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Environmental deterioration: Water conservation management in Anantapur district of Andhra Pradesh

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Abstract
The Anantapur district is located in the Rayalaseema region in the southern part of Andhra Pradesh. It receives rains during the South-West monsoon from June to September, and during the North-East monsoons from May to November. However, being far from the coastal belt, Anantapur receives meager rainfall. The high Western Ghats also reduce the rainfall from South-West monsoon. The rainfall during the later part of the North-East monsoon reason is erratic in this tract, as it is much influenced by the depressions in the Bay of Bengal. Even though the total rainfall may appear adequate, it's poor distribution results in partial or complete failure of crops during many years. Based on the pattern of monsoon rainfall, the pre-rainy, rainy and post-rainy season periods are recognized.The over utilization of groundwater has led to grim situation in 21Mandals/ Blocks out of 63 Mandals/ Blocks that have been categorized as Over Exploited Blocks and Critical Mandals/blocks respectively. Table 4 gives the list of such Mandals/blocks. This paper makes an analysis of the impact of water conservation techniques on various components society in general and individual farmer in particular.

Keywords: South West Monsoon, Growing Period, Seasonal Rainfall, Dry Spell, Water Conservation, Ground Water

Introduction
Rainwater harvesting structures are a part of a strategy for water conservation. People in all parts of country have a long standing tradition of rainwater harvesting by designing different types of structures and management systems. The Indus Valley Civilization, that flourished along the banks of the river Indus and other parts of western and northern India about 5,000 years ago, had one of the most sophisticated urban water supply and sewerage systems in the world. The fact that the people were well acquainted with hygiene can be seen from the covered drains running beneath the streets of the ruins at both Mohenjodaro and Harappa. Another very good example is the well-planned city of Dholavira, on Khadir Bet, a low plateau in the Rann in Gujarat.

Water Conservation
Water Conservation has three broad connotations; maximum storage of rainwater, economical and optimal use including prevention of wastage/ leakage and multiple use - Reuse and Recycling. In urban water supply almost 30 to 40% of the water is wasted through the distribution system. In Industrial sector also, there is a scope of economy in use of water. Public awareness should be generated through a massive campaign of communication through all available media and by the utility management itself setting an example for conservation. All urban dwellers should be made aware of the source from which water is being brought to the city and from which additional water will have to be brought in the future. They should be aware of the costs involved, not only in financial terms, but also the cost that other communities have to incur in terms of opportunity lost by not using the water. The measure for water conservation should include metering of supplies as a matter of policy and increase in tariff rate on a sliding scale. Use of treated effluents, in place of filtered water for horticulture and large gardens, and fitting of waste-not taps on public stand-posts to avoid wastage of water should be encouraged.

Ground Water Dams or Sub-Surface Dykes or Underground Bandharas (Ugb)
These are basically ground water conservation structures and are effective in providing sustainability to ground water structures by arresting sub-surface flow.

A ground water dam is a sub-surface barrier across stream, which retards the natural ground water flow of the system, and stores water below ground surface to meet the demands during the period of need. The main purpose of ground water dam is to arrest the flow of ground water out of the subbasin and increase the storage within the aquifer. By doing so the water levels in upstream part of ground water dam rises saturating the otherwise dry part of aquifer.

Latest technologies now available

Satellite data from IRS-2A/2B/2C/2D with PAN merged data would result in a high resolution of about 5.7m to 10m. Use of Google-Earth data is also being done by some of the agencies as tools for water conservation. Very powerful GIS softwares like Erdas Imagine, Arc Info, MapInfo, etc. are available in the market today for synthesizing digital data of various forms.

Current Situation

About 65 million hectares (45%) out of the 141 million hectares net sown area in the country, is currently under irrigation, i.e. 76 million hectares are rainfed and correspond to some of the most backward regions of the country. There are 112 most “irrigation deprived” districts. State wise list of irrigation deprived districts is given in table 1.

Table 1: State Wise Most Irrigation-Deprived Districts in India

State	District(s)
Andhra Pradesh (4)	Adilabad, Anantpur, Mehbubnagar, Rangareddi
Assam (19)	Barpeta, Bongaigaon, Darrang, Dhemaji, Dhubri, Dibrugarh, Goalpara, Golaghat, Hailakandi, Jorhat, Kamrup, Karimganj, Kokrajhar, Lakhimpur, Marigaon, Nagaon, Sibsagar, Sonitpur, Tinsukia
Bihar(7)	Begusarai, Darbhanga, Jamui, Khagaria, Madhepura, Purnia, Samastipur
Chhattisgarh (11)	Bastar, Dantewada, Jashpur, Kanker, Kawardha, Korba, Koriya, Mahasamund, Raigarh, Rajnandgaon, Surguja
Gujarat (6)	Amreli, Dahod, Panchmahal, Surendranagar, The Dangs, Valsad
Jharkhand(16)	Bokaro, Chatra, Deogarh, Dhanbad, Dumka, Garhwa, Giridih, Godda, Gumla, Hazaribagh, Pakaur, Palamu, PashchimiSingbhum, PurbiSinghbhum, Ranchi, Sahibganj
Karnataka (6)	Bidar, Chikmagalur, Dharwad, Gulbarga, Hassan, Haveri
Madhya Pradesh (5)	Dindori, Mandla, Panna, Shahdol, Umaria
Maharashtra (23)	Akola, Amravati, Aurangabad, Bid, Buldana, Chandrapur, Dhule, Hingoli, Jalna, Latur, Nagpur, Nanded, Nandurbar, Osmanabad, Parbhani, Pune, Raigarh, Ratnagiri, Sindhudurg, Thane, Wardha, Washim, Yavatmal
Orissa (12)	Balangir, Dhenkanal, Jharsuguda, Kandhamal, Kendujhar, Khordha, Malkangiri, Mayurbhanj, Nabarangapur, Nayagarh, Naupada, Sundargarh
Uttar Pradesh (2)	Chitrakoot, Sonbhadra
West Bengal (1)	Puruliya
Total	112

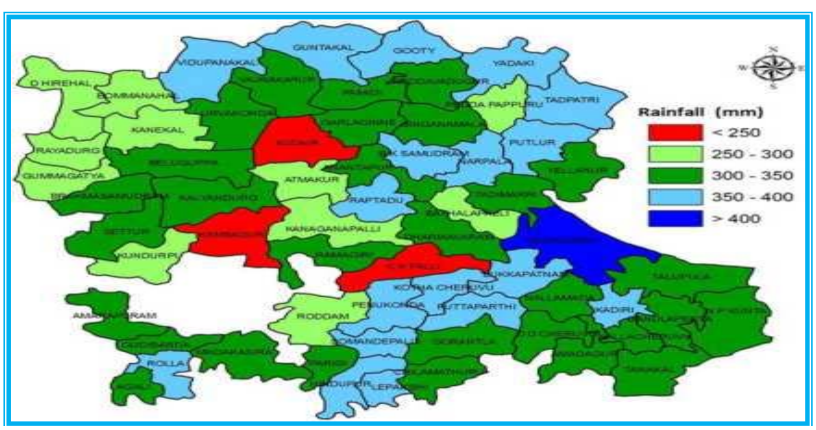
Source: F.No.J-11011 /07/2016-RE.1 (351427) Government of India Ministry of Rural Development [Office of Secretary (RD)]

Ground Realities in Ananthapuramu District

Anantapur is one of the drought-prone districts in the rain shadow area of Andhra Pradesh. The annual average rainfall of the district is 572 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, while 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 (Fig 1).



Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 1: Mean rainfall during South West monsoon period across various mandals of Anantapur district

The length of growing period is variable across mandals spanning from less than 70 to 120 days (Fig 2).

Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

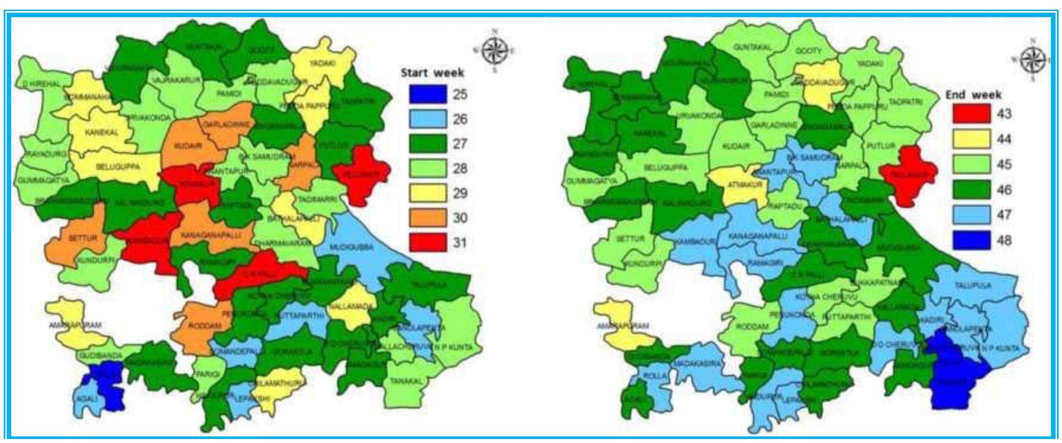
Fig 2: Length of growing period of Annatapur district

In nine mandals namely Tadipatri, Yellanur, Putlur, Kadiri, Gandlapenta, Nallacheruvu, Tanakal, N.P. Kunta, and Talupula the LGP was maximum ranging from 90120 days. In 17 mandals viz. D. Hirehal, Bommanahal, Kanekal, Rayadurg, Beluguppa, Kudair, Atmakur, Kalyandurg, Gummanagatta, Brahmasumudram, Settur, Kankurpi, Kanagalipalli, Ramagiri, C.K. Palle, Roddam and Amarapuram have the lowest LGP of <70 days. The majority of the central region of the district comprising 37 mandals has an LGP of 70-90 days.

Annual and seasonal rainfall

The annual rainfall of the district ranges between 335 (1985) to 823 (1996) mm with an average of 548 mm (Standard Deviation: 129 mm and co-efficient of variation of 24%) which highlights high degree of inter-annual variability in rainfall pattern. The seasonal rainfall due to Southwest monsoon (June- September) ranged between 135 (1994) and 641 (1988) mm with an average of 323 mm (Standard Deviation of 118 mm and co-efficient of variation of 37%). The district also receives rainfall due to NE which ranges between as low as 30 (1989) to as high as 332 (1975) mm with an average of 155 mm (Standard Deviation of 65 mm and co-efficient of variation of 42%). The trends in onset and withdrawal of South-west and North-East monsoons are presented in Fig 3.

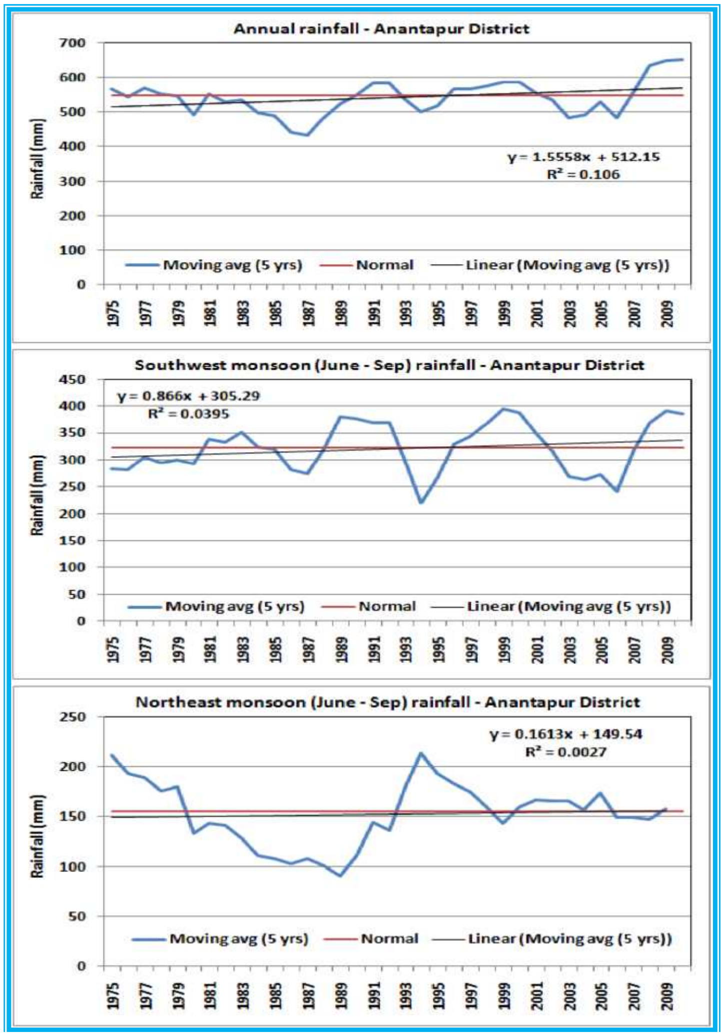
Mean week of start of growing period in different mandals of Anantapur district Mean week of end of growing period in different mandals of Anantapur district.



Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 3: Mean week of start and end of growing period in different mandals of Anantapur

The high variability in Southwest monsoon rain is an indicative of risk associated with farming in this district. The 5-year moving average rainfall pattern of annual, south-west and Northeast monsoon seasons is depicted in Fig. 4. Out of 40 years of data analyzed for annual rainfall pattern, there are 23 near normal (-19 to +19% of normal), 9 deficit (<-19% of normal) and 8 excess (>19% of normal) rainfall years. During the Southwest monsoon season, the district rainfall was near normal in 13 years and deficit in 16 years and in excess for 11 years. There is no consistent declining trend in annual and seasonal rainfall in the district. On the contrary, there is a slight increasing trend in annual and Southwest seasonal rainfall which is statistically non-significant.

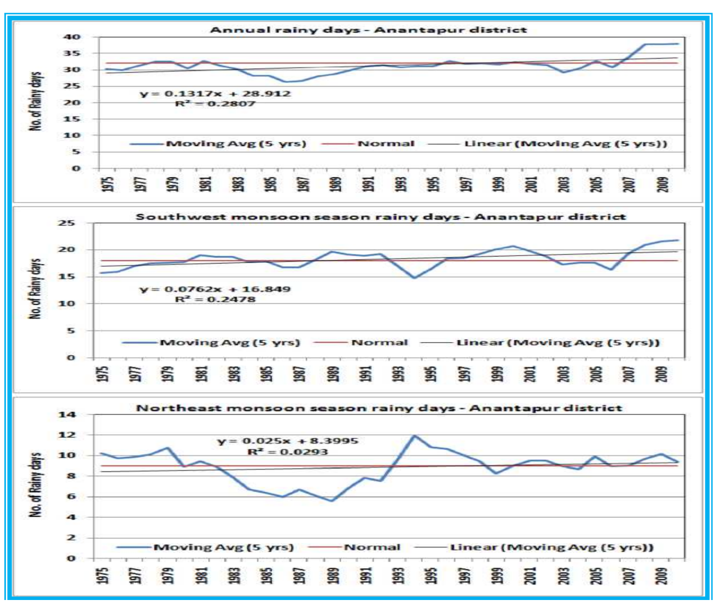


Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 4: Variability of annual, southwest and northeast monsoon seasonal rainfall in Anantapur district (5-year moving average)

Rainy days

The district receives 548 mm annual rainfall in 32 rainy days with a variability of 18% (Fig 5).



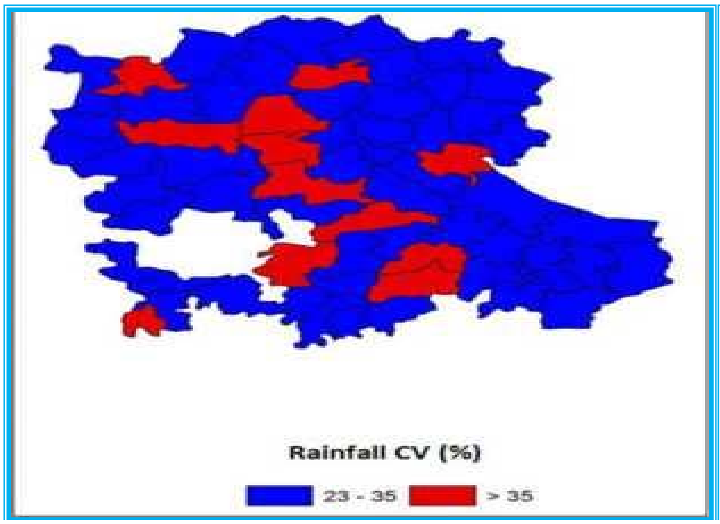
Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

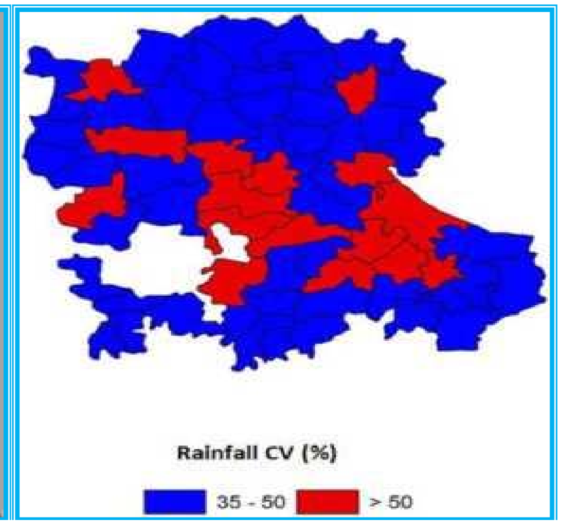
Fig 5: Variability of annual, southwest and northeast monsoon seasonal rainy days in Anantapur district (5-year moving average)

During Southwest monsoon season, a rainfall on 323 mm occurs in 18 days with a variability of 24% and during Northeast monsoon there were 9 rainy events on average with the variability of 35%. On average each rainfall event during Southwest monsoon period produces 18 mm rainfall only which may not sufficient to bring the top 45 cm soil to field capacity. The 5-year moving average pattern showed a statistically significant increasing trend both in annual and Southwest monsoon rainy days but the same was absent in Northeast monsoon season. The increase in the number of rainfall events will have implications in the better temporal distribution of rainfall.

Spatial and temporal variability in rainfall

The key factor effecting groundnut growth and yield is the characteristic and the length of the moisture environment during the crop growing season. The variability in rainfall across different mandals was analyzed for different time periods which showed that the variability in annual rainfall is high in Atmakur, Rapthadu, Chenne Kothapalle, Roddam in the central part of the district and Gorantla, Puttaparthi in the southern parts and Bommanahal, Pamidi and Kudair mandals on the northern side. The southwest monsoonal rain was found to be highly variable in the south-eastern and central parts of the district with mandals like Mudigubba, Bukkapatnam, Nallamada, Kadiri and Puttaparthi (Figs.6 and 7). The variability in annual rainfall during recent decade (2001-2010) compared to previous decade (1991-2000) increased over north western part of the district comprising Bommanhal, D. Hirehal, Kanekal, Vidapanakal, Vajrakarur, Rayadurg and Beluguppa mandals (Fig 7).





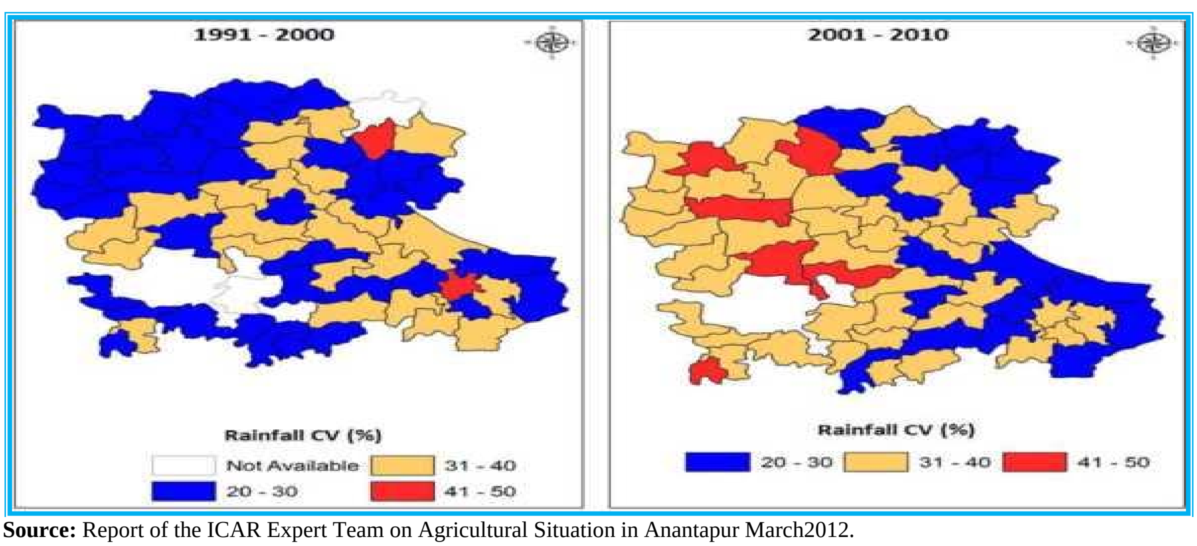
Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 6: Variability in annual monsoonal rainfall in Anantapur

Fig 7: Variability in South-west rainfall in Anantapur

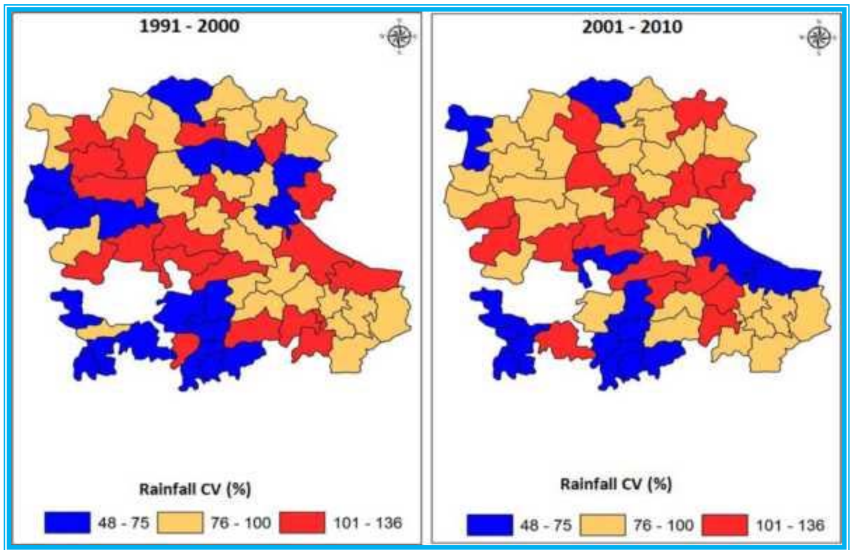
Influence of length of dry spell

The variability in June rainfall increased in recent decade in Garladine and Singanamala, Putluru, Narpala, Ramgiri and Madakasira mandals (Fig 9) while variability in July rainfall was found to increase in recent decade in the western and north-eastern part of the district (Fig 10). In Gumagutta and Rayadurg mandals, the September rainfall, which is crucial for releasing optimum yields, was highly variable in the recent decade compared to previous decade (Fig 11).



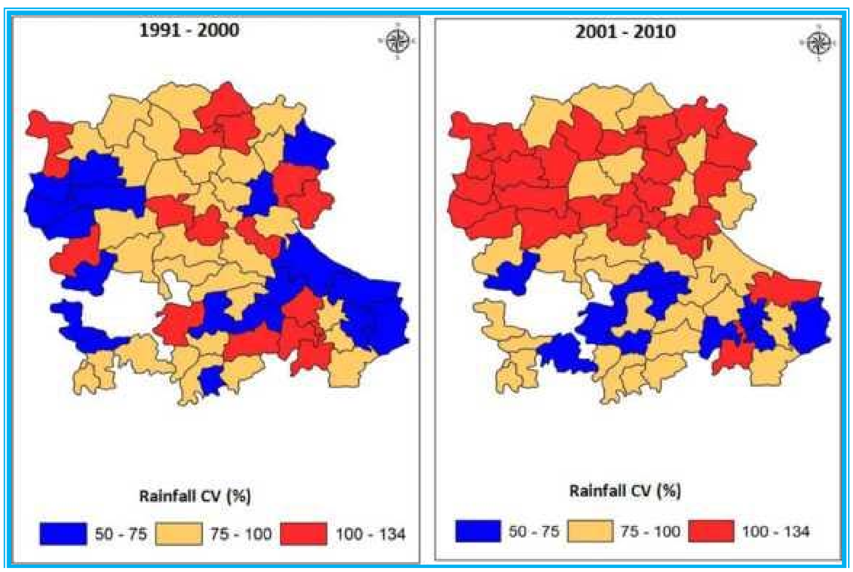
Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 8: Decadal variability in annual rainfall of Anantapur



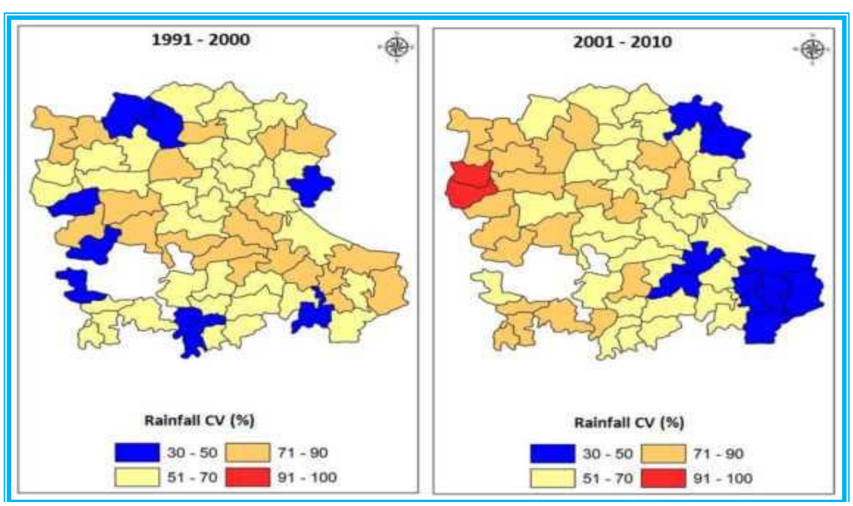
Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 9: Decadal variability in rainfall during the month of June in Anantapur



Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March 2012.

Fig 10: Decadal variability in rainfall during the month of July in Anantapur

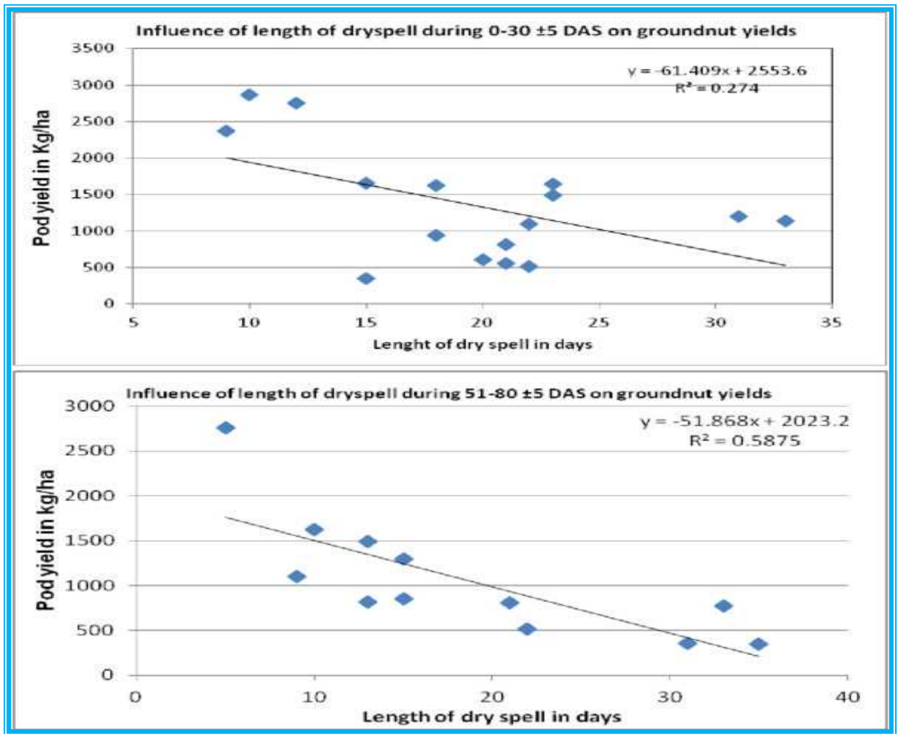


Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 11: Decadal variability in rainfall during the month of September in Anantapur

Rainfall in Anantapur district was found to be erratic and highly variable leading to droughts of varying intensities and durations during the crop season. Drought stress directly and physically reduces plant vegetative growth there by reducing cell turgor. When groundnut is grown under rainfed condition with a high variable rainfall, long-term drought stress results in both reduced vegetative and reproductive growth.

The effect of length of dry spell at different growth stages of groundnut on the pod yield at Anantapur indicated that yields decline if the stress is for three weeks and more in the early vegetative stage (0-35DAS). The impact will be more pronounced during start of pegging and seed growth (51-85 DAS). Pod yields declined drastically in years when the length of dry spell exceeded 30 days during this stage (Fig 12). The frequent failure of monsoonal rains during these critical periods is the crux of the crop failures in the district.



Source: Report of the ICAR Expert Team on Agricultural Situation in Anantapur March2012.

Fig 12: Influence of length of dry spell at different phenophases of groundnut

Programmatic Responses

Keeping in view of this the Government of India introduced several schemes for water conservation and water management. These programmes are intended to create sustainable livelihoods through Natural Resource Management that enhance productivity of land, restore ecological balance and provide diverse livelihood options to the rural households is the key to eradication of poverty and hunger. Successful efforts have been made in States for water conservation in recent years. The ‘Mukhyamantri Jal Swalalamban Abhiyan’ in Rajasthan, the ‘Dobha’ or Farm Ponds construction in Jharkhand, the ‘Mission Kakatiya’ in Telangana. ‘Neeru Chettu in Andhra Pradesh, "Kapil Dhara’ in Madhya Pradesh, bore well recharge in Karnataka, ‘Jalyukt Shivar’ in Maharashtra are some of the recent initiatives, the present Framework draws on many of the good practices in these States and some other initiatives.

Water Conservation Programmes/ Initiatives

There has been increasing recognition over the years of the need for water conservation and water management. Consequently, there have been a number of schemes initiated by different departments, which have as their critical component, water conservation and water management issues. There is the need, therefore, for a convergence of related activities under these schemes — especially at the district level — to optimize their benefits. Some of the schemes of the various departments of the government of India, which have a strong sustainability component and may be converged at the district level, are as follows:

National Afforestation Programme

Under this programme, all afforestation schemes of the Ministry of Environment and Forests have been brought under a single umbrella scheme being implemented through decentralized Forest Development Agencies (FDA) set up at the district level. The FDAs have a strong linkage to the District Panchayat and Village Forest Protection Committee. The overall objective of the scheme is to develop the forest resources with people’s participation, with focus on improvement in livelihoods of the forest-fringe communities, especially the poor. Financial support under the scheme is provided for soil and moisture conservation.

National Project for Repair, Restoration and Renovation of Water Bodies

This scheme was announced by the Union Finance Minister in his Budget Speech 2004-05 with the aim to repair, renovate and restore all the water bodies directly linked to agriculture. Managed by the Ministry of Water Resources, the project envisages active community participation. Under the scheme, projects are to be taken up in one or two districts each in the states. The states are to take up restoration of water bodies having original irrigation culturable command area of 40 ha upto 2000 ha to revive, augment and utilize their storage and irrigation potential. Priority is to be accorded by states to areas, which are arid, drought-prone, tribal-dominated, backward while selecting districts.

River Valley Project and Flood Prone River Programme
The centrally sponsored programme of soil conservation for enhancing the productivity of degraded lands in the catchments of River Valley Project and Flood Prone River, in the present form, is being implemented since November 2000 by the Ministry of Agriculture and Cooperation.

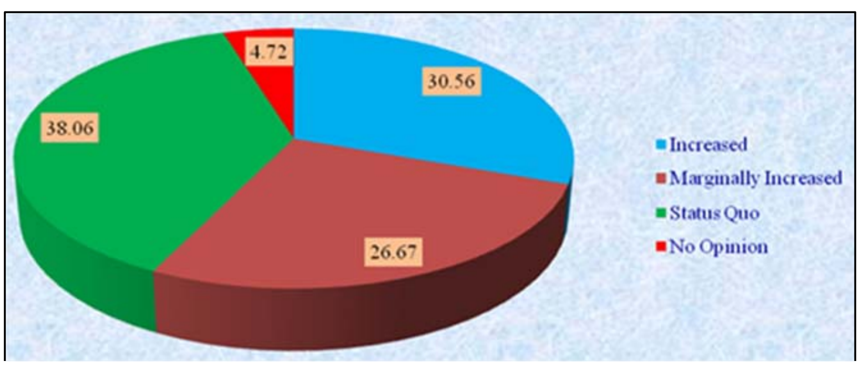
National Rural Employment Guarantee Scheme
The National Rural Employment Guarantee Act was notified on 7th September 2005. The NREGS' objective is to strengthen livelihood opportunities and create durable assets in rural areas through legal guarantee of 100 days of employment in a financial year to a rural household that demands employment within 15 days of demand. Among the works undertaken under NREGS, water conservation and water harvesting has a high priority.

As per Schedule -I of Mahatma Gandhi NREGA, there are 153 kinds of works identified as permissible works, of which 100 kinds of works relate to NRM alone (list enclosed as Annexure-3). Out of the 100 NRM works, 71 are water related. Around Rs.24300.00 crore was spent on NRM works in FY 2015-16 which is 58.41% of the overall expenditure. In FY 16-17 (so far) expenditure on NRM related works has crossed 63%. The technical man power under Mahatma Gandhi NREGA is not adequately trained to carry out these works and as such the works executed are often unsatisfactory in quality and do not conform to the desired technical specifications. The works permitted under MGNREGA includes the following.

a) Water conservation and water harvesting;
b) Drought proofing (including afforestation and tree plantation);
c) Irrigation canals including micro and minor irrigation works;
d) Provision of irrigation facility,
e) Horticulture plantation and land development facilities to land owned by households belonging to the SC and ST or Below Poverty Line families or to beneficiaries of land reforms or to the beneficiaries under the IAY of the GOI or that of the SF or MF as defined in the Agriculture Debt Waiver and Debt Relief Scheme, 2008.
f) Renovation of traditional water bodies including desilting of tanks;
g) Land development
h) Flood control and protection works including drainage in water logged areas;
i) Rural connectivity to provide all - weather access; and
j) Any other work which may be notified by the central Government in consultation with the state Government;

Results and Discussion
Traditional rainwater conservation systems comprise mainly tanks, ponds and Ooranis (drinking water ponds). Considering the erratic rainfall obtaining in our country, they have been constructed by our ancestors over the past centuries, to capture the monsoon rains and store them for later use when required. During the past few decades they are getting due importance under the water conservation programmes.

Impact on Ground Water Table
The water conservation techniques undertaken under water conservation programmes retain the running water in particular structure. This helps for the percolation of water to the lower layers of earth and recharges the occupiers. This process is expected to enhance the ground water table. The opinions of the farmers on the impact of water conservation techniques on ground water table are presented in fig.13.



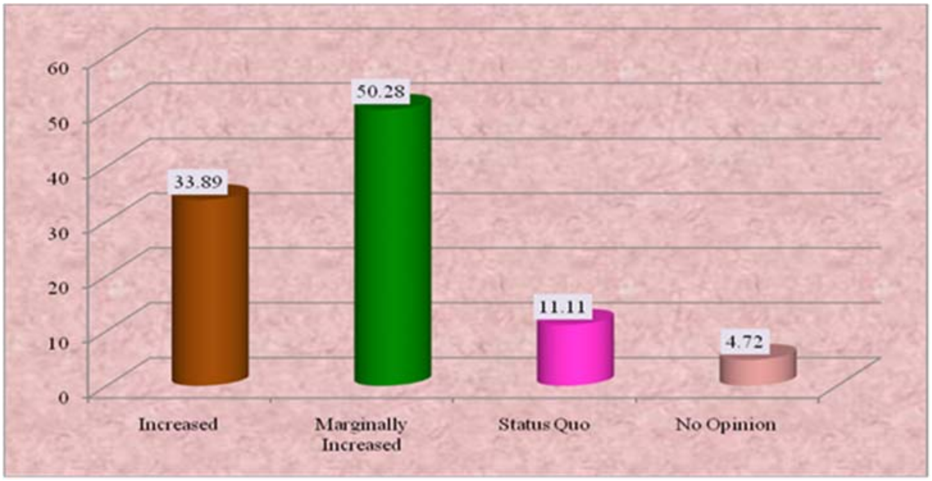
Source: Field Data

Fig 13: Respondents Opinions on the Impact of Water Conservation Techniques on Ground Water Table

Figure 13 shows that the ground water table increased due to creation of water conservation techniques in study area has been expressed by 110 (30.56 %) respondents. Only negligible percentage of (4.72 %) respondents has no opinion on the enhancement of water table in study area. While majority of the respondents constituting 38.06 per cent of the respondents have expressed that there is no change in water table even after creation of water conservation techniques in through water conservation programmes in their area and 26.67 per cent are at the opinion that there is some improvement in water table due to water conservation techniques.

Impact on the Availability of Surface Water
Creation of water conservation techniques not only expected to improve ground water table but also enhances the

availability of surface water for longer period. The availability of surface water for longer period in study area mitigate the problem of drinking water for cattle, sheep, goats etc., as such during field survey the opinions of the respondents on the availability of surface water for longer period was registered and the same is presented in fig.14.



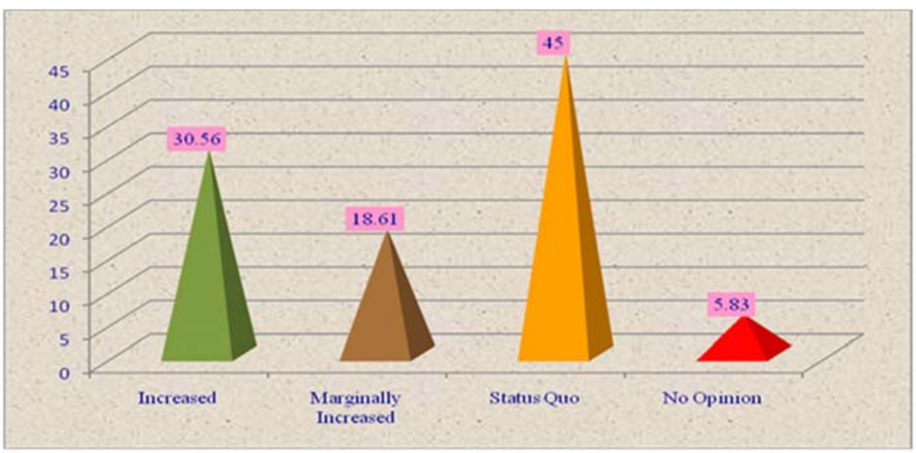
Source: Field Data

Fig 14: Respondents Opinions on the Impact of Water Conservation Programmes on the Availability of Surface Water

As per fig.14 more than half (50.28 %) of the sample respondents reported that there is some improvement in the availability of surface water due to water conservation techniques constructed under water conservation programmes. Moreover nearly 33.89 per cent of the respondents have observed that there are significant changes in the availability of surface water for longer period in the study area. About 11.11 per cent of the respondents stated that there is no change in the availability of surface water for longer period in the study area. Nearly 4.72 per cent of respondents have not expressed any opinion on the availability of surface water in the study area.

Impact of Rejuvenation of Open Wells

Generally, the increase of ground water table will results in the rejuvenation of open wells as well as bore wells. The opinion of respondents on the impact of water conservation techniques created through water conservation programmes son rejuvenation of open wells is presented in fig.15.



Source: Field Data

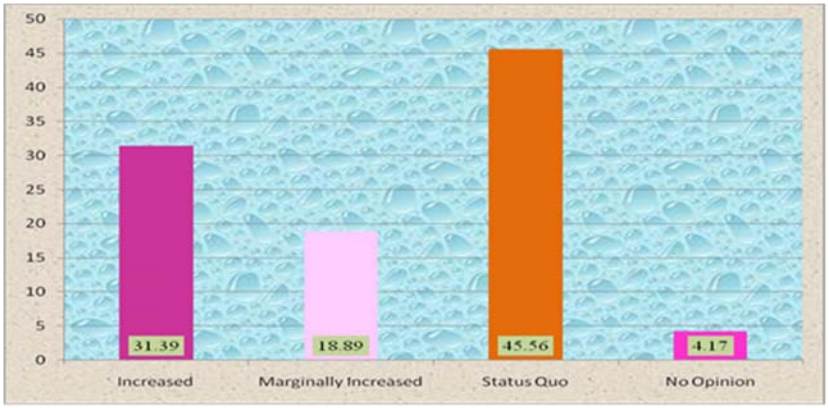
Fig 15: Respondents Opinions on the Impact of Water Conservation Programmes on Rejuvenation of Open Wells

Fig.15 indicates that nearly 49.17 per cent of the sample respondents found that they water conservation techniques of water conservation programmes have positive impact on rejuvenation of open wells. To be precise, 30.56 per cent reported clear increase in the rejuvenation of open wells, while 18.61 per cent observed only little increase in the rejuvenation of open wells. About 45 per cent of respondents declared no change in the rejuvenation of open wells. Around 5.83 per cent have no opinion on the impact of water conservation techniques in the rejuvenation of open wells.

Impact on the Rejuvenation of Bore Wells

In the study area bore wells are major irrigation sources for farmers. Some of the bore wells dried up due to droughts and lack of water conservation techniques for the improvement of ground water table. As such during field survey the respondents views are collected on the rejuvenation of bore wells.

The opinion of sample respondents on the impact of water conservation techniques on rejuvenation of bore wells is presented in fig.16.



Source: Field Data

Fig 16: Respondents Opinions on the Impact of Water Conservation Programmes on Rejuvenation of Bore Wells

The fig.16 shows that nearly half (50.28%) of the respondents expressed that water conservation techniques have positive impact on rejuvenation of bore wells. Among them 31.39 per cent reported significant increase and 18.89 per cent little increase in the rejuvenation of bore wells is reported by 45.56 per cent of the sample respondents. While, only 4.17 per cent have no opinion on the impact of water conservation programmes on rejuvenation of bore wells.

Conclusion

In rain fed area for water conservation/ harvesting, the work should be planned on water conservation approach i.e. planning and treating the area on ridge to valley concept. Work should start from ridge, only than it will be durable and effective. In non arable area/ forest area, for soil and water conservation full package of soil and water conservation with scientific survey, planning, design and layout should be taken, so that the programmes of the government proves to be durable, economical and productive.

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