివరించారు. పొటాష్ (మ్యూరేట్ ఆఫ్ పొటాష్) 60 శాతం ఉంటుందని చెప్పారు. ఎర్రనేలల రైతులు తప్పా నల్లరేగడి, చవుడు, ఇసుక, బంకమట్టి తదితర రైతులు తమ భూముల్లో దుక్కిలో పది కిలోల జింక్‌సల్ఫేట్ వాడాలని సూచించారు. అలాకాకుండా 2 గ్రాములు జింక్‌సల్ఫేట్ లీటరు నీటికి కలిపి పిచికారి చేసుకోవాల్సిందిగా సూచించారు. ఇనుపధాతు లోపం ఉన్న భూముల్లో అన్నబేధి ఆరు గ్రాములు నిమ్మకాయ రసం లీటరు నీటికి తప్పనిసరిగా పిచికారి చేయాలని సూచించారు.

భూసార విభాగ ప్రధానశాస్త్రవేత్త విజయశంకర్‌బాబు



కలిపి ఉన్న మిశ్రమ ఎరువులు

★ 20.20.0.13: వీటిని ఆంగ్లంలో ఎన్.పి.కె.ఎస్ అంటారు. ఇందులో 20 శాతం నత్రజని, 20 శాతం ఫాస్పరస్, 0 శాతం పొటాష్ 13 శాతం పొటాషియం ఉంటుంది.

★ 19.19.19: ఎన్.పి.కె అంటారు. ఇందులో నత్రజని 19, భాస్వరం 19, పొటాషియం 19 శాతం ఉంటుంది.

డీఏపీ: డై అమ్మోనియం ఫాస్ఫేట్ అంటారు. ఇందులో 18 శాతం నత్రజని, 46 శాతం భాస్వరం ఉంటుంది.

★ 20.20.0: ఎన్.పి.కె. నత్రజని 20, ఫాస్పరస్ 20, పొటాషియం 0 శాతం ఉంటుంది.

★ 16.16.16: ఎన్.పి.కె నత్రజని, భాస్వరం, పొటాషియం 16 శాతం చొప్పున ఉంటుంది.

★ 17.17.17: ఎన్.పి.కె నత్రజని, భాస్వరం, పొటాషియం 17 శాతం వంతున ఉంటుంది.

★ 14.35.14: నత్రజని 14, భాస్వరం 35, పొటాషియం 14 శాతం చొప్పున ఉంటుంది. పై విధంగా రైతులు తమ భూములకు ఎటువంటి రసాయనిక ఎరువుల అవసరమో దాని అనుసరించి మందులు వేసుకోవాలని తెలియజేశారు. అనవసరంగా మోతాదు మించి మందులు వాడకం వలన పంటలకు ఏ మాత్రం ప్రయోజనం ఉండదని తెలియజేశారు.

భూసార పరీక్షలతోనే అధిక దిగుబడులు

శాస్త్రవేత్త విజయ్‌శంకర్‌బాబు

రాయదుర్గంరూరల్ : రైతులు పండించే పంటల్లో అధిక దిగుబడి సాధించాలంటే ముందుగా భూసార పరీక్షలు తప్పనిసరిగా చేయించాలని శాస్త్రవేత్త విజయ్‌శంకర్‌బాబు రైతులకు సూచించారు. శుక్రవారం వ్యవసాయ కార్యాలయంలో వ్యవసాయ ఏడీ రవి ఆధ్వర్యంలో భూసార పరీక్షలు, నేల ఆరోగ్యం, ఎరువుల యాజమాన్యంపై పండ్ల తోటల రైతులకు అవగాహన సదస్సు నిర్వహించారు. శాస్త్రవేత్త డాక్టర్ విజయ్‌శంకర్‌బాబు మాట్లాడుతూ రైతులు పండించే పంటలకు తగిన మోతాదులో ఎరువులను వాడితే అధిక దిగుబడులు సాధించవచ్చు న్నారు. పంటలకు సూక్ష్మపోషకాలు మొక్క అభివృద్ధి చెందుతున్న దశలో వాడితే పంట దశ మారుతుందని తెలిపారు. ప్రధాన పోషకాలను మొక్కలు వృద్ధి చెందిన తరువాత వాడినట్లయితే అధిక దిగుబడి వచ్చే అవకాశం ఉంటుందని ఆయన వివరించారు. నూనె గింజల పంటకు గంధకం చాలా అవసరమైనదని, ముఖ్యంగా రైతులు ఏదైనా పంటను వేసే సమయంలో తప్పనిసరిగా భూసార పరీక్షలు చేయించాలని తెలిపారు. రైతులకు భూసార పరీక్షలు చేసే విధానాన్ని ఆయన వివరించారు. ఒక సారి భూపరీక్ష చేసినట్లయితే అది మూడు సంవత్సరాల వరకు రైతులు లాభాన్ని చేకూరుస్తుందన్నారు. ఈ కార్యక్రమంలో ఏవోలు విజయ్‌జ్యోతికుమార్, శ్రీనివాసులు, నిర్మలకుమార్, రైతులు పాల్గొన్నారు.

సమావేశంలో మాట్లాడుతున్న శాస్త్రవేత్త విజయ్‌శంకర్‌బాబు

భావి తరాలకు సారవంత భూములు అందించాలి

ప్రపంచ నేలల దినోత్సవంలో రైతులకు శాస్త్రవేత్తల పిలుపు


Brain Storming Session on
“Soil Testing and Fertilizer Use”
January 24, 2014
Organized by

భూసారమే రైతుకు ఆధారం..

ఒకసారి చేయిస్తే మూడేళ్లపాటు రక్ష

న్యూస్‌టుడే, బుక్కరాయసముద్రం: ఒక్కసారి భూసార పరీక్షలు చేయిస్తే ప్రతీ ఏడాది ఒక్కో ఎకరానికి రూ.1200 నుంచి రూ. 1500 వరకు ఆదా చేయవచ్చు. అంతేకాకుండా మూడేళ్లపాటు భూసార పరీక్షలు చేయించనవసరం లేదు. ప్రతి రైతు భూమి స్వభావం, ఎరువుల విలువ తెలుసుకోవాల్సిన అవసరం ఎంతయినా ఉందని ఆచార్య ఎన్.జి.రంగా వ్యవసాయ విశ్వవిద్యాలయ ప్రధాన శాస్త్రవేత్తలు చెబుతున్నారు. గత పదేళ్లగా వారు పరిశోధించి తేల్చిన అంశాలు ఇవి.

జిల్లాలో 8.50 లక్షల హెక్టార్లలో సాగు చేస్తున్న వేరుసెనగ రైతులు దాదాపు 19 శాతం ఎరువులకు ఖర్చు చేస్తున్నారు. నేల పరీక్ష చేయించుకుని దాని ప్రకారం రసాయనిక ఎరువులు వాడితే సాగు ఖర్చు గణనీయంగా తగ్గించుకోవడమే కాకుండా నేల సారాన్ని కాపాడుకోవచ్చు

10 నుంచి 15 ఏళ్లగా భాస్వరం, పోషకం విలువలు అందించే డీఏపీ ఎరువులనే ఎక్కువగా వాడుతున్నారు. దీని వల్ల సహజంగా భాస్వరం నిలువలు పెరిగి అదే సమయంలో పోషకాల సమతుల్యం దెబ్బ తినడం వల్ల దిగుబడులు తగ్గి నేల సహజ స్థితిని కోల్పోతుంది.

నేల ఆరోగ్యాన్ని కాపాడుకునేందుకు భూసార, నీటి పరీక్షలు చేయించుకోవాల్సిన అవసరం చాలా ఉంది. ఖరీఫ్‌లో విత్తనానికి ముందు ఈ పరీక్షలు చేయించుకుంటే రాబోయే మూడేళ్లు వీటిని అనుసరించి ఎరువుల వాడకుంటే సరాసరి ఎకరానికి రూ.1700 పెట్టుబడి తగ్గించుకోవచ్చు

27 ఏళ్లగా ఆచార్య ఎన్.జి. రంగా వ్యవసాయ విశ్వవిద్యాలయం రేకులకుంట మెట్ట వ్యవసాయ పరిశోధన స్థానం జరిపిన భూసార పరీక్ష ఫలితాలను విశ్లేషిస్తే.. సగం రసాయనిక ఎరువులు, సగం సేంద్రియ ఎరువులు కలిపి వాడిన చోట దిగుబడులు పెరగడంతో పాటు నేల ఆరోగ్యస్థితి (భౌతిక స్థితి) వృద్ధి చెందింది. సూచించిన మేరకు రసాయనిక ఎరువుల వాడకం వల్ల నేలకు అన్ని పోషకాలు సమతుల్యంగా అందించడం వల్ల దిగుబడులు అనూహ్యంగా పెరిగాయి.

వేరుసెనగలో భూసార పరీక్షననుసరించి ఎరువుల వాడకం

కేజీ॥ ఎకరాలలో...

	యూరియా	సింగల్ సూపర్ ఫాస్ఫేట్	మ్యూరేట్ ఆఫ్ పొటాష్
తక్కువ	20	100	32
మధ్యస్థం	20	50	16
ఎక్కువ	20	-	-

భూసార పరీక్షలు తప్పనిసరి

ప్రతి మనిషికి వైద్యం చేయించుకోవడం ఎంత ముఖ్యమో... ప్రతి రైతు భూసార పరీక్షలు చేయించుకోవడం అంతే ముఖ్యం. ఇష్టానుసారంగా రసాయనిక ఎరువుల వాడకం వలన భూమి సహజస్థితిని పూర్తిగా కోల్పోయింది. అందువల్లనే దిగుబడులు గణనీయంగా తగ్గుతున్నాయి. పరిశోధనా స్థానంలో అధునాతనమైన పరీక్ష కేంద్రం ద్వారా భూసార పరీక్షలు చేశాం.

- మట్టి నమూనాల ప్రధాన శాస్త్రవేత్త విజయశంకర్

Abbreviations

MSL – Mean Sea Level

mm – milli meter

SWM – South West Monsoon

NEM – North East Monsoon

^0C – Degree Celsius

PET – Potential Evapotranspiration

Ha - Hectare

Cm - Centimeter

% - Per cent

LGP - Length of Growing Period

t - tonn

kg - Kilogram

NS – Non Significant

AICRPDA - All-India Coordinated Research Project for Dryland Agriculture

ARS – Agricultural Research Station

S Em - Standard Error mean

CD – Critical Difference

ACIAR - Australian Centre for International Agricultural Research

Rs. - Rupees

ORP – Operational Research Project

RWH -Rain Water Harvesting

BC ratio – Benefit Cost ratio

RWUE – Relative Water Use Efficiency

@ - at the rate of

Hr - hour

Mg – mega gram

m^{-3} - meter cube

viz – Vice verce

Ec – Electrical Conductivity

N - Nitrogen

P, P_2O_5 - Phosphorus

K, K_2O - Potassium

DAP - Diammonium Phosphate

Zn - Zinc

Fe - Ferrous

Cu - Copper

Mn - Manganese

OC - organic carbon

$ZnSO_4$ - Zinc Sulphate

SSP - Single superphosphate

Ca - Calcium

S	- Sulphur
FYM	– Farm Yard Manure
q	- Quintal
MOP	– Muriate of Potash
CO_2	- Carbondioxide
DMP	– Dry Matter Production
PSB	– Phosphate Solubilising Bacteria
$FeSO_4$	- Ferrous Sulphate
RFD	- Recommended Fertilizer Dose
ITK	- Indigenous Technical Knowledge
B	- Boron
GNS	- Groundnut shells
ICAR	- Indian Councial of Agriculture Research
NATP	- National Agricultural Technology Project
BD	- Bulk Density
IR	- Irrigation Requirement
WHC	- Water Holding Capacity
SQI	- Soil Quality Index
MBC	- Microbial Biomass Carbon
HRFD	- Half Recommended Fertilizer Dose
SYI	- Sustainable Yield Index
SAT	- Semi Arid Trotics
DFID	- Department for International Development
Fig	- Figure