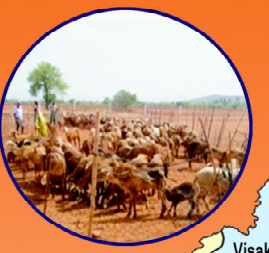
Promising Technologies for Dryland Agriculture



ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY

ALL INDIA COORDINATED RESEARCH PROJECT FOR DRYLAND AGRICULTURE

AGRICULTURAL RESEARCH STATION

ANANTHAPURAMU - 515 001

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Promising Technologies for Dryland Agriculture

In Commemoration of

GOLDEN JUBILEE YEAR OF ANGRAU

&

ARS-ANANTHAPURAMU

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FOREWORD

Rainfed agriculture in India accounts for about 60 per cent of the net cultivated area which supports 40 per cent human and 60 per cent livestock population. The contribution from agricultural sector towards GDP is very crucial as 65 – 70 per cent of the population is mainly dependent on agriculture for their livelihood. The Agricultural growth in dryland areas is determined by the bio-physical and socioeconomic 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.

The All India Co-ordinated Research Project for Dryland Agriculture (AICRPDA) main centre, Ananthapuramu was started in 1971 and has carried out commendable research work on dryland agriculture for the past four and half decades. This project has been carrying out location specific adaptive research on rain water management, soil and water conservation, crops and cropping system, farming system crop improvement, energy management, integrated nutrient management and alternate land use systems. This publication contains the essence of important technologies developed for profitable rainfed farming including improved crop varieties, soil test based fertilizer application through integrated nutrient management, *insitu* and *exsitu* water conservation methods like rain water harvesting, farm ponds, crops and cropping system, seed to seed mechanization in groundnut, contingency plans for climate exigencies and farming systems approach for enhancing health and income.

I compliment Dr. B. Sahadeva Reddy, Chief Scientist, all other scientists and staff involved in bringing out this publication entitled **"Promising Technologies for Dryland Agriculture"**. I am sure that this publication would form a valuable source of scientific information for scientists, extension workers, stake holders/farmers and all others engaged in the development of dryland agriculture to improve productivity in rainfed agriculture and enhance the livelihood security of farming.

A. Padma Raju

Date : 26-8-2015 **(A.PADMARAJU)**

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PREFACE

Natural Resource Management has important research agenda in view of the climate change, degradation of land and declining productivity in greenrevolution areas. Efficient methods of soil and rain water conservation and water harvesting become important areas of dryland agriculture research to achieve sustainability. Variation in crop yields is more in dry lands due to non receipt of timely rainfall and prolonged dry spells during crop periods. Adoption of soil and moisture conservation measures and improved management practices will help in getting higher yields.A large number of location specific practices for *insitu* moisture conservation, water harvesting and supplemental irrigation have been developed and tested successfully at All India Co-ordinated Research Project for Dryland Agriculture (AICRPDA), Agricultural Research Station, Ananthapuramu.

Dryland Agriculture occupies a prominent place in rural livelihoods of Andhra Pradesh. In Andhra Pradesh out of 92.04 lakh ha of cultivable land an area of 34.56 lakh ha is under rainfed agriculture, mainly in scarce rainfall and southern agro climatic zones.

AICRPDA, ARS, Ananthapuramu is continuing efforts to generate location specific technologies in the areas of rain water management, integrated nutrient management, cropping systems, farming systems, alternate land use and energy management.

The booklet entitled **"Promising Technologies for DrylandAgriculture"** brings out the achievements made by AICRPDA, ARS, Ananthapuramu which will be highly useful for researchers and extension workers. I am confident that this excellent research outcome by AICRPDA, ARS, Ananthapuramu will be useful for farmers, researchers, NGOs and Officials of Department of Agriculture who are involved in Natural Resource Management Programmes and activities. I compliment the efforts of Dr. B. Sahadeva Reddy, Chief Scientist and his staff for compiling the achievements with all details.

Date : 26-8-2015

(K. RAJA REDDY)
DIRECTOR OF RESEARCH

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Introduction

Ananthapuramu district lies in the Rayalaseema region of Andhra Pradesh between $13^0$40' and $15^0$15' northern Latitude and $76^0$50' and $78^0$30' eastern Longitude.

Climate

Ananthapuramu is one of the drought-prone districts in the rain shadow area of Andhra Pradesh. The annual average rainfall of the district is 552 mm. The normal rainfall for the South West monsoon period is 338 mm which forms about 61.2% of the total rainfall for the year. The rainfall for North East monsoon period is 156 mm, 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 5 runoff events per annum and PET is 2140 mm.

The normal onset of the monsoon is around June and could be delayed even up to end of August. There is high coefficient of variation for the onset data which is typical of the district and is the major cause of uncertainty in farming.

There is high spatial variability in annual rainfall in the district. Out of 63 mandals in the district, Kudair, Kambadur and C.K. Palli receive <250 mm mean rainfall during the South-West monsoon period, Only Mudigubba mandal gets >400 mm rainfall. All other mandals receive between 250-400 mm rainfall during SW monsoon. The length of growing period is variable across mandals spanning from less than 70 to 120 days.

Soils

Red soils are dominant in the district and occupy 66% of total geographical area (TGA). Red clayey soils occur extensively in all mandals. Red loamy soils account for 16% of TGA and remaining 50% area is under red clayey soils. Tank irrigated valley alluvial soils (Saline/ sodic soils) occur to an extent of 12% of TGA and distributed in all mandals. Black soils occupy 10% area in the district and are distributed in Tadipatri, Putlur, Yellanur, Uravakonda, Vajrakarur, Beluguppa and Vidapankal mandals. Rock lands occur in 12% of TGA and are distributed mainly in Beluguppa, Rayadurg, Bukkapatnam, Puttaparthi, Penukonda, O.D. Cheruvu mandals.

In general, the depth of majority soils ranges from extremely shallow (10-25 cm) to shallow (25-50 cm). Deep soils (100-150cm) are also found in some parts of the district. The soils are low in organic carbon and available nitrogen, medium to high in available phosphorous and available potassium content. About 40% soils are below critical level of Zinc and 33% soils are below critical level for iron.

In Ananthapuramu district, about 47% area has very gentle (1-3%) slope, followed by 23% area with gentle (3-8%) slope, and about 12% area is moderately steep slope (15-30%). Land capability classification suggests that 50% of the lands are class III followed by class IV lands occupying 20% of the area. The landscape is undulating and has large arid, treeless expansions of poor soils. Due to the impoverished soil conditions, scanty rainfall, indiscriminate grazing and poor protection, many of the forests have almost disappeared. Most parts of the district are desolate and barren.

Crops and cropping systems

The total geographical area of the district is 19.13 lakh ha out of which 69.6 per cent is the net sown area. In the district, 68% of the farmers come under marginal and small category. Most of the farmers are resource poor and practice rainfed farming. Smallholdings (< 3.0 ha) dominate (60%) the district. The district is more frequently prone to drought. Of the 133 years of record *i.e.,* from 1876-1877 to 2008-09, 66 years were drought years. Mechanization is difficult in small land holdings but labour scarcity is also very high.

The district has 90% area under rainfed conditions. Groundnut is the principal *Kharif* crop grown over an area of about 8 lakh ha. The area under this crop increased from 2.5 lakh ha in 1970's to 8 lakh ha by 2000 and maintained at that level ever since with year to year fluctuation depending on the rainfall. Large year to year fluctuations are noticed in the average productivity. Highest productivity (1328 kg/ha) was recorded in 1996 and lowest yield (67 kg/ha) was recorded in 2006. During the 1960s, cereal crops such as sorghum, finger millet and others (50% area) dominated the agriculture scenario, and groundnut (20% area) was a minor crop. Presently, over 70% of the cultivated area is under groundnut due to its commercial value and declining demand to millets. Further, it is a valuable source of fodder for livestock during dry years or in case of crop failures.

Livestock

The geographical area of the district is 19.13 lakh ha., of which permanent pastures constitutes of 25968 ha (1.36%). As per the latest (18th) livestock census, the district had 7.3 % of cattle, 4.0% of buffaloes, 12.6% of sheep, 9.4% of goats and 5.4% of pig population of the state.

The district ranks first in goat population in the state and is having highest livestock population next only to Mahabubnagar. About 57.6 % of the households in the district possess livestock. The district is having highest Hallikar breed cattle, which is used extensively for agricultural operations. Sheep and goat constitute 73% of the total livestock population of 58.10 lakh.

About Agricultural Research Station, Ananthapuramu

Agricultural Research Station, Ananthapuramu was established on March 31, 1964 in Rekulakunta village which is 11km away from Ananthapuramu. The geographical location of the station is at $14^0\ 41^1$N latitude, $77^0\ 40^1$E longitude and 350 m altitude. The farm is located in 150 acres out of which 10.43 acres is under buildings. The soils in the farm are sandyloam with pH of 6.5 and available organic carbon content ranges from 0.42 to 0.65 per cent. Initially, this station was started as Soil Conservation Research Centre and the preliminary research at the station was on soil conservation research during the earliest phase of existence of the station, focused mainly on optimization of bund structures in controlling soil erosion. The results showed that likely runoff incidents for Ananthapuramu district were estimated as 5 (minimum 3, maximum7). The annual soil loss was estimated as 4 t/ha per year and the runoff as 20 per cent of the rainfall. Optimum space between contour bunds was found as 50 m. The cross section of the bund could be reduced upto 0.63m^2. Contour bunding and contour cultivation gave better yields compared to cultivation along the slope. Later on, multi disciplinary research work was initiated in all aspects of dryland agriculture to meet the needs of farmers. The research station comes under Scarce Rainfall Zone of Andhra Pradesh with high amount of variation in the distribution of rainfall. Sowing rain starts in July and rainy season ends in October. Delay in onset of monsoon, prolonged dry spells and early cessation of monsoon are common features of dryland agriculture.

All India Coordinated Research Project for Dryland Agriculture, All India Coordinated Research Project on Agrometeorology, Operational Research Project (Dryland Agriculture), Farm implements, AICRP on Pearmillet have been started functioning since 1970, 1972, 1983, 1984 and 2008 respectively.

AICRP for Dryland Agriculture conducts location specific interdisciplinary research with the following mandate:

- To optimize the use of natural resources.
- To minimize soil and water loss and to protect environment.
- To evolve simple technologies for adoption by farmers to increase crop productivity.
- To evolve suitable cropping systems, alternate crops and production technologies to match weather aberrations.
- Screening of crop varieties to increase and stabilize crop production in dryland through developing cropping systems and management practices.
- Testing the techniques evolved at Research Station on the farmers fields under Operational Research Project.
- Designing and testing farm implements.
- To study crop weather relationships.
- To develop alternate land use and forming systems.
- To train the farmers and extension agencies on improved production technology.

The ongoing research projects at ARS, Ananthapuramu.

S. No.	Name of the Scheme	Year of start
1.	All India Coordinated Research Project for Dryland Agriculture	1971
2.	All India Coordinated Pearlmillet Improvement Project	1972
3.	All India Coordinated Research Project on Agrometeorology	1983
4.	Operational Research Project	1984
Non plan		
1.	Soil Conservation Research Scheme	1964
Others		
1.	Gramin Krishi Mausam Sewa	1996
2.	Rastriya Krishi Vikas Yojana	2008
3.	National Initiative on Climate Resilient Agriculture	2010
4.	AICRP on Arid legumes (Voluntary Centre)	2013
5.	AICRP on Castor (Voluntary Centre)	2014

Other activities of research station

Extension activities:

Training programmes: Need based training programmes are being conducted to the farmers and officials of the line department from time to time, covering the topics on natural resource management,improved varieties,cropping and farming systems, farm mechanization, INM and IPM. Scientists also participated in *Rythuchaitanya yatras, Rythupolallo Sastravethalu, Kisan melas, Polambadi,* field days, focus group discussions, farmers – scientists interaction meetings, diagnostic field visits etc.,

Scientists have published several scientific information in vernacular language for the benefit of farmers.

Seed production:

Large scale production of breeder seed of improved groundnut varieties (K6, Narayani, ICGV 91114) was initiated in 2008 on farmers fields under outsourcing basis. The seed was supplied to Govt. Agencies for further multiplication of seed materials.

Infrastructure facilities available

- Automatic Digital Nitrogen Analyzer
- Groundnut Seed Grader
- Photosynthesis System
- SpadChlorophyll Meter
- GPS
- Theta Probe and Data Logger
- Atomic Absorption Spectrophotometer
- Double beam UV Spectrophotometer
- Automatic Weather Station
- Profile moisture probe
- Rainout Shelters
- Engineering Workshop
- Air-conditioned ConferenceHall
- Zoom stereo microscope
- Transgenic glass house
- Modified Atmospheric package*etc.,*
- Well equipped laboratory for Agronomy, Soil Science and Plant Pathology
- Custom hiring centre

Technology 1: Sub soil chiseling (Deep ploughing) for Insitu moisture conservation.

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Generally farmers cultivate the soil with tractor drawn cultivator which cuts the top soil to a depth of upper 15 to 20 cm only. This traditional type of tillage stores the rain water to a limited extent and during heavy rainfall events runoff takes place leading to soil erosion.

Technology description: In order to over come the adverse effects of sub-soil compaction in *alfisols* and to break the hard layer to increase water intake rate and reduce run off, deep ploughing once in 3 years (residual effect of deep ploughing was observed for only 2 years) with sub soiler upto 40 to 50 cm depth without soil inversion was found good.

Conservation Furrow with Subsoiler in Redgram

Impact: Higher pod yield in ground nut with deep tillage and conservation furrow with sub soiler in redgram recorded higher seed yield compared to normal tillage with cultivator. Deep, well branched and rapidly growing root system helps in absorbing more moisture by exploiting higher volume of soil.

Technology 2: Soil test based P fertilizer application for groundnut in shallow arid alfisols

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Farmers apply blanket application of phosphorous (40 kg/ha) for groundnut which has lead to high buildup of P in soil. This induces micro nutrient deficiencies in the soil.

Technology description: Based on long term nutrient management studies, prescription of fertilizer doses based on soil test values for groundnut have been developed. Application of full recommended fertilizer dose (40 kg/ha P_2O_5 or 250 kg/ha in the form of SSP) applied when the soil test values for P was low and half the recommended fertilizer dose (20 P_2O_5 kg/ha or 125 kg/ha in the form of SSP) is sufficient when P is in medium in range. However application of P not required when the soil test values are high.

Soil test based fertilizer applied to groundnut

Impact: This recommendation has been spread through all the Agricultural divisions of Ananthapuramu district in an area of 70% area of groundnut in 8.50 lakh ha. The concept has reduced the cost of cultivation of *kharif* groundnut with a saving of about Rs.22.0 crores (about 70% of the area of 8.50 lakh ha) on the cost of cultivation in Ananthapuramu district. Also Government will be able to save precious foreign exchange as phosphatic fertilizers need to be imported.

Technology 3: Sheep penning to increase nutrient status in rainfed soils (revalidation of ITK)

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu and Kurnool (AESR 3.0).

Existing practice: The availability of FYM is decreasing in the villages due to fodder scarcity and labour shortage for cattle and milch animal maintenance. Cost of FYM and its application to fields are high. In view of this, farmers are adopting sheep penning as an alternative source of organic manure.

Technology description: Sheep and goat manure are relatively lower in moisture content and higher in nutrient value than cattle manure .Average nutrient composition (%) of sheep and goat manure is 1.93 N , 0.6 P and 1.90 K . Four years (2009-10 to 2012-13) of study on sheep penning ($2m^2$/animal) overnight on the field resulted that 13% increase in pod yield and 41% increase in haulm yield was recorded compared to contol. Available Potassium in soil was significantly increased in sheep penning treatment compared to control. Available micronutrients in soil such as Fe and Zn also increased in sheep penning treatment compared to control.

Sheep penning

Impact: In Ananthapuramu district, nearly 320 sheep cooperative societies are existing. In general,3500-4000 sheep per ha are utilized to fertilize the lands. This traditional practice still provides a valuable source of manure for maintaining the fertility status of soil and reduced the cost of production of cultivated crops.

Technology 4: Improved groundnut varieties K-6, Narayani, Dharani and ICGV 91114

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0).

Existing practice: Farmers are using local bunch groundnut with low productivity.

Technology description: K-6, Narayani, Dharani and ICGV 91114 tolerant to drought and with higher pod yield of 14-20 percent. The pods are bigger than local bunch and fetch more price in the market.


K-6

Narayani

ICGV 91114


Dharani

Impact: In Ananthapuramu district, K-6 was taken up in 6.0 lakh ha, Narayani in 1.0 lakh ha and ICGV 91114 in 0.5 lakh ha out of 8.50 lakh ha under rainfed situation in *kharif*. All these three varieties are drought resistant and high yielding compared to local variety.K6 variety was spread to all the districts in Andhra Pradesh, Tamilnadu and Karnataka states.

Technology 5: Use of small and medium seeds for groundnut cultivation

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Farmers of the region usually go for sowing of bold seed in groundnut cultivation which not only increases the seed cost incurred, but also restricts its availability.

Technology description: In groundnut, seed cost constitutes nearly 36% of total cost of production. Pod yield did not differ significantly by using small seed compare to bold seed in groundnut.Higher net returns and benefit cost ratio were realized with small and medium compare to bold seed. Thus cost of cultivation was reduced by using small seed to sow groundnut crop.Small groundnut seed can be recommended for sowing under rainfed situation to reduce cost of cultivation and risk of incurring heavy losses during drought years as seed cost alone constitutes 30 % of the total cost of cultivation of groundnut.

Impact: This technology is slowly percolating through University Extension personnel, State Department of Agriculture and Non-Government Organization in the district which in turn is gaining acceptability from farming community.

Technology 6: Ananta Bullock drawn planter for sowing rainfed crops

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: The farmers are using four row bullock drawn local *gorru* for sowing of groundnut in rainfed areas of the zone. The seed is sown by a person through *Jadigam* having four circular holes connected to furrow through seed tubes. The optimum seed rate could not be achieved by this due to manual dropping of seed. Two pairs of bullock and four labour are required to complete the sowing operation. The cost of sowing is about Rs. 500 per acre. The field capacity is 1.0 to 1.5 ha per day.

Technology description: Ananta bullock drawn groundnut planter is provided with a vertical rotor type seed metering mechanism for seed placement in the row. This covers four rows at a time with row to row distance of 30 cm and maintains seed to seed distance of 10 cm in a row at 4-5 cm depth of sowing. **The recommended seed rate *i.e.* 100 kg/ha can be maintained.** The field capacity is in between 1.5 to 2 ha/day. The capacity of hopper is 8 kg for groundnut. Recommended plant population of 33 per m^2 can be obtained.

Ananta Bullock drawn planter

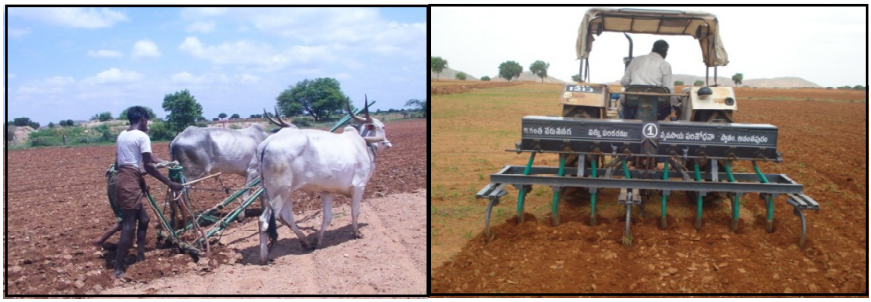
Performance: It can cover 4 rows at a time and has a field capacity of about 0.37 ha h^{-1} and the cost per unit was about Rs.8500/-. Wastage of seed and one labour for dropping of seed can be avoided.

Technology 7 : Tractor Drawn Ananta Groundnut Planter (8 rows)

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh; red soils of Ananthapuramu, Chittoor, Kurnool and Kadapa districts in rainfed groundnut areas (AESR 3.0).

Existing practice: The farmers are using four row bullock drawn local *gorru* for sowing of groundnut in rainfed areas of the zone. The seed is sown by a person through *Jadigam* having four circular holes connected to furrow through seed tubes. **The optimum seed rate could not be achieved by this due to manual dropping of seed.** Two pairs of bullock and four labourers are required to complete the sowing operation. The cost of sowing is about Rs. 500 per acre. The field capacity is 1.0 to 1.5 ha per day.

Technology description: Tractor drawn Ananta groundnut planter (8 row) is introduced to mechanize the groundnut sowing in the district for timely operation with mechanical advantage and intercropping facility. A 5 cm width covering blade is also fitted behind the furrow openers to cover the furrows after seed placement. The inclined disc plate seed metering mechanism gives correct seed to seed distance and maintains the recommended seed rate of 90 to 100 kg/ha. It covers 8-rows at a time. The intercropping of redgram or castor can also be sown using ananta planter along with groundnut sowing. The spring type cultivator of this planter facilitates to sow in stony and pebble slopy soils. The cost of ananta planter is approx. Rs.60, 000.



Ananta Bullock and Tractor drawn groudnut planter

Performance: Ananta planter maintains the recommended seed rate and required plant population. The seed damage is negligible and placement of seed is at proper depth of 4-5 cm. The field capacity is 6 to 7 ha/day and can cover large area before the soil moisture is dried up. Its cost of operation is Rs. 250 per acre. The germination and plant population was to the full satisfaction of the farmers.

Impact: Timely sowing in optimum soil moisture conditions covering large areas is possible with Ananta Planter. The technology was spread to all the farmers in Ananthapuramu district by custom hiring centres. Even the Ananta planter was spread to all the groundnut growing districts in Andhra Pradesh and Karnataka State.

Technology 8: Tractor drawn Ananta planter cum boom sprayer

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: The productivity of rainfed groundnut fluctuates widely due to insufficient and erratic rainfall during the crop growth period. Due to late receipt of rains farmers are sowing groundnut beyond August 15th to September 1st week.

Technology description: It is used for simultaneous sowing of groundnut and herbicide spraying for control of weeds in initial stages. It is provided mainly with piston type pump for developing the sufficient pressure, six flat pattern nozzles arranged on the boom to develop spray, two drums of each 200 liters capacity, seed hopper of 40 kg capacity and inclined plate metering mechanism for sowing of seed. The pump gets the power from PTO shaft of tractor for pumping of the chemical from tank into nozzles through pipes. It can sow seed in 8 rows at a time and spray the herbicide at the application rate of 200 liters per acre. The field is 5 – 6 ha/day and maintains required seed rate of 100 kg/ha, seed to seed distance 10 cm in a row and depth of seed placement 4-5cm. Its cost is about Rs.65,000/-

Tractor drawn Ananta planter

Performance: It can be used for simultaneous sowing of seed and herbicide application, It has field capacity of 0.47 ha per hour and herbicide application rate of 500 liters per ha. The saving in man hours requirement and interms of cost of sowing was quite substantial and justified the use of planter cum boom sprayer.

Technology 9: Ananta Aqua planter for sowing rainfed crops

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Generally farmers sow the rainfed crops whenever rain is received with optimum soil moisture. In delayed sowing *i.e.* beyond August, yields of rainfed crops will be reduced particulary groundnut.

Technology description: Aqua Planter is used to supplement water in conjunction with groundnut sowing simultaneously. It is mainly provided with two water drums of each 200 liters capacity with suitable GI pipes, seed hopper and inclined plate seed metering mechanism. Sufficient quantity of water is supplied in each opened furrow while sowing seed itself, so that seed will germinate and further crop can sustain by using the subsequent rainfall. Two drums of water is sufficient for 1/4th acre area. It can sow 8 rows at a time with seed rate of 100 kg/ha and field capacity 3 – 4 ha/day. The depth of seed placement is about 4-5cm. Its cost is about Rs.60,000/-.

Ananta Aqua planter

Impact: Timely sowing can be done with aqua planter developed by ARS, Ananthapuramu by using 1600 to 3200 lt per acre depending up on the moisture content of the soil.

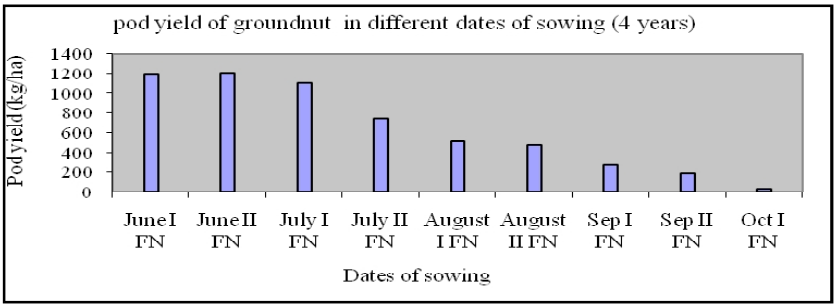
Technology 10: Timely sowing of rainfed crops for higher profitability

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: During recent years, the yields of groundnut crop have been reduced drastically or the crop failed some times due to severe drought. Hence, there is a need to replace the groundnut crop with any other profitable and sustainable crops.Groundnut is an important commercial crop of Ananthapuramu district is recommended to be grown during July to October. But due to the frequent droughts occurring at different phenophases of the crop and also other biotic stresses (RHC, leaf miner, PSND, stem rot, late leaf spot and rust), the groundnut crop yields are not only low but unstable.

Technology description:

- The optimum time of sowing for groundnut is June to July.
- Best yields with pigeon pea and castor can be obtained when sown during June.
- Pigeonpea, Castor, Sorghum and Foxtail millet were found better alternate crops for groundnut.
- If rainfall is delayed beyond August, sowing of contingent crops such as horsegram, greengram, pearl millet, cowpea and sorghum/ fodder sorghum is profitable.



Impact: Timely sowing helps in achieving optimum utilization of seasonal rainfall, reduces the incidence of pests and diseases, and escapes terminal drought. Now farmers realized importance of timely sowing. Castor and pigeon pea were grown during June , groundnut during June to July, then beyond August contingent crops such as Sorghum , Horsegram, pearl millet and Cowpea.

Technology 11: Groundnut + pigeonpea intercropping

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu and Kurnool districts (AESR 3.0).

Existing practice: Farmers are cultivating rainfed groundnut as sole crop or mixed crop with other pulses (without distinct row proportion).

Technology description: Intercropping of groundnut + pigeon pea in 7:1or11:1or 15:1 increases net returns compared to sole groundnut. Intercropping of groundnut + pigeon pea resulted in high returns compared to farmers practice (sole crop or indefinite row proportion) and acts as an insurance during the situations of main crop failures.

Groundnut + Pigeonpea intercropping

Impact: Intercropping of groundnut + pigeon pea was adopted in 70 % of the total groundnut area (9.85 lakh ha) in Scarce Rainfall Zone which resulted in high returns to the farmers. Approximately a farmer could be able to get an additional income of Rs.3000 per ha (about 200 kg/ha).

Technology 12: Intercropping of groundnut with mixed pulses (Pigeonpea, cowpea and horsegram) to conserve soil moisture.

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0).

Existing practice: Farmers cultivate groundnut as a sole crop under rainfed situation.

Technology description: Sowing groundnut + mixed pulses (pigeonpea + horsegram + cowpea) in 15:1 will arrest run off flow, besides increased returns by 18-22 percent compared to sole groundnut.

Impact: In Ananthapuramu district, the practice of intercropping of groundnut with mixed pulses has been well adopted in sloppy fields. In an area of 1.0 lakh ha this practice is adopted.

Intercropping of groundnut with mixed pulses

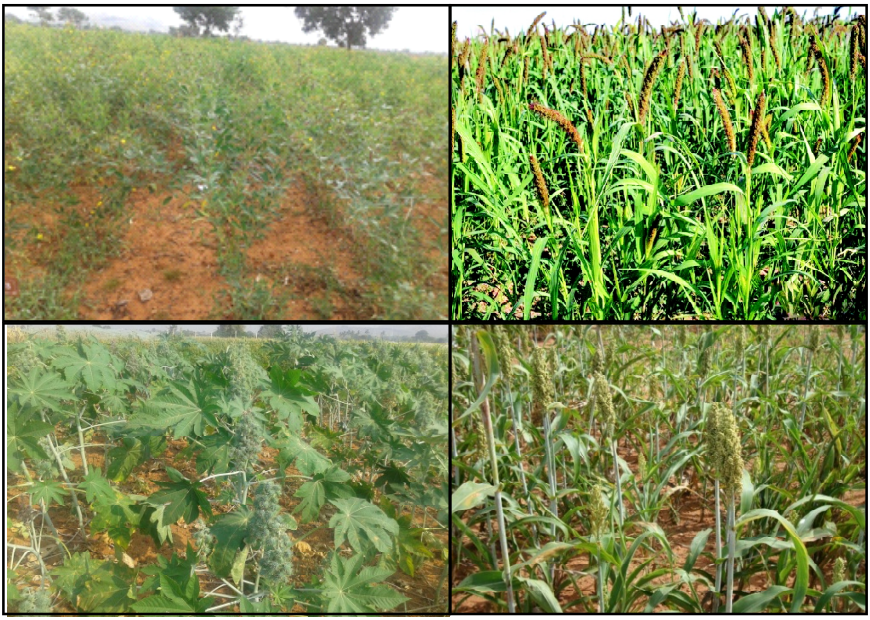
Technology 13: Profitable crops other than groundnut for rainfed alfisols

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu and Kurnool (AESR 3.0)

Existing practice: Groundnut, is an important commercial crop of Ananthapuramu district is recommended to be grown during June to July.

But due to rainfall variability and frequent droughts occurring at different phenophases of the crop and also other biotic stresses (RHC, leaf miner, PSND, stem rot and late leaf spot) , groundnut crop yields are not only low but unstable. During recent years, the yields of groundnut crop have been reduced drastically or the crop failed sometimes due to severe drought.

Technology description: Redgram, castor, foxtail millet and sorghum can be grown as profitable crops in addition to groundnut. During drought years redgram, castor and sorghum yields were higher compared to groundnut.



Impact: Redgram, castor, foxtail millet and sorghum crops could be grown successfully by farmers in Ananthapuramu district. In *Kharif 2012*, redgram and castor crops were taken up in 50000 ha and 15000 ha in Ananthapuramu district.

Technology 14: Contingent crops for delayed monsoon

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Farmers cultivate groundnut under normal monsoon during *kharif* situation. Even under delayed monsoon either fields left fallow or sown with groundnut though lower yields are obtained.

Technology description: Under delayed monsoons beyond August 15th, instead of groundnut, horsegram, clusterbean, pearlmillet, sorghum, cowpea and greengram are suitable for rainfed Alfisols.

Horsegram **Bajra** **Sorghum**

Impact: Contingent crops for delayed monsoon taken up successfully by farmers in Ananthapuramu district. In *Kharif 2006 and 2009*, sorghum and horsegram were taken up in 3.4 and 0.1 lakh ha in Ananthapuramu district.

Technology 15: Insitu moisture conservation measures for higher groundnut productivity.

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0).

Existing practice: Farmers follow sowing either along the slope or across the slope depending upon their convenience in sowing. Besides this, they don't follow any *Insitu* moisture conservation measure to conserve both soil and moisture.

Technology description: Opening of conservation furrows at every 3.6m interval or compartmental bunding (15m x 10m) in groundnut coupled with sowing across the slope not only conserves moisture but also increases the groundnut productivity to the tune of 10 to 14 per cent.

Soil and moisture conservation practice

Impact: It has gone as a component of soil and moisture conservation measure in watershed areas.

Technology 16: Tractor Drawn Ananta Interculture Implement

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh; red soils of Ananthapuramu, Chittoor, Kurnool and Kadapa districts in rainfed groundnut areas (AESR 3.0).

Existing practice: Weeding is one of the important operations in rainfed groundnut and is manually done by *metla guntaka* and *danti guntaka* driven by a pair of bullocks in between rows at 20 and 40 days after sowing. Intra row weeding is done by human labour at 30-40 days after sowing in Ananthapuramu region. The field capacity is around 4 to 5 acres per day.

Technology description: The pneumatic tyres of 8.3" X 32" size were fitted to the rear wheels of the tractor. The tractor with small tyres can run in the groundnut field at a row spacing of 30cm. The interculture implement

with 8 tynes was developed with T-shape and V-shape sweeps fitted to the tynes and field tested. The size of the sweeps ranges from 4" to 6". The cost of pneumatic tyres and interculture implement with sweeps are approx. Rs. 30,000.

Performance: The tractor drawn interculture implement can run in between the row spacing of 30 cm without any plant damage. Its field capacity is 4 to 5 ha/day. The cost of interculture operation is Rs. 200 per acre. Small size sweeps of 4" are used for 1st interculure operation at 20 to 25 days of sowing and 6" size sweeps used for 2nd interculure operation at 40 days of sowing.

Intercultivation with danthulu

Intercultivation with tractor (small pneumatic tyres)

Impact: By introducing this technology in the zone, the field capacity increases to almost double and performs timely operation. The women labour drudgery is reduced to maximum extent. By replacing the traditional practice with tractor drawn interculture implement in Ananthapuramu region, a saving on weeding cost can be reduced.

Technology 17: Tractor Drawn Boom Sprayer

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh; red soils of Ananthapuramu, Chittoor, Kurnool and Kadapa districts in rainfed groundnut areas (AESR 3.0).

Existing practice: The farmers are generally using hand sprayers, knapsack sprayers for spraying of chemicals. It cannot maintain the uniform distribution of spray liquid. Its field capacity is around 4 to 5 acres / day. It is more time consuming and labour intensive. The cost of operation is about Rs.250 per acre.

Technology description: Tractor drawn boom sprayer consists of 20 nozzles with a length of 12 meters. The boom sprayer can be operated in groundnut crop duly replacing the original tyres with small tyres of 8.3" x 32" size. It is operated by the tractor P.T.O. shaft. Its field capacity is high. The tank capacity is 500 liters, which contains the spraying liquid. The cost of boom sprayer with pump and attachment comes to Rs.30000.

Performance: It covers 12 m width, i.e 40 rows at a time. The spraying liquid is distributed uniformly to the crop. By fixing the forward speed of tractor and P.T.O., the spray liquid can be controlled. The cost of operation comes to Rs.150 per acre. The field capacity of boom sprayer is 20 to 25 ha / day.

Tractor drawn boom sprayer

Manual spraying

Impact: By introduction of this new technology, the field capacity can be largely increased to control the epidemic situations, thereby crop loss due to pest and diseases can be minimized.

Technology 18 : Water harvesting and supplemental irrigation to rainfed groundnut

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut, red soils, Ananthapuramu (AESR 3.0)

Existing practice: Farmers are cultivating groundnut in an area of 8.5 lakh ha under rainfed situation in Ananthapuramu district. Crop failure occur due to prolonged dry spells at ortical stages.

Technology description: A farm pond of 250 m^3 capacity (size of 10 x 10 m with 2.5 m. depth) with side slopes of 1.5:1 is sufficient for catchment area of 1 ha. Soil + Cement lining with 6:1 ratio was found very effective in reducing scepage losses. A supplemental irrigation of 10 mm through sprinkler at 45 days after sowing (pegging stage) will increase pod yield of groundnut.

Farm pond and Supplemental irrigation in groundnut

Impact: Adoption of this technology will increase the pod yield of groundnut by 28 per cent for each 5 ha of catchment. By following this practice there will be an additional groundnut pod yield of 25,500 tonnes under rainfed situation in Ananthapuramu district, which will be about Rs. 7.65 crores.

Technology 19: Management techniques for late sown groundnut

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Due to frequent dry spells and other biotic stresses, groundnut crop yields are not only low but unstable.The productivity of rainfed groundnut fluctuates widely due to insufficient and erratic rainfall during the crop growth period. Due to late receipt of rains farmers are

sowing groundnut beyond August 15th to September 1st week. Groundnut yields were low due to heavy incidence of late leaf spot and leaf webber.

Technology description: Study revealed that leaf webber + late leaf spot control in late sown groundnut resulted higher yields. Pooled data of three years experimentation results revealed that for late sown groundnut under rainfed situation, higher pod yield (284 kg/ha) and B:C ratio (1.18) was recorded with leaf webber+late leaf spot control followed by leaf webber control. Higher pod yield (383kg/ha) and B:C ratio (1.56) was realized with leaf webber control with supplemental irrigation. Leaf webber control (quinolphos@2 ml /litre of water with 2 or 3 sprays) and late leaf spot control(hexaconazole @2ml/litre of water) is required to get better pod yield in late sown groundnut when onset of monsoon is delayed.

Impact: Groundnut yields can be increased by leaf webber control (quinolphos@2 ml /litre of water with 2 or 3 sprays) and late leaf spot control(hexaconazole @2ml/litre of water) is required to get better pod yield in late sown groundnut when onset of monsoon is delayed.

Technology 20: Tractor Drawn ANGRAU Blade Guntaka

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh; red soils of Ananthapuramu, Chittoor, Kurnool and Kadapa districts in rainfed groundnut areas (AESR 3.0).

Existing practice: General practice of harvesting is by hand pulling of plants when the crop comes to maturity. If rain occurs during the period of harvesting, hand pulling is easy. However, the soil becomes hard and compacts if there is no rainfall at the time of harvest. The farmers use bullock drawn *madaka* to open the furrow along the rows to loosen the soil and plants are removed from the loosen soil to minimize pod loss. Under these circumstances the harvesting losses are more even upto 20%. The cost of operation is about Rs.400 per acre. Its field capacity is only 1.0 to 1.5 ha per day.

Technology description: The tractor drawn blade guntaka was introduced to perform the harvesting operation easy and more economical. It covers 4 rows at a time. The harvesting can be done at right time to avoid other field losses. The cost of blade guntaka is Rs.12,000. The worn out blade can be replaced with a new one in the blade slot which is fixed to the 6" pipe frame. Each blade can run for 20 to 25 hours in a hard pan of soil. If the soil is moist, its life can be extended for another 10 to 15 hours. Its repairs can be attended easily by the local artisans.

Performance: It can cover 4 rows at a time and have a field capacity of 4 to 5 ha per day. The cost of operation comes to Rs.300 per acre. Timely operations avoid the field losses and fetches high market price of groundnut.

Manual harvesting

ANGRAU blade guntaka

Impact: By introduction of this new technology in 9.5 lakh ha of rainfed groundnut areas of the zone, a sum of Rs.23.75 crores can be saved to the farmers. The harvesting losses could be saved. The human drudgery for women labour is eliminated.

Technology 21: Tractor drawn groundnut digger shaker cum windrower

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: The productivity of rainfed groundnut fluctuates widely due to insufficient and erratic rainfall during the crop growth period. Due to late receipt of rains farmers are sowing groundnut beyond August 15th to September 1st week.

Technology description: It is used for harvesting of groundnut crop at soil moisture levels of 8 -15 % and operated with above 45 H.P tractor. It has the working width of 120 cm and covers 4 rows of groundnut crop at row to row spacing of 30 cm. Its overall dimensions are 1700 x 1000 x 1050 mm provided with soil loosening tool of sweep type, a pick conveying mechanism and gatherer windrower. The soil engaging tool is made of high strength mild steel. At the rear, a gatherer windrowers the conveying crop. While conveying, soil get removed from crop due to shaking action.

Tractor drawn groundnut digger shaker cum windrower

Performance: The field capacity is 0.8 – 1.0 ha/h. Harvesting and soil separation efficiencies are 96 and 95% respectively. Saving in labour cost and time are 50 and 95% respectively compared to manual harvesting. Its cost is about Rs.1,80,000. It can harvest groundnut 2-2.5 acre per one hour.

Technology 22: Groundnut dry pod Thresher

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh; red soils of Ananthapuramu, Chittoor, Kurnool and Kadapa districts in rainfed groundnut areas (AESR 3.0).

Existing practice: The farmers are accustomed to hand stripping of groundnut pods from the plants at a later date after harvesting. The harvested crop is transported and heaped in the farm houses and stripping will be done as and when the labour is available. The stripping capacity of one labour varies from 40 to 50 kg/day and stripping cost comes to Rs. 200 per 100 kg of pods.

Technology description: The groundnut threshers are introduced in the region to make the stripping operation easy and economical. The threshers are having high stripping capacity depending upon the crop yield. The threshers can be used immediately 5 days after harvesting without transportation and heaping. The cost of groundnut thresher is Rs. 1,20,000/ . The operation is simple and repairs if any can be done by local artisans. Due to early threshing of groundnut crop, the haulms are better preferred by the animals.

Performance: The groundnut threshers are having high stripping capacity of 200 to 300 kg/hr. The cost of operation comes to Rs. 33 per 100 kg of pods. The thresher can be moved from one field to another on pneumatic tyres with a pair of bullock or by a tractor.

Groundnut dry pod thresher

Impact: By introduction of this new technology, it is estimated that Rs. 5.25 crore is saved to the farmers of Ananthapuramu region. The quality produce free of aflatoxin and better price can be achieved by the farmers due to timely and early threshing.

Technology 23: Groundnut wet / fresh pod Thresher

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh; red soils of Ananthapuramu, Chittoor, Kurnool and Kadapa districts in rainfed groundnut areas (AESR 3.0).

Existing practice: The farmers are accustomed to hand stripping or dry pod threshing with thresher of groundnut pods from the plants at a later date after harvesting. The harvested crop is transported and heaped in the farm houses and stripping will be done as and when the labour is available by dry pod thresher or hand stripping. Immediately after harvest of groundnut (October to November) coincides with cyclonic rains resulting heavy losses to the farmers. Even after the rains the pods were rotten with aflatoxin.With the help of wet / fresh pod thresher groundnut crop can be threshed immediately after harvest of groundnut.

Technology description: It is used for separating pods from plants immediately after harvesting of groundnut crop. The farmer no needs to wait for drying of crop after harvesting for threshing. It is operated with

540 RPM PTO shaft of 35 – 45 H.P tractors. It consists of frame, feed hopper, drum type threshing cylinder, concave, oscillating sieves, blower and pod outlets. The groundnut pods are separated from plants between cylinder and fixed concave by rubbing and impact forces and fall down through cleaning sieves. Blower separates plant stalk and leaves from pods. Cleaned pods come from main outlet. It has the output capacity of 300 kg/h with 96 % threshing efficiency. Initial cost is around Rs. 1,80,000. It can easily transported from one place to another place as it is provided with pneumatic tyres. Six no.s of labour are required for operation.

Groundnut wet pod thresher

Impact: It is very useful where the influence of north east monsoon will be more and continuous rains occur at harvesting time.

Technology 24: Groundnut grader for kernel separation

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0).

Existing practice: Groundnut farmers of Ananthapuramu district are preferred to sell the kernels instead of pods as they are getting remunerative

price. Groundnut decorticators are available to separate the kernels, but the graders are not available to separate different size of kernels. In general farmers sell groundnut pods to trader or oil mills without decorticating and receive low price for their produce. If they could sell their produce after decorticating and grading kernels farmers can realize higher returns. Besides being rain fed crop ill filling of pods is a common feature. Also in a variety like K6 one kernel will be bigger and other one is smaller under rain fed situation. About 70 per cent of groundnut kernel is exported from India. If farmers sell their produce after decorticating and grading they will have more profits. In Ananthapuramu district is about 8.5 lakhs groundnut is cultivated in *kharif* under rainfed situation. Hence groundnut processing and grading will have an important market.

Technology description: Three sizes of sieves were fabricated and grader was operated with different pulley speeds. In first sieve the seed size is 1.24 cm, second sieve the seed size is 1.06 cm and third sieve the seed size is less than 1 cm. The grader was found to be useful for separation of different sizes of kernels without any damage, thus value addition is possible. About 300 kg of kernel could be processed in one hour.

Impact: A groundnut kernel grader is used for grading of groundnut kernel into three sizes i.e greater than 1.24 cm, in between 1.06 – 1.24 cm and less than 1.06 cm. Its capacity is 300 kg/h without any kernel damage and operated with 2 H.P electric motor. Small kernel could be utilized for sowing and bold kernel can be sold for confectionary thus increases income of farmer by 15 – 20%.

Technology 25 : Groundnut based farming system

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Ananthapuramu district is drought prone district where only mono cropping of groundnut (80% cultivated area) is being followed due to low and erratic rainfall situations and with only 14-17 weeks of rainy period, the employment opportunity is only for a short period of 3-4 months.

Technology description: For a farm system of 1 ha of land, groundnut as a *kharif* rainfed crop with sheep rearing (10 rams) for 4 months (November to February) improved total net returns by 100 percent compared to crop alone. Besides, it provides 65 man days of employment after harvest of groundnut. On farm studies also indicates that under integrated farming systems, farmers benefited by getting additional income of Rs. 200 per sheep per month after harvest of groundnut.

Impact: Farmers in Ananthapuramu district have adopted in 20 percent of rainfed situation of 8.5 lakh ha. Technology has resulted in increased income among farmers by about Rs. 5,000 per ha.

Technology 26: Soapnut trees for class-VI lands

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Soils of land capability class VI consists of gravel sandy loam on very gently sloping lands with severe erosion. These soils limit the root zone owing to their shallow depth (0 – 20 cm). Trees can increase productivity and improve sustainability, but it is not a "quick fix" for every land use situation.

Technology description: Four tree species viz, soapnut, tamarind, ber and custard apple were established under rainfed situation in class VI lands. Among all the trees soapnut alone gave fruits only during good rainfall year *i.e.*, 2008-09.While the rest of the trees (ber, custard apple and tamarind) have failed to bear any fruits.

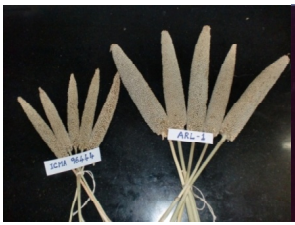
Impact: Management of class VI soils is an important aspect in watershed areas for which soapnut plantation is a better option.

Technology 27: Growing of Hybrid Pearl millet in place of Local varieties

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, Rainfed groundnut growing red soils, Ananthapuram (AESR 3.0)

Existing practice: Farmers are using local varieties of pearl millet with low productivity.

Technology description: Newly developed pearl millet hybrid *i.e.*, ABH -1 (Ananthapuram Bajra Hybrid – 1) is downey mildew disease tolerant and moderately drought tolerant, with medium maturity duration (85-90 days). This hybrid gives higher grain yield of 15 – 20 percent (1500 – 2000 kg/ha grain yield under rainfed condition) than the local variety and the plants are having more number (3 - 4) of productive tillers per plant.



Field view of ABH - 1 Parental lines of ABH - 1 Pearl millet Hybrid ABH - 1

Impact: In Ananthapuram and Kurnool districts in Front Line Demonstrations in 10 ha area of farmers field, the newly developed pearl millet hybrid ABH – 1 has expressed 26.60% higher grain yield and 25.25% higher dry fodder yield than the local check variety during *kharif* 2014.

Technology 28: Weather based prediction model for Emergence of Red Hairy Caterpillar

Recommendation Domain: Scarce Rainfall Zone of Andhra Pradesh, Rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing Practice: Occurrence of pests and diseases on groundnut is common under rainfed conditions causing considerable damage resulting in yield reduction. Using of chemicals to control these pests and diseases in groundnut involves not only huge costs of the chemicals, but also for spraying.

Technology Description: Information on the occurrence of red hairy caterpillar damage helps the farmers to go for bonfires on community basis and also to check the pest by using dust formulations in the initial stages of the pest. In this way, huge amounts of expenditure on plant protection in rainfed groundnut can be saved.

Relationship between weather and Emergence of Red Hairy Caterpillar: Based on the studies conducted under AICRP on Agrometeorology, a model was developed to provide the emergence of RHC.

The model is $Y = 4.3441 X + 163.5$ $R2=0.45$.

Where, Y= No. of predicted RHC moths, X = Rainfall during June through September (mm)

Emergence of RHC moths was found to be closely associated with heavy rain events. The no.of RHC moths reaches a peak 3 to 4 days after rain event.

Optimum adult moth emergence was noticed when there is a rainfall of 20 mm. Emergence was not there during the days with more than 20 mm rainfall or heavy downpour, but peak emergence was noticed after 2 – 3 days of heavy rainfall.

RHC moths emergence depends up on the amount of rainfall received during July and August. If heavy rains are received during July, the emergence of RHC moths during August will be less.

Rainfall received during July caused almost a constant rate of emergence of RHC moths up to 8 days after the receipts of rainfall. But with the rains received during August, the moth emergence of RHC moths was slow at the beginning with a gradual increase and finally the emergence of moths decreased.

Depending upon rainfall received during June through September, emergence of red hairy caterpillar moths can be predicted three days in advance depending on the catches in light trap and the forecast can be passed on to the farmers through mass media and extension agency. This will be highly useful for groundnut farmers.

Impact: The model was used for issuing agro-advisory services to the farmers which helped to take timely control measures.

Technology 29: Weather based Forewarning model for Incidence of Groundnut Leaf miner

Recommendation Domain: Scarce Rainfall Zone of Andhra Pradesh, Rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing Practice: Leaf miner is a regular and serious pest in rainfed groundnut causing considerable damage and yield reduction.

Technology Description: Advance forecast on the incidence of leaf miner based on the prevailing weather conditions helps the farmers to take up control measures in time to avoid crop damage and yield loss.

Relationship between weather and Leaf miner:

Weather based prediction model was developed to predict the occurrence of leaf miner based on the studies conducted under AICRP on Agrometeorology.

Leaf miner damage = 0.473 + 0.004 Tmin+ 0.13 RH I - 0.19 RH II – 0.26 SSH R2= 0.91

The weather parameters observed at the time of peak leaf miner damage were T max 24.4 to 36.6 0C, T min 23.4 to 25.5 0C, RH –I 64 to 70 % and RH –II 33 – 37%.

Leaf miner outbreak was recorded when heavy rainfall occurred after a long gap. The leaf miner activity was reduced when more 10 mm rainfall was received continuously.

Overall observations indicated that increase in diurnal variation in temperature increased the pest damage. Maximum temperature of more 33^0C and afternoon humidity less than 40% found to be favorable for incidence of leaf miner.

Impact: The model developed for predicting the leaf miner pest in groundnut was validated and the same was utilized for giving the forewarning in theweather based agro-advisory bulletins. Using the models developed for forewarning of leaf miner in groundnut, 5 days in advance, the pest can effectively be controlled.

Technology 30: Management of Late Leaf Spot Disease in Rainfed Groundnut

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Late leaf spot disease caused by *Phaeoisariopsis personata* is an important fungal foliar disease of rainfed groundnut. As the name indicates, it occurs late in the season and affects the pod and fodder yields. Farmers think it is the symptom of maturity and harvest the crop prematurely, thereby reaping very low yields. It is estimated that 15-20% loss in pod yield and 25-40% loss in haulm yield is caused by the disease alone.

Technology description: Investigations carried out both at Agricultural Research Station, Ananthapuramu and several locations on many farmers' fields revealed that pod filling phase was most critical for late leaf spot disease in groundnut. However, by spraying with 0.1% Carbendazim + 0.2% Mancozeb or Hexaconazole (0.2%) at 75 DAS, the late leaf spot disease was controlled, pod growth period was extended and thereby pod and haulm yields increased, leading to higher economic returns from rainfed groundnut. Improvement in quality of both groundnut pods and fodder was also recorded.

Performance : When the impact of management of late leaf spot disease was demonstrated on farmers' fields of Pennar – Manirevu National watershed area, it resulted in higher pod and haulm yields by 13.8 and 16.4% respectively.

Table : Pod and haulm yields of groundnut as influenced by late leaf spot management

Treatment	2000-2001			2001-2002		
	Pod yield (kg/ha)	Haulm yield (kg/ha)	Net returns (Rs./ha)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Net returns (Rs./ha)
T1: Spraying hexaconazole	1641	2246	12101	659	2047	3584
T2: No management against LLS	1508	1955	11740	555	1735	2573
CD 5%	NS	118.0	NS	85.0	190.0	--
SE.M+	79.68	38.32	447.50	27.90		62.70

Impact : The practice of keeping the crop healthy during the most critical pod filling phase by simple fungicide spray will benefit the large masses of farming community and improve / raise their economic status. An additional annual income of about Rs. 38 crores can be generated by this simple technology in Ananthapuramu district alone.

Technology 31: Management of Peanut Stem Necrosis Disease

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: Peanut Stem Necrosis Disease (PSND) is a viral disease in groundnut. This disease occurred in epidemic proportion in Ananthapuramu district of Andhra Pradesh, covering more than 2.5 lakhs hectares of groundnut during *kharif* 2000. The economic crop losses as a result of this epidemic disease were estimated to exceed more than Rs. 250 crores of rupees even under plant protection.

Technology description: Many crop plants that are intercropped or used in crop rotation in groundnut production system were tested for virus susceptibility and found that the virus can also infect sunflower, cowpea, moong bean and marigold. Most widely distributed weeds in groundnut and adjacent fields were tested for the presence of virus and several flowering weeds were confirmed as collateral hosts for the virus . Among them, the most prominent weeds for the spread of Peanut Stem Necrosis Disease are

1. ***Parthenium hysterophorus***
2. ***Tridax procumbense***
3. ***Commelina benghalensis***
4. ***Acanthospermum hispidum***
5. ***Achyranthus aspera***

Among all the collateral hosts *parthenium* is the major source of inoculum for the disease

Recommended cultural practices for peanut stem necrosis disease management

Since *parthenium* plays as a source in virus spread, removal of parthenium from fallow fields pathways, wastelands, and on field bunds will reduce disease incidence. This infact was demonstrated in a farmers' field by removing *parthenium* on bunds and within field. The disease incidence was reduced to 5 per cent as opposed to over 60 per cent incidence when *parthenium* was retained on field bunds.

Disease incidence and spread was reduced effectively by growing four to eight rows of border crop preferably with pearl millet or sorghum.

The technology was disseminated by ORP scientists and other extension organizations of the University through several awareness programmes to farmers, school children and public.

Farmers of Pennar-Manirevu National watershed area are habituated to sow sorghum crop around groundnut fields. Even after the closure of ORP work in 2001 in that watershed area, even now (*kharif* 2009) the farmers are following the technology.

Performance : The methods developed for prevention of Peanut Stem Necrosis Disease are eco-friendly and can be easily be adopted by small farmers. The methods advised are non-monetary and simply by removing parthenium in surrounding groundnut fields, the disease can prevented. If these methods are applid to even 30 per cent of the groundnut cultivated area where this disease appeare, an amount of atleast Rs. 250 crores can easily be saved.

Technology 32 : Pheromone mediated Mass Trapping ; An efficient technique to manage leaf miner (Aproaerema modicella) in Groundnut under the Scarce Rainfall Zone of Andhra Pradesh

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: The leafminer *aproaerema modicella* is known to be a regular and serious pest infesting vast stretches of rainfed groundnut resulting in heavy losses to the crop and during thisperiod , Andhra Pradesh habitually suffers with acute drought and water scarcity. Because the concealed mode of life of the larvae and pupae under the leaf epidermis, the control of this pest continues to be a problem.Recently the sex pheromones have been successfully employed for monitoring andalso for direct control through pheromone mass trapping and mating disruption techniques

Technology description: Pheromone mass trapping techniques can be used efficiently for leaf miner management in groundnut in the farmers' fields. The delta sticky traps were installed @ 20 per ha within 10-15 days of emergence of groundnut crop.

Performance : Significant differences were recorded in the incidence of leafminer in terms of damage in the fields of pheromone mass trapping and farmers practice methods .

Impact : The farmers of project operating villages saved an amount of Rs.942 /ha compared to non-project farmers and higher yield of 148 kg/ha with net returns of Rs.5970/ha than non-project farmers.

Technology 33: **Storage in Modified atmosphere with CO_2; An efficient technique to prevent the infestation of *Caryedon serratus* (L.) in stored groundnut seed**

Recommendation domain: Scarce Rainfall Zone of Andhra Pradesh, rainfed groundnut growing red soils, Ananthapuramu (AESR 3.0)

Existing practice: In India groundnut is stored as both pods as well as Kernels. Both forms are susceptible to groundnut seed beetle *(Caryedon serratus* Olivier), which acts as a primary pest of stored groundnut causing both qualitative and quantitative losses. The traditional storage techniques have now become inadequate to check the insect damage to seeds and grains. Previously, chemicals / insecticides used to control stored insects leave objectionable residues in treated commodity and generally are hazardous to handle and apply. Some of the stored product insects have also developed resistance to these insecticide.

Technology description : Use of modified atmosphere through the introduction of CO_2 has been considered as one of the safest methods to control storage pests. MAP provides a way to eliminate insects from stored commodities without polluting the atmosphere and are considered as the safer traditional fumigants. No harmful residues remain after the treatment of the commodity with CO_2 treatment with CO_2 in residue free

The samples were exposed to CO_2 with the help of MAP Mix 9001ME .This is PBI Dansensor A/S equipment for gas mixing and monitoring of gas and pressure and is a proportional gas mixer especially designed for packaging machines where the gases N2 ,CO2 and O2 were used in 3-gas combinations. The treated samples were packed by package machine simultaneously.

Performance : Except 10 percent CO_2 concentration all the remaining concentrations of CO_2 *viz.,* 20%, 30% and 40% did not recorded any seed damage even after six months of treatment. The normal air treatment recorded 51.9% damage in seeds followed by 42.8%damage in 10% CO_2 treatments.

Impact : Farmers can save the seed safely without damage by insect pests upto three to six months.

Technologies 34 : ICT in Agriculture

Recommendation domain: The farmers, NGOs and officials of the Anantapuramu and Kurnool districts.

Technology Description: Weather based Agro-advisory bulletins were issued to the farmers and officials of the through mass media, NGOs and extension agencies and feedback from the farmers being collected.

Agro-Advisory through SMS disseminated to the farmers and officials of the Scarce Rainfall Zone.Started sending SMS using KISAN SMS portal of Govt. of India website www.farmer.gov.in from September 2013 onwards. 358 SMS were communicated to 23573 farmers and officials of Department of Agriculture and ANGRAU in Scarce Rainfall Zone and so far 1253907 members were benefited from the SMS sent by the AMFU, Ananthapuramu. (www.mkisan.gov.in)

Disseminating the weather forecast and real time agro advisory information through **Voice call** to the tail end clients in collaboration with the reliance foundation since last 7 months to 577 farmers of the Anantapuramu and Kurnool districts.

Existing Practice: Farmers does not have the information regarding the weather forecast and agro advisories information through ICT.

Performance: The information through ICT (like SMS & Voice call) provide the medium range forecast enable the growers for the timely planning of the operations like sowing, irrigation and plant protection measures.

Impact: Reduce the cost of the cultivation and improves the yields of the dryland agriculture.

INDEGINOUS TECHNICAL KNOWLEDGE (ITK)

ITK - 1

Rope – a physical barrier for preventing damage due to wild boars

Location from where the above ITK has been collected : Eguvapalli village of Garladinne mandal and Salakamcharuvu of Singanamala mandal

Purpose of the ITK : To scare the wild boars

Theme area : Plant protection

Description of ITK : Damage to the crop due to wild boars is a serious menace in the hill side areas. Farmers protect the crops from wild boars by tieing ropes all along the boundary of the field which acts as a physical barrier for entry to the wild boars

Advantage : Minimizes damage due to wild boars

Constraints in adoption : Labour consuming, Availability of roaps

Scope for upscaling : Large scope

Researchable issue : Type of rope, pesticide to be smeared to the, rope, longevity of the system

ITK - 2

Cultivation across the slope *(Vaaluku Aaddanga Sedyam)*

Location from where the above ITK has been collected : Pennar-Manirevu National Watershed, Kalyandurg mandal, Anantapur, K.Agraharam watershed, Garladinnemandal, Anantapur Dist.

Purpose of the ITK : To conserve rainfall

Theme area : Rainwater management

Description of ITK : The farmers of the rainfed areas sow the crop across the slope though not along the contour line in order to minimize the soil and runoff losses. It is an age old practice

Advantage : It minimizes the runoff losses and conserves soil moisture.

Constraints in adoption : Time consuming when field length is less across the slope.

Scope for upscaling : Most of the farmers are following.

Researchable issue : Contour sowing can be advised.

ITK - 3

Agave as a vegetative bund *(Kitha naratho valuku addanga katta)*

Location from where the above ITK has been collected : Pampanur, Atmakur mandal, Anantapur Dist and Atmakur, Atmakur mandal, Anantapur Dist.

Purpose of the ITK : To prevent soil erosion

Theme area : Rainwater management

Description of ITK : Farmers grow agave as a boundary bund and also as a vegetative barrier to control soil and runoff losses, besides using for extracting fibre

Advantage : Prevents erosion losses

Constraints in adoption : Slow establishment, Needs attention

Scope for upscaling : Availability of agave slips is a problem. Can be included in watershed programmes.

Researchable issue : Efficient management technologies for growth of agave slips are to be developed. Fast growing varieties are to be screened.

ITK - 4

Half bund as a soil and moisture conservation measure

Location from where the above ITK has been collected : Kalyandurgmandal,Anantapur Dist.Nayanavaripalli of Singanamalamandal, Anantapur Dist. Jalalapuram of Garladinnemandal, Anantapur Dist.

Purpose of the ITK : To prevent soil erosion

Theme area : Rainwater management

Description of ITK : Some of the farmers are having very good idea on topographic features of their land. While aligning bunds, either with soil or with stones gathered from the cultivated area, they take utmost care and take up bunding work where the slope is more and soil and rainfall is lost through erosion.

Advantage : Prevents erosion losses

Constraints in adoption : Time and labour consuming

Scope for upscaling : Already in practice under NREG programmes

Researchable issue : Longevity studies of the bund, Specifications of the bunds depending on the slope of the land.

ITK - 5

Piling up of sand bags for gully plugging

(Isukanimpina sanchulanu vankaku addamuga unchuta)

Location from where the above ITK has been collected : Vaddupalli of Atmakur mandal, Anantapur Dist.

Purpose of the ITK : To prevent soil erosion

Theme area : Rainwater management

Description of ITK : Gully plugging with sand bags is an age old practice to prevent gully erosion and to conserve rain water. Generally plastic bags are filled with sand and piled one above the other in a criss-cross manner across the gully. Thus the gully is plugged and in due course of time, the unproductive area which was previously affected with gully erosion will be bought under cultivation

Advantage : Prevents erosion losses.

Constraints in adoption : Participatory work, Availability of sand is a problem

Scope for upscaling : Large scope by including under watershed programmes

Researchable issue : Stacking height, longevity of bags, amount of silt trapped in unit time

ITK - 6

Stone checks to prevent rill erosion
(Pillakaluvalaku addamuga rallanuparachuta)

Location from where the above ITK has been collected : Nusikottala, Manirevu, Kalyanadurg mandal, Anantapur Dist.

Purpose of the ITK : As an erosion preventive measure

Theme area : Rainwater management

Description of ITK : The intelligent farmers take up soil and moisture conservation measures even in the initial stages of erosion *i.e.*, at the stage of rill erosion by placing small stones which are gathered in their own fields.

Advantage : Prevents rill erosion

Constraints in adoption : Maintanance is a problem, Care should be taken while cultivating the fields

Scope for upscaling : Already being practiced.

Researchable issue : Size of the stones, Nutrients lost in the eroded area, Shape of alignment of stones.

ITK - 7

Groundnut intercropped with mixed pulses as an in-situ moisture conservation measure

(Verusanagalo pappudinusulanu antharapantaga)

Location from where the above ITK has been collected : Pennar-Manirevu National Watershed, Kalyanadurg mandal, Anantapur Dist. Gooty, Anantapur Dist.

Purpose of the ITK: For *Insitu* moisture conservation, meets the family needs.

Theme area : Rainwater management

Description of ITK : This is a successful ITK and is acting as a component of soil and moisture conservation technology. When groundnut is intercropped with mixed pulses, the intercrop row acts as a vegetative barrier for runoff water. Thus, it acts as an in-situ moisture conservation measure.

Advantage : *Insitu* moisture conservation, Higher net returns

Constraints in adoption : Availability of suitable seed at sowing time

Scope for upscaling : Large scope by supplying redgram seed mixed with all pulses

Researchable issue : Proportions of different pulses are to be standardized.

ITK - 8

Mixed farming as a livelihood activity

Location from where the above ITK has been collected : Ramadasupeta of Garladinne mandal, Anantapur Dist.Nusikottala of Kalyanadurg mandal, Anantapur Dist.

Purpose of the ITK : Regular income to meet family needs.

Theme area : Integrated Farming System

Description of ITK : Mixed farming is being followed since ages, keeping in view of the family demands . It not only improves the economic status of the farmer, but also meets the day to day family requirements.

Advantage : Additional and regular income, meets nutritional demands of the family

Constraints in adoption : Capital involvement, high maintenance cost

Scope for upscaling : Large scope by providing short term loans

Researchable issue : Proportions of different components, suitable to categary of farmers. Remunerative breeds are needed.

ITK - 9

Non - monetary threshing floor *(Pedatho alikina kallam)*

Location from where the above ITK has been collected : All parts of the district

Purpose of the ITK : For post-harvest handling of the produce

Theme area : Post-harvest technology

Description of ITK : Most of the farmers,irrespective of their category, do not have well structured/ plastered cement threshing floors. Hence, they are in the habit of plastering the back- yards with cow dung slurry for using that platform as a threshing floor.

Advantage : For post harvest handling of farm produce.

Constraints in adoption : Availability of place. Availability of cow dung

Scope for upscaling : Already in existence.

Researchable issue : Thickness of the cow dung slurry for plastering. Longevity studies

ITK - 10

Traditional bullock drawn seed drill for sowing
(Mamoolu vittanapu gorru)

Location from where the above ITK has been collected : All parts of the Scarce Rainfall Zone of A.P

Purpose of the ITK : To sow the seeds of row crops

Theme area : Energy Management

Description of ITK : Traditional bullock drawn seed drill is developed with own knowledge of the farmer to sow the row crops under rainfed situations. The recently improved seed drills are based on the main idea of the traditional seed drill only.

Advantage : To sow the row crops

Constraints in adoption : Availability of drought animals, high maintenance cost of animals

Scope for upscaling : Already in use

Researchable issue : Metering device is needed, Attachment to sow intercrops, Attachment to drill fertilizer.

ITK - 11

Seed treatment of Redgram with kerosene to prevent ashy weevil damage *(Kirasanailatho vithanasuddi)*

Location from where the above ITK has been collected : Eguvapalli village of Garladinne mandal, Anantapur Dist.

Purpose of the ITK : To prevent pest damage.

Theme area : Cropping Systems

Description of ITK : Some of the farmers of the rainfed area treat the redgram seed with kerosene against some of the pests like ashy weevil.

Advantage : Prevents pest damage

Constraints in adoption : Availability of kerosene

Scope for upscaling : Remote scope

Researchable issue : In depth studies are required on its efficiency

ITK - 12

Drilling of intercrop by using pora tube (Hallow bamboo tubes)

(Veduru gottamutho antharapantalanu vitthuta)

Location from where the above ITK has been collected : All parts of the district

Purpose of the ITK : To sow intercrops

Theme area : Cropping Syatem

Description of ITK : Because of non-availability of improved seed drills to drill the seed of main crop and also intercrop simultaneously, farmers simply use pora tube (hallow bamboo tubes) behind the local seed drill for drilling the seeds of intercrops.

Advantage : For proper drilling of intercrops

Constraints in adoption : Labour shortage and tedious

Scope for upscaling : Already in existence.

Researchable issue : Development of automatic bullock drawn planter.

ITK - 13

Sheep penning for increasing the productivity of groundnut and other crops in rainfed situation.

Location from where the above ITK has been collected : Farmer's Name:R.Vijayabhaskara Reddy, Village : Sivapuram, Mandal : Singanamala, District:Anantapur

Purpose of the ITK : The availability of FYM is decreasing in the villages due to more farm mechanization. Dependence of farmers on draught animals is negligible. In view of this farmers adopting sheep penning as an alternative source of organic manure. As they have no idea how much they would get benefited by this practice, hence there is necessary need to establish / standardize the ITK.

Theme area : Nutrient management

Description of ITK : Cattle herders who used to own large herds of sheep, goat and cattle were requested by farmers to leave their animals for the night in their fields (Acharya *et. al.,* 2001) for which they were paid. This practice enhances the process of on-site decomposition of animal feed residues and provides the nutrients to the soil directly Sheep dung fresh contains 0.5-0.7 % N, 0.4-0.6 %P2O5 , 0.3-1.0 % K2O and sheep urine contains 1.5-1.7 % N , traces of P2O5 and 1.8-2.0 % K2O.

Advantage : Standardization and validation of sheep penning will be useful to know duration required for penning to get similar yield increase obtained with FYM.

Constraints in adoption : Sheep penning feasible only if flock sheep available in the village or near b by villages.

Scope for up scaling : There is increasing trend towards groundnut based farming system with sheep as component.

Researchable issue : To know the effect of sheep penning on pod yield and soil fertility. To know the soil fertility status and physical properties of soil and incidence of pests and diseases.

ITK - 14

Bullock drawn blade harrowing to control emerged weeds aday after sowing of groundnut.

Location from where the above ITK has been collected : Name of the farmer: K.Lakshmi Reddy, Village: P.KothapalliTehsil: B.K.Samudram, District: Anantapur, Agro-ecology : Scarce Rainfall Zone

Purpose of the ITK : To control emerged weeds in groundnut immediately after sowing of groundnut.

Theme area : Energy management

Description of ITK : In Anantapur district groundnut is cultivated in about 8.5 lakh ha. in*kharif* under rainfed condition. About 80% of groundnut is sown with bullock drawn seed drill. In Anantapur district, farmers sow groundnut in *kharif* under rainfed conditions by making use of 4 row bullock drawn seed drill and later furrows are closed by planking. After completion of sowing on the next day blade harrowing is done to control the just emerged weeds. This is a technique that is followed to control the weeds under rainfed conditions immediately after sowing groundnut crop.

Advantage : Early control of weeds will eliminate the competition for moisture, nutrients, space and solar radiation. Thus crop will have advantage of weed free situation during early stage.

Constraints in adoption : Timely blade harrowing may not possible due to demand for bullocks for groundnut sowing.

Scope for up scaling : Introduction of blade harrowing with tractor will help timely blade harrowing.

Researchable issue : To develop a suitable blade harrow for weeding in groundnut on the next day after sowing.

VISION 2030

Dryland Agriculture and Integrated farming systems

Crop scenario:

Rainfed agriculture is one of the significant areas for improving food production and enhancing livelihood security in Andhra Pradesh. The total geographical area of Andhra Pradesh is 160.2 lakh ha. The net sown area is 67.19 lakh ha, net irrigated area is 28.08 lakh ha. Rainfed area is 39.11 lakh ha and it accounts for 58.21 % of net sown area. The total population of Andhra Pradesh is 4.94 crores. Agricultural sector contributes 27%, Industrial sector contributes 23% and Services sector contribute 49.7% of the Gross State Domestic Product (4.19 crores).Among the 13 districts of Andhra Pradesh, Ananthapuramu district is having highest area under rainfed agriculture (9.65 lakh ha) and top rainfed priority rank followed by YSR Kadapa, Kurnool, Chittoor and Prakasam districts.

Major constraints:

Climatic: Short length of crop period**,** erratic rainfall, late onset and early withdrawal of monsoon, prolonged dry spell, drought and inadequate irrigation

Soil: Undulating topography, Land degradation, Poor soil fertility, Low water holding capacity, hard sub soil, soil loss through run off

Socio – Economic: Small land holdings, poor farmers, Lower credit off take, Poor socio economic growth, illiteracy and povertyAll these constraints are leading to less investment on inputs, low productivity, under developed market infrastructure, poor post-harvest management, high risk and low yields in rainfed agriculture.

Goal: *Reducing vulnerability to drought , climate change and increasing the productivity of dryland crops and livelihoods.*

Mission: Sustaining the livelihoods of the small and marginal farmers who will still depend on agriculture despite increased climate variability and shrinking land holding size.

Focus: *Reducing vulnerability to drought, climate change and increasing the productivity of dryland crops and livelihoods in rainfed areas of Andhra Pradesh.*

Significant Achievements

- June – July is the optimum time for sowing of groundnut.
- Using small and medium seeds for sowing in groundnut instead of bold seeds will reduce seed cost without reduction in pod yield.
- Intercropping of groundnut + mixed pulses in 15:1 ratio reduced runoff loss and increase the net returns by 18-22%.
- Contour bunding and contour cultivation practice proved better for higher groundnut yield compared to cultivation along the slope.
- Dead furrow at an interval of 3.6 m in groundnut proved to be suitable soil moisture conservation measure.
- Groundnut + Piegonpea (11:1) and Groundnut + Castor (15:1) found to be suitable inter cropping systems under rainfed conditions. Even, if groundnut crop fails due to drought, redgram crop will give net profit of Rs.3000/ha.
- Early sowing of redgram and castor during the month of June will give better yields compared to delayed sowing.
- Castor, redgram, korra and sorghum were identified as alternate crops for groundnut.

- Horsegram/Pearl millet/Sorghum/Fodder Sorghum/Cowpea/ Greengram are the suitable contingent crops under delayed onset of monsoon.
- Groundnut (1 ha)+Sheep rearing (10Rams) found to be remunerative farming system for small and marginal farmers of dry lands.
- Sheep penning @ 1sheep/sq.m/one night resulted in increase in pod yield of groundnut by 13% and haulm yield by 41%. Sheep penning recorded increase in available potassium, Iron and Zinc in the soil.
- Soil test based phosphatic and potassium fertilizer application for groundnut crop reduced the cost of inorganic fertilizers and increased the groundnut yield by 5-22% apart from reducing micro nutrient deficiencies in shallow arid alfisols.
- "Organic farming" found to be effective in utilization of locally available resources for sustainable dryland Agriculture.
- Application of sand @ 40t/ha in shallow red soils improved the soil physical parameters and groundnut yield.
- Application of 20 – 40 – 40 kg NPK/ha found suitable for groundnut and the same dose of fertilizers was also found sufficient for groundnut + redgram intercropping.
- Integrated nutrient management with 50% of recommended dose of nutrients through inorganic fertilizers and 50% through FYM/ groundnut shells improved soil physical, chemical properties, soil quality index, sustainable yield index and groundnut yields.
- Application of zinc sulphate @ 25kg/ha for each crop or 50 kg/ha once after three crops is recommended for higher yields in groundnut.
- Foliar application of ferrous sulphate @ 2g/l is recommended for control of iron deficiency and increase in groundnut yield.

- Farm Pond (soil & cement lined in the ratio of 6:1) of 10mx10mx2.5m found to be cost effective to provide supplemental irrigation (10mm) through sprinkler at critical stages in groundnut.
- Supplemental irrigation with sprinklers using the water stored in farm pond increased groundnut yields by 25-30%.
- Developed *Eenati Gorru,* Bullock drawn automatic seed drill, Tractor drawn Anantha Planter, Aqua-Planter, Tractor drawn boom sprayer for simultaneous sowing as well as herbicide application, Anantha Tractor drawn inter cultivator, ANGRAU Blade Guntaka for groundnut harvesting, machinery for groundnut decortication, dry and wet pod threshing.
- Threshing of groundnut crop should be completed within 5 days after harvest of the crop conveniently skipping the heaping operation using peg type groundnut thresher to save labour costs.
- Deep ploughing with sub soiler at 40-50 cm once in 3 years helps in breaking of sub soil hard pan and water infiltration and increases the groundnut yield.
- Developed Integrated Pest Management Module in groundnut.
- Developed pheromone mediated mass trapping of groundnut leaf miner (20 traps/ha) resulted in reduced incidence of leaf miner and increased the net income (Rs.5000/ha).
- Modified atmospheric storage with 20% carbon dioxide resulted in no incidence of *Carrydonserratus* in stored groundnut.
- Developed weather based forewarning system for Red Hairy Caterpillar (RHC), late leaf spot (LLS), Groundnut Leaf Miner (GLM) and Peanut Stem Necrosis Disease (PSND).
- Spray carbendazim @ 0.1 % + mancozeb 0.2% or hexaconazole (2ml/L) around seventy days age of the crop, coinciding first fortnight of October to control late leaf spot disease and for higher economic returns.

- For managing PSND grow 4 rows of tall growing sorghum or pearl millet as border crop and also remove all weeds especially *parthenium* on field bunds, on road sides and in fallow lands adjacent to the groundnut field.
- Collected mandal wise rainfall details and developed mandal wise rainfall database of Andhra Pradesh.
- Prepared Climatic Classification Maps for Ananthapuramu and Kurnool Districts of Scarce Rainfall Zone.
- Delineated arid mandals in Andhra Pradesh.
- Conducted awareness programmes on climate change in various districts of Andhra Pradesh for creating awareness in the farmers regarding ill effects of climate change.

Issues, Strategies and Framework:

S. No.	Issues	Strategies	Expected outcome (in terms of varieties /technologies etc.,)	Output (In terms of cost reduction/productivity enhancement etc.,)
1.	Suitable cultivation practices for short duration redgram	Development of Agronomic practices for short duration redgram in rainfed alfisols	Optimum time of sowing, spacing, fertilizer schedule and suitable varieties.	Farmers can get higher yields by adopting improved agronomic practices.
2.	Cultivation practices for castor hybrids	Agronomic practices for castor hybrids in rainfed alfisols	Suitable cultivars, optimum time of sowing can be find out.	Farmers can get higher yields by adopting improved agronomic practices.
3.	Suitability of dual purpose fodder crops for rainfed alfisols	To find suitable fodder crop sunder delayed onset of monsoon	Suitable fodder crop can be suggested to farmers	Farmers can be benefitted by growing suitable fodder crop under delayed monsoon conditions.
4.	*In-situ* rain water conservation through subsoiling in alfisols	Impact of subsoiling on rain water conservation and its effect on growth and yield of rainfed crops	Efficient in-situ rain water conservation	15-20 % yield can be improved
5.	Lack of suitable equipment for sowing of clusterbean	Development and evaluation of Clusterbean planter	Farmers can save seed and obtain recommended plant population per acre	It facilitates in time sowing and reduce cost of cultivation
6.	Lack suitable equipment for simultaneousso	Development and evaluation of groundnut +	Farmers sow groundnut + redgram	It facilitates simultaneous sowing and

	wing of groundnut + redgram inter cropping.	redgram planter	simultaneously	reduce cost of cultivation by 20 %.
7	Long term integrated nutrient management by utilizing agricultural farm wastes.	Effects of both organics and inorganics will be studied on long term basis in dryland agriculture both on soil as well as crop productivity.	Farmers could save on fertilizer cost besides maintaining soil health on sustainable basis.	25-30% on fertilizer input could be saved.
8	Carbon sequestration & organic carbon management in rainfed soils.	Measurements and possibilities of enhancing carbon stocks in rainfed soils will be studied.	By maintaining carbon pools in the soil will helps in soil biota rejuvenation and thereby enhancing productivity in rainfed soils.	It facilitates ease in maintaining soil moisture and soil health.
9	Soil enzymes and their influence in dryland soils in improving soil health, nutrient use	Soil enzymes estimation and the measures to enhance the availability of different soil enzymes will be studied.	By improving soil enzyme activity with the efficient use of bio fertilizers along with organics may reduce the production cost in rainfed agriculture.	Soil enzymes will enhance the applied as well as the available nutrients in soils in a better way.
10	Development of Soil Resource Database	Soil resource data base serves as a guide to improve the productivity of land resources	Helps in characterizing the existing land resources, assessing their suitability for various land	Soil resource data base and soil map is the tool, which can help in the management of land resources

			uses and to prepare a rational land use plan	in a sustainable manner at village or at individual farmer's level.
11	Rain water conservation and Increasing water holding capacity of rainfed sandy soils	Effect of Hydrophilic polymer on soil water – dynamics and yield of groundnut in alfisols	Effective utilization of available rain water for growthincreases yield.	Hydrophilic polymers will improve water retention by soil and helps to overcome dry spell and yield reduction.
12	Rainfed areas are ideally suitable for organic farming in view of the existing low use of chemical inputs and less yield declines when farms are converted from chemical to organic management.	Organic farming in rainfed groundnut	Technology for organic groundnut production utilizing the locally available on and off farm organic wastes and manures.	Organic agriculture is an admirable fit for dryland farmers. Itwill lead to improvement of soil health, use of local inputs and local labour apart from higher economic returns from organically produced groundnut.
13	Wide spread adoption of organic manures addition and farming measures can improve the soil quality through increase in Soil Organic Carbon (SOC) sequestration and improvement in agronomic	Assessing the carbon sequestration potential of organic farming in rainfed groundnut	Evaluation of carbon sequestration potential of the rainfed soils with long term organic farming.	The soil carbon stocks affects and moderates soil processes and functions. Soil quality is strongly governed by SOC stock and its quality. Agricultural practices fine-tuned to mitigate & adapt the

	productivity of rainfed agro ecosystems			adverse impact of the climate change and soil degradation
14	Increased emission of greenhouse gases into the atmosphere and associated adverse effects due toclimate change necessitates identification of systems with high carbon sink as a mitigation strategy.	Assessment of carbon sequestration in different agro forestry systems under rainfed conditions	Changes in the soil Carbon stocks have major impact on the atmospheric CO_2 concentration. Soil processes and functions like physical, chemical, biological and ecological soil quality are strongly governed by soil organic carbon stocks.	Increase in soil organic carbon stocks by different agro forestry systems enhances the sustainability of the ecosystem.
15	Phosphorus and secondary nutrients calcium, magnesium, and sulphur are essential for nitrogen fixation, pod development and oil content in groundnut.	Survey for phosphorus and secondary nutrient status in groundnut growing soils of Ananthapuramu district	This will reveal the nutrient status of Farmer's field's with respect to Phosphorus calcium, magnesium, and sulphurand their build up or depletion in soils.	Helps to advise the farmers to correct the imbalance application of nutrients for the maintenance of required nutrient status of the crop.
16	Regular monitoring of the deterioration or buildup of major nutrients in soils is necessary for fertilizer prescriptions.	Bench mark survey and monitoring of groundnut growing soils of Anantapuram district for nutrient status	Continuous monitoring of nutrient status and other physical properties of groundnut growing soils will help in	Saves the unnecessary expenditure on fertilizers by the farmers and avoids the buildup of nutrients.

		and other physical properties	necessary fertilizer recommendations in the district	
17	Lack of comprehensive weather information of all the districts of AP	Collection of available weather data from Agromet observatories at various research institutes, agricultural colleges of ANGRAU, IMD and Directorate of Economics and Statistics, Govt. of AP.	Development of Agromet Data bank at AICRP on Agrometeorology, which will help in ready retrieval of the weather data for utilization in	This helps in maintenance and analysis of long term weather data and studies on climate change, variability and impact on productivity of various crops in AP apart from being a good source of information for future studies.
18	Identification of climatic and soil constraints for yield reduction and failure of various crops and management strategies for the sustainable agriculture and socio economic development of the farmers.	Micro level crop planning based on rainfall and soil suitability for Ananthapuramu district	Mandal level rainfall analysis, soil suitability information & rainfall and soil related constraints for crop production. Rainfall and soil suitability based mandal level crop plans for Ananthapuramu district.	Once the rainfall and soil suitability based crop plans are demonstrated to the farmers, they will witness the benefits of adopting the suitable crop plans for their region and this will lead to the overall improvement of agricultural production of the region and socio economic

				development of farmers in Ananthapuramu district.
19	Agro climatology of groundnut and Bengalgram	Crop-Weather relationship studies in Groundnut &Bengalgram	Impact of weather at various phenophases on yield of groundnut and bengalgram and statistical models for prediction of yield.	Helps in yield forecasting before harvest of the crop based on the weather.
20	Crop weather relationships and weather based insurance indices for alternate crops for groundnut	Crop – weather relationship in alternate crops for groundnut	Optimum weather parameters at various phenophases to obtain higher yield in alternate crops to groundnut	Helps in suggesting the better alternate crops based on seasonal weather conditions and development of insurance indices will help the farmers to get insurance in case of crop failure due to vagaries of weather.
21	Wide Variations in meeting crop water requirement needs through rainfall at critical phenophases of groundnut for obtaining better	Estimation of Actual Evapotranspiration and crop coefficients for groundnut	Quantification of water requirement and possibility of receiving rainfall to meet the water requirement at region level	Helps in delineation of areas where the rainfall is not sufficient to meet water requirement of groundnut at critical phenophases, suggesting alternate crops

	yields			based on water requirement.
22	Crop condition and yield forecasting of groundnut and bengalgramusing simulation models	Crop growth modelling in popular and newly released varieties of groundnut and bengalgram	Development of genetic coefficients for yield forecasting under various growing environments and simulation models.	Regional yield forecasting before harvest of the crop which will help in policy level decisions.
23	Lack of micro level real time weather based Agromet advisories to farmers	Issuing mandal (micro) level real time weather based Agromet advisories to farmers based on instead of Agromet advisories at district level	Micro level real time weather based Agromet advisories to all the farmers.	Farmers can reduce cost of cultivation by following weather based agro advisories in various farm operations and crop losses due to extreme weather events like excess rainfall, cyclones, hailstorms etc.,
24	Poor pod set and yield loss in bengalgram due to fog in scarce rainfall zone	Impact of fog on podset in Begalgram	Identification and quantification of weather parameters leading to poor podset in Bengalgram and control measures to avoid ill effects of fog on pod set.	Yield loss due to poor podset caused by fog upto 200 to 500 kg/ha in bengalgram can be minimized.

Action Plan: Thrust area wise for different disciplines

A. Short term (3-5 years)

- Collection of weather data from various research stations of ANGRAU and IMD stations for all the districts of Andhra Pradesh
- Studies on influence of weather on popular varieties of groundnut
- Studies on influence of weather on groundnut pests like leaf miner, red hairy caterpillar, Sucking pests, Spodaptera and Helicoverpa.
- Studies on influence of weather on popular varieties of chickpea
- Studies on impact of extreme weather events like drought, fog, hailstorms etc., on productivity of rainfed crops
- Creating awareness to farming community on weather based decision making in cultivation of crops
- Creating awareness to farming community on climate change and its impact on Agriculture.
- Ways to control evaporation losses from farm pond water.
- Fixing of nutrients requirement for rainfed castor.
- Boron & other micronutrients (Zn & Fe) management.
- Studies on interaction of potassium and magnesium in enhancing the productivity levels in rainfed Alfisols
- Foliar sprays of different nutrients / chemicals to mitigate drought in groundnut.Ø Evaluation of spacing on castor varieties/hybrids
- Weed management in rainfed castor
- Evaluation of redgram hybrids in drylands
- Weed management in clusterbean
- Evaluation of suitable double cropping systems in rainfed alfisols
- Evaluation of improved breeds of backyard poultry.
- Conversion of groundnut haulms into pellets for fodder purpose.
- Assessing the soil physical and fertility constraints
- Maintenance of soil health and identification of better nutrient management practices

- Evaluating the suitable soil management practices to increase the organic carbon content in the soils
- Evaluating the usefulness of hydrophilic polymers on soil moisture retention and yield improvement in rainfed crops
- Monitoring nutrient status of the rainfed soils

B. Medium term (6-9 years)

- Development of Agromet databank for all the districts of Andhra Pradesh
- Mandal wise rainfall analysis of Andhra Pradesh for crop planning
- Forecasting of crop condition and yield of groundnut and chickpea using crop growth models
- Developing the forecasting models for various pests of groundnut
- Studies on influence of weather on alternate crops for groundnut
- Estimation of actual evapotranspiration losses and water requirement of rainfed crops
- Extending micro level (Mandal/Village) real time weather based agro advisories services to all farmers of Andhra Pradesh.
- Studies on catchment – farm pond size relationships.
- Minimum quantity of water for supplemental irrigation to dryland crops.
- Solubulisation & enhancing the availability of fixed nutrients in soils by using biological inputs
- Soil test based fertilizer application for different rainfed crops.
- Value addition to dryland crops.
- Characterization and classification of soils
- Evaluating the crops suitability based on land capability
- Development of soil resource data base, soil physical and fertility maps
- Assessment of carbon sequestration potential of various production systems
- Revising the recommended dose of fertilizers for rainfed groundnut

c. Long term (10-15 years)

- Micro level crop planning based on rainfall characteristics of the region and soil suitability
- Development of document on agro climatology of groundnut in Andhra Pradesh
- Development of document on agro climatology of chickpea in Andhra Pradesh
- Developing user friendly, real time weather based pest forecasting models and management practices for control of groundnut pests
- Developing weather based insurance indices for rainfed crops
- Crop and irrigation planning in rainfed areas based on available rainfall and its ability to meet water requirement needs of various crops
- Micro level crop management through weather based agro advisories and making the farmer's climate resilient and less vulnerable to climatic risks.
- Studies on different farm pond water delivery systems.
- Long term integrated nutrient management by utilizing agricultural farm wastes.
- Carbon sequestration & organic carbon management in rainfed soils.
- Soil enzymes and their influence in dryland soils in improving soil health, nutrient use efficiency.
- Evaluation of agroforestry systems under rainfed conditions.
- Evaluation of integrated farming system modules for rainfed conditions.
- Evaluation of different fodder trees / forage crops in dryland
- Evaluation of different Agro forestry systems for rainfed areas.
- Development of combiners for groundnut
- Development of technology for organic farming in rainfed groundnut
- Soil health management utilizing locally available organic resources
- Increasing the organic carbon content in rainfed soils
- Soil and moisture conservation in rainfed areas by adopting suitable management practices

Research indicators and Time frame

Research indicators and Time frame – ARS, Anantapuram	
Time frame	**Mile stone to be achieved**
Short term(3-5 years)	
2015-2020 2015-2020 2015-2020 2015-2020 2015-2020 2015-2018 2015-2018 2015 to 2018	➢ Collection of weather data from various research stations of ANGRAU and IMD stations for all the districts of Andhra Pradesh ➢ Studies on influence of weather on popular varieties of groundnut ➢ Studies on influence of weather on groundnut pests like leaf miner, red hairy caterpillar, Sucking pests, Spodaptera and Helicoverpa. ➢ Studies on influence of weather on popular varieties of chickpea ➢ Studies on impact of extreme weather events like drought, fog, hailstorms etc., on productivity of rainfed crops ➢ Creating awareness to farming community on weather based decision making in cultivation of crops ➢ Creating awareness to farming community on climate change and its impact on Agriculture. ➢ Ways to control evaporation losses from farm pond water. ➢ Fixing of nutrients requirement for rainfed castor. ➢ Boron & other micronutrients (Zn & Fe) management. ➢ Studies on interaction of potassium and magnesium in enhancing the productivity levels in rainfed Alfisols ➢ Foliar sprays of different nutrients / chemicals to mitigate drought in groundnut. ➢ Evaluation of spacing on castor varieties/hybrids ➢ Weed management in rainfed castor ➢ Evaluation of redgram hybrids in drylands ➢ Weed management in clusterbean ➢ Evaluation of suitable double cropping systems in rainfedalfisols ➢ Evaluation of improved breeds of backyard poultry. ➢ Conversion of groundnut haulms into pellets for fodder purpose. ➢ Assessing the soil physical and fertility constraints ➢ Maintenance of soil health and identification of better nutrient management practices ➢ Evaluating the suitable soil management practices to increase the organic carbon content in the soils ➢ Evaluating the usefulness of hydrophilic polymers on soil moisture retention and yield improvement in rainfed crops ➢ Monitoring nutrient status of the rainfed soils

Medium term(6-9 years)	
2015-2024	➢ Development of Agromet databank for all the districts of Andhra Pradesh
2015-2024	➢ Mandal wise rainfall analysis of Andhra Pradesh for crop planning
2015-2024	➢ Forecasting of crop condition and yield of groundnut and chickpea using crop growth models
2015-2024	➢ Developing the forecasting models for various pests of groundnut
2015-2021	➢ Studies on influence of weather on alternate crops for groundnut
2015-2021	➢ Estimation of actual evapotranspiration losses and water requirement of rainfed crops
	➢ Extending micro level (Mandal/Village) real time weather based agro advisories services to all farmers of Andhra Pradesh.
2015 to 2024	➢ Studies on catchment – farm pond size relationships.
	➢ Minimum quantity of water for supplemental irrigation to dryland crops.
	➢ Solubulisation & enhancing the availability of fixed nutrients in soils by using biological inputs
	➢ Soil test based fertilizer application for different rainfed crops.
	➢ Value addition to dryland crops.
	➢ Characterization and classification of soils
	➢ Evaluating the crops suitability based on land capability
	➢ Development of soil resource data base, soil physical and fertility maps
	➢ Assessment of carbon sequestration potential of various production systems
	➢ Revising the recommended dose of fertilizers for rainfed groundnut

Long term(10-15 years)	
2015 to 2030	➢ Micro level crop planning based on rainfall characteristics of the region and soil suitability ➢ Development of document on agro climatology of groundnut in Andhra Pradesh ➢ Development of document on agro climatology of chickpea in Andhra Pradesh ➢ Developing user friendly, real time weather based pest forecasting models and management practices for control of groundnut pests ➢ Developing weather based insurance indices for rainfed crops ➢ Crop and irrigation planning in rainfed areas based on available rainfall and its ability to meet water requirement needs of various crops ➢ Micro level crop management through weather based agro advisories and making the farmer's climate resilient and less vulnerable to climatic risks. ➢ Studies on different farm pond water delivery systems. ➢ Long term integrated nutrient management by utilizing agricultural farm wastes. ➢ Carbon sequestration & organic carbon management in rainfed soils. ➢ Soil enzymes and their influence in dryland soils in improving soil health, nutrient use efficiency. ➢ Evaluation of agroforestry systems under rainfed conditions. ➢ Evaluation of integrated farming system modules for rainfed conditions. ➢ Evaluation of different fodder trees / forage crops in dryland ➢ Evaluation of different Agro forestry systems for rainfed areas. ➢ Development of combiners for groundnut ➢ Development of technology for organic farming in rainfed groundnut ➢ Soil health management utilizing locally available organic resources ➢ Increasing the organic carbon content in rainfed soils ➢ Soil and moisture conservation in rainfed areas by adopting suitable management practices

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