Global Theme on Agroecosystems

Abstracts of Students' Research Projects

2000–2008

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

Science with a human face

Citation: ICRISAT. 2008. Abstracts of Students' Research Projects (Research Scholars, Apprentices, Research Fellows and Trainees) 2000-2008. Global Theme on Agroecosystems. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). 92 pp.

Global Theme on Agroecosystems

Abstracts of Students' Research Projects

2000–2008

ICRISAT

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

Contents

2004

2003

2002

2001

Abstracts of Students' Research Projects

(Research Scholars, Apprentices, Research Fellows and Trainees)

2000–2008

Year 2008

Title	:	**Mapping spatial variability of micronutrients in Tumkur district**
Name	:	**Tina Geisler**
Institute	:	**Germany**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Period	:	**2008**

Abstract:

One of the major reasons for low rainwater use efficiency in the micro watersheds is inappropriate soil fertility management practices followed by farmers. In the community watershed management, it is a challenging task to provide soil health information to farmers in the SAT as there are large numbers of smallholder farmers in the region.

It is difficult to do agricultural management in a whole district without having fundamental information base of physical conditions of the area. To support improved and balanced nutrient management decisions, the present work deals with the spatial variability of boron, sulfur and zinc in Tumkur district of Karnataka in South India. In order to interpolate the results of stratified soil sampling in the villages, an interpolation method in the Geographical Information System (GIS) at a suitable scale was standardized and the results were validated. Through the standardized GIS-based interpolation method, agricultural extension personnel and farmers, watersheds can be provided with reliable and cost efficient soil analysis results of total Tumkur district for developing balanced nutrient management strategies.

Title	:	**Crop simulation modeling**
Name	:	**B Gangaiah**
Institute	:	**Indian Agricultural Research Institute, Pusa, New Delhi**
Supervisors	:	**Suhas P Wani and Piara Singh, Principal Scientists**
Period	:	**2008**

Abstract:

This study was undertaken to assess the crop simulation model. It has been found that the DSSAT and APSIM models are useful tools for predicting the effects of climate change on agricultural production, productivity vis-à-vis the food security of the world. For example, the effects of high temperatures at grain filling stage on performance of wheat can be simulated by using APSIM. The models help in estimating potential yields and in conducting the yield gap analysis. Because of the availability of these

models, experimentation at all location where information on soil and weather are not available can be avoided. Thus, models can be handy in evaluation of breeders. However, there are drawbacks like the usefulness of the models has to be judged by the user for his situation and they cannot be applied for all situations. It also requires knowledge of programming (FORTRAN/ C++) skills to develop or modify models.

Title	**:**	**Impact of climate change on agricultural productivity in India's semi-arid tropics**
Name	**:**	**Todd Matthew Wynn**
Institute	**:**	**USA**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**2008**

Abstract:

Climate change is predicted to negatively affect agricultural productivity in India's semi-arid tropics. The possible damaging effects vary depending on the magnitude of the changes in temperature, rainfall, and standard deviation of rainfall. Irrigation is one method that potentially offsets negative effects of climate change by as much as 30% in the aggregated regression.

Disaggregating the model by income tercile showed similar negative effects of climate change on land values but with differing marginal effects of irrigation. The tercile analysis showed that the lowest income households are the most negatively affected. Add to that, they also have the least capacity to adapt to these changes. The highest income households are likely to suffer because a large part of their income (56%) comes from agriculture. However, these households have a higher capacity to adapt by implementing irrigation.

This paper also revealed some misgivings about the Ricardian method as the magnitude of the effect of atmospheric CO_2 differs from plant to plant, especially with regard to their ability in using CO_2. Despite these misgivings, the analysis through this method shows that by holding technology and CO_2 fertilization constant, a temperature increase of only 1° Celsius will have considerable negative effects on agricultural productivity, with increasing damages as temperatures continue to increase.

Since dryland agriculture is so susceptible to climate change, farmers in India should irrigate their land to mitigate the risks of climate change. The Government of India should influence farmers to irrigate their land through subsidies on well digging, bore-well drilling, and by funding effective watershed projects. In addition, effective meteorological reports should be made available to farmers to help them decide the best time to plant and harvest. Access to weather forecast reports could greatly increase the farmer's ability to react to upcoming weather anomalies and effectively plan for the upcoming growing period.

Title	**:**	**Study of vermicompost for *Jatropha* de-oiled cake and its effect on tomato plants in greenhouse**
Name	**:**	**K Anuradha**
Institute	**:**	**Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist and team**
Year	**:**	**2007**

Abstract:

The continuous use of chemical fertilizers over a long period may cause imbalance in the micro flora and thereby, indirectly affect the biological properties. Ultimately, it may have an adverse effect on the soil, leading to land degradation.

There is a need to improve soil fertility by using available resources of the farm for increasing crop yield. One of the ways would be by utilization of waste through recycling for environmental safety, economic stability and ecological sustainability. Several methods have been developed to convert bio-wastes into organic manure. Vermicomposting is one such method that uses earthworms as biological agents.

Increasing industrialization in the developing world is leading to increase in the demand of fossil fuel. Several crop and tree species are good source of products that can be processed to produce bio-fuel on a sustained basis.

Bio-diesel is a renewable fuel that can be produced from vegetable oils, animal fats, used cooking oil, and waste from the pulp and paper industry. In the arid and semi-arid regions, particularly on the degraded lands and lands affected by moving sands, *Jatropha curcas* L. has proved to be a promising oil-bearing tree. The seeds of this Euphorbiaceae tree contain more than 30% oil, which can be used for making bio-diesel. The solid residue that is left after oilseed has been pressed free of oil is used as good organic manure through vermicomposting.

The present study on vermicompost from *Jatropha* de-oiled cake and its effects on the yield of tomato plant also deals with the evaluation of microbial population, analysis of all biological parameters and chemical properties and comparison of all the above parameters with different organic matter used (grass and millet + sorghum husk).

Vermicomposting bins were prepared with *Jatropha* de-oiled cake along with different concentrations of cow dung slurry, organic matter (grass and millet + sorghum husk) and earthworms.

The samples were collected from the bins before releasing the earthworms and at the time of harvest for microbial, biological and chemical analysis. The microbial population of bacteria, fungi and actinomycetes were more in the vermicompost samples collected before releasing earthworms (S_1).

In the study of biological parameters, soil respiration, microbial biomass C and microbial biomass, N were recorded high in the samples collected before releasing earthworms (S_1) and in the sample that were collected at the time of harvesting (S_2) of T_2 where the vermicompost has been prepared from de-oiled cake with sorghum + millet husk as an organic matter.

The effect of vermicompost on the growth of tomato plant was studied. Among all the treatments, when compared to biological, morphological and microbial analysis, treatment T_2 showed good results in terms of height of the plant, number of flowers, number of branches, production of fruits in early stage and in number of fruits.

Year 2007

Title	:	**Effect of *Gliricidia* (*Gliricidia sepium*) on quality of Vertisols and Alfisols**
Name	:	**M Dinesh Babu**
Institute	:	**Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	:	**Suhas P Wani and Ch Srinivasa Rao, Principal Scientist & Scientist**
Year	:	**2007**

Abstract:

Global climate change due to the greenhouse effect and its impact on plant productivity is a major issue of concern to the scientific community. CO_2 is one of the principal greenhouse gases and global warming is a major consequence. Soil organic carbon is a key part of carbon cycle, which also plays an important role in crop production. Green manuring is a time-tested strategy to produce organic matter for the soil amelioration and nutrient supply. In this regard, this project focuses on identifying farming systems that can reduce CO_2 concentration in the atmosphere and increase the stocks of soil organic carbon and other nutrients while maintaining or increasing the systems' productivity. The main objective of the present study was to study the influence of the long-term effect of *Gliricidia* plantations on soil health parameters as *Gliricidia* is best known for its carbon and nitrogen fixing property.

Five soil cores were collected at each grid point from rhizosphere and non-rhizosphere, from different depths 0 - 20, 20 - 40, 40 - 60, 60 - 80 and 80 - 100 cm and analyzed for microbiological, physical and chemical properties of the soil. Enumeration of microbes (bacteria, fungi and actinomycetes) was done by the dilution plating technique using appropriate media, respiration rate of the soil sample, which indirectly reflects the amount of carbon present in the soil. Microbial biomass carbon, microbial biomass nitrogen measurements were carried out by chloroform fumigation and incubation method, and mineral nitrogen and net N mineralization measurements were done by steam distillation method.

Significant differences were observed between rhizosphere and non-rhizosphere soil with regard to microbial and biological parameters in the 0 – 20 cm depth and 20 – 40 cm depth, respectively, and for chemical parameters at all the depths. Microbial population in the rhizosphere and non-rhizosphere soils averaged 1.2 $x10^4$ and 0.8 x 10^4 cfu g^{-1} of soil, which showed a twofold significant difference. SOC accounted to 36.4 tonnes per hectare in rhizosphere while it recorded at 30.6 tonnes per hectare in non-rhizosphere. A significant correlation ($r = 0.40^*$) was observed between the soil organic carbon (SOC) and the microbial biomass carbon because of increase in microbial population, which in turn showed a gradual increase in C:N ratio in the soil.

Clearly, the increase in SOC is significant contribution to the overall carbon sequestration potential. Further research is needed to identify the mechanisms responsible for the observed patterns of soil organic carbon within and adjacent to the *Gliricidia* bunds and to quantify the C in biomass and deeper soil layers.

Title	**:**	**Heavy metal contamination in various soil types under rain-fed production systems of India**
Name	**:**	**S Rama Gayathri**
Institute	**:**	**Jawaharlal Nehru Technological University**
Supervisors	**:**	**Suhas P Wani & Ch Srinivasa Rao, Principal Scientist & Scientist**
Period	**:**	**2007**

Abstract:

Rain-fed agriculture in India extends over 97 m ha, consisting nearly 67 per cent of the net cultivated area, contributing 44 per cent of the country's food production and supporting 40 per cent of the country's human population. Agriculture in rain-fed areas is uncertain because of its full dependence on rain and generally poor fertility of soils. For higher yields, nutrients like nitrogen, phosphorous and potassium are essential. However, the heavy metal contamination could also lessen the yields. An attempt has been made to study the heavy metal concentrations in various soil types under rain-fed production systems of India The soils that occur in rain-fed areas include Alfisols, Vertisols, Aridisols, and Inceptisols.

Soil samples from 21 locations of the All India Coordinated Research Project for Dryland Agriculture (AICRPDA) were characterized for availability of total Cd, Co, Cr, Ni, Pb, Cu, Mn, Zn and Mo based on profile sampling. These 21 locations covered agroecological regions from 2.3 to 12.3, semi-arid, arid and sub-humid climate, soils of Vertisols, Vertic sub-groups, Alfisols, Inceptisols and Aridisols. Rainfall ranged from 412 to 3178 mm among locations. Various physico-chemical properties of 21 profiles indicated that most of the locations were low in organic carbon, showing less than 0.5 per cent. Clay content varied widely among soil types. Low organic matter in these soils is one of the important factors contributing to low soil fertility.

The concentration of heavy metals (Cd, Co, Cr, Ni, Pb, Cu, Mn and Zn) in all the soil samples in India was found to vary between 0.05 and 2681 mg/kg. The concentration of Cd was low compared to other heavy metals and ranged between 0.8 and 4.9 mg/kg. The concentration of cobalt ranged from 4.8 to 46.6 mg/kg, chromium between 31.6 and 246.9 mg/kg, nickel between 10.2 and 102 mg/kg, lead between 0.05 and 6.8 mg/kg, copper between 4.2 and 114.3 mg/kg, manganese between 136 and 2681 mg/kg and zinc ranged between 8.1 and 129.3 mg/kg in soils. These results suggest that soils from different locations under rain-fed production systems of the country vary widely in heavy metal status.

Title	:	**Assessing the feasibility of organic farming in the peri-urban watersheds of Andhra Pradesh**
Name	:	**Ishani Pruthi**
Institute	:	**Teri School of Advanced Studies, New Delhi, India**
Supervisors	:	**Suhas P Wani and K L Sahrawat, Principal Scientist & Visiting Scientist**
Period	:	**2007**

Abstract:

Sustainable agriculture is the need of the hour. The present system of agriculture which we call 'conventional' and practiced world over, evolved in the West as a product of their socio-economic environment, which promoted an overriding quest for accumulation of wealth. This method of farming adopted by other countries, is inherently self-destructive and unsustainable.

Organic farming is a sustainable way with use of natural products, both in case of inputs and for pest control. However, its economic feasibility and practicability in densely populated India depends on availability of huge quantities of organic matter to sustain higher yields. Peri-urban agriculture can greatly contribute to this by the supplement of sewage and sludge from the city as well as market for organically-produced foods. The report analyzes the feasibility of organic farming in Kothapally village, a peri-urban watershed of Andhra Pradesh. After careful analysis and observations with the aid of extensive surveys, the development of watershed consortium could be linked with farmer awareness levels. A control village was surveyed and the results were analyzed. In the immediate context, after having a discussion with farmers, keeping in mind their concerns, constraints and food security issues, it can be concluded that conversion to organic farming will not be feasible in the peri-urban villages. It would be possible only after proper awareness programs.

The concept of eco-farming is introduced where the input systems are chemical as well as organic but the chemicals are used judiciously. A form of this system is seen in Kothapally. This can be further refined and implemented as a sustainable system to meet the ever-growing food demand in India.

Title	:	**Soil microbial-diversity as influenced by the cropping systems**
Name	:	**T Keerthi**
Institute	:	**Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	:	**Suhas P Wani & KL Sahrawat, Principal Scientist & Visiting Scientist**
Period	:	**2007**

Abstract:

Soil microorganisms vary widely in semi-arid soils as compared to other tropical soils due to the poor vegetation, which is the result of erratic and scanty rainfall. The treatment of soil by chemical fertilizers, bio-fertilizers not only enhances soil fertility but also enriches microbial life. Microbial diversity, being an integral part of biodiversity includes bacteria, fungi, actinomycetes, etc. New strains for crop improvement, sustainable agriculture, land reclamation and use of rhizosphere bacteria for disease suppression have been the most sought after in scientific arenas.

This project involves the study of microbial diversity, influenced by the cropping systems in the soil samples collected from Kothapally, Andhra Pradesh. Microbiological and chemical properties of the soil samples were analyzed to study the microbial diversity of the cropping systems. Enumeration of microbes (bacteria, fungi and actinomycetes) was done by dilution plating technique, using appropriate media; microbial biomass carbon and microbial biomass nitrogen were determined by chloroform fumigation and incubation method, mineral nitrogen and net nitrogen mineralization by steam distillation method. Diversity in the colony morphology of bacteria and fungi were recorded, different staining techniques were performed and the results were recorded.

Population of bacteria, fungi and actinomycetes were affected significantly with different rates of fertilizer treatments at all the crop growth stages. Increasing trend of microbial population was noticed after 30 days of sowing and was reduced to half of the initial population at the flowering stage. Significant increase in actinomycetes population and a decline were observed in bacterial and fungal population as the crop was growing. Percentage of carbon and nitrogen content were reduced with the growth of the crop i.e., from pre-sowing (T0) to vegetative stage (T1) and to flowering stage (T2) from 84% - 77% and 87% - 80% which correlated with the decline in microbial population, especially as it reached flowering stage due to the maximum utilization of the soil nutrients by the plants.

This study enabled us to partially unravel the synergistic interactions of microbial population and the five cropping systems (cotton, maize-pigeonpea, maize, chrysanthemum and tomato). The outcome of this experiment necessitates further studies in exploiting the complex processes, which regulate the dual impacts of micronutrients and beneficial soil organisms to derive a technology for sustainable crop production.

Title	**:**	**Impact of integrated pest management (IPM) practices on the occurrence of pesticide residues in watersheds**
Name	**:**	**K Kiran Kumar Reddy**
Institute	**:**	**Jawaharlal Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Suhas P Wani & Ch Srinivasa Rao, Principal Scientist & Scientist**
Period	**:**	**2007**

Abstract:

The present study was undertaken to assess the "Impact of integrated pest management (IPM) practices on the occurrence of pesticide residues in watersheds" at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, in 2007. Pesticide residues analysis was done in two vegetable crops (tomato and cucumber), collected from different fields and water samples from bore wells and open wells of Kothapally village. The residues were estimated using a quick, simple, inexpensive and effective sample preparation method, followed by concurrent analysis with gas chromatography-mass spectrometry (GC-MS).

The results indicated the presence of residues of monocrotophos, chlorpyrifos, cypermethrin and endosulfan in both vegetable and water samples. The monocrotophos residues ranged from 0.001 to 0.011 mg kg^{-1}, chlorpyrifos from 0.001 to 0.330, endosulfan from 0.001 to 0.466, and cypermethrin from 0.001 to 0.118 mg kg^{-1}. In all the samples, the residue levels of four chemicals were less than the maximum residue limit (MRL), except in one where the residue of chlorpyrifos in cucumber (0.330) was more than MRL (0.2 ppm). As the season advanced, the residues increased considerably. This may be due to the use of pesticides during the harvest period by the conventional farmers. In case

of IPM farmers, the presence of residues may be due to the leftover residues in the soil and water. Another reason may be the presence of non-IPM farmers beside their fields.

The water samples from open/bore wells revealed the presence of pesticide residues though the residue levels were below MRLs. Open wells had more residues than bore wells due to direct exposure of open wells to air. This is a preliminary study carried out at the village. Further detailed studies covering more crops and products need to be conducted for better results.

Title	**:**	**Study of vermicompost prepared from *Pongamia* de-oiled cake and its effect on tomato plant in greenhouse experiment**
Institute	**:**	**Jawaharlal Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist and team**
Period	:	**2007**

Abstract:

Chemical fertilizers used on a large scale result in leaching and volatilization, causing groundwater pollution and environmental degradation. Bio fertilizers can be a big boon for our country where farmers are marginal landholders. Use of organic and bio fertilizers offer a great opportunity for sustainable crop production.

Bio fertilizers are better alternatives for reclamation of wasteland when compared with chemical fertilizers. For most of the crops and soil condition, up to 20% of the nitrogen requirement can be met through bio fertilizers, which can be best replacement for chemical fertilizers. It may help to reduce the cost on chemical fertilizers and avoid soil problems.

There is need to improve soil fertility by using available resources on the farm for increasing crop yield. Some of the obnoxious weeds and crop residues can be converted into value added farm compost through enrichment with rock phosphate (RP) and biological agents such as phosphate solubilizing microorganisms like *Aspergillus awamori*, free-living nitrogen-fixing bacteria such as *azospirillum* species, fungi and earthworms.

Organic fertilizers include both plant and animal bi-products. They act slow. Organic nitrogen fertilizers include oil cakes, fish manure, dried blood from slaughter houses, etc., whereas organic phosphorous are from bones and organic potassium are from cattle dung ash, wood ash, leaf mould, tobacco stems and water hyacinth.

Bio-diesels are ester-based oxygenated compounds derived from natural, renewable biological sources such as vegetable oils. *Pongamia pinnata* is one of the major bio-diesel yielding plants. Vermicompost was prepared from de-oiled cake of *Pongamia* and included different types of organic matters like grass and millet husk. Later, the vermicompost was analyzed biologically and microbially. It was found that vermicompost prepared from *Pongamia* de-oiled cake and grass as an organic matter gave good results among other treatments.

Title	**:**	**Studies on microbial parameters and dehydrogenase enzyme in the soils under *Jatropha* and *Pongamia***
Name	**:**	**D Narasimha Reddy**
Institute	**:**	**Vellore Institute of Technology, Tamil Nadu, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**2007**

Abstract:

Rhizosphere and non-rhizosphere soil samples from watersheds of different locations - ICRISAT, Siddapur, Velchel, Kothlapur - were collected from fields under different plantations. Rhizosphere and non-rhizosphere soil samples were collected from *Jatropha* and *Pongamia* plantations. Microbial population was recorded in both rhizosphere and non-rhizosphere soils. Microbial population was greater in the rhizosphere soil samples than in non-rhizosphere soil samples. High counts of microbial population were observed in soils with the pH in the range of 6.5-8.0. The numbers of fungi, bacteria and actinomycetes were greater in the rhizosphere than in non-rhizosphere soil samples. Soil samples collected from ICRISAT, Siddapur, Velchel, Kothlapur were analyzed for microbial activity (bacteria, fungi, actinomycetyes) and dehydrogenase enzyme activity. Biomass C was estimated using chloroform fumigation and incubation method. Soil respiration was also estimated.

The results obtained were in turn correlated with rhizosphere and non-rhizosphere samples. The results showed that mean values of biological parameters were found to be higher in the rhizosphere than in non-rhizosphere of *Pongamia* and *Jatropha*. Biomass C as well as microbial population was more in *Pongamia* soil samples than the *Jatropha* soil samples, which may be because of the presence of alkaloid called jatrophin in *Jatropha* seeds. Soil enzymes in dehydrogenase activity were more in *Pongamia soil* samples than the *Jatropha* soil samples.

Title	**:**	**Identification and quantification of vesicular-mycorrhizae in the rhizosphere of *Jatropha* and *Pongamia***
Name	**:**	**Nida Hasan**
Institute	**:**	**TERI University, New Delhi, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist and team**
Period	**:**	**2007**

Abstract:

The various genera of vesicular-arbuscular mycorrhizae (VAM) were identified and quantified from root and soil samples of *Jatropha* and *Pongamia*. Samples were obtained from Kothapally village (a managed watershed) and various accessions were collected from the ICRISAT campus. VAM were identified by spore morphology studies and quantified by using the gridline intersect method. VAM diversity was low as only three genera viz. *Glomus*, *Acaulospora* and *Scutellospora* were identified. Also spore counts were low. But the spore counts showed a significant correlation with root colonization, yielding a R^2 value of 0.9. The highest colonized accessions were from Mumbai and a few districts of Andhra Pradesh. Dependence of root colonization was also studied with respect to various physico-

chemical parameters of the soil. The correlation between available phosphorous and root colonization was high with a R^2 value of 0.9. Similarly, the R^2 values for root colonization vs. exchangeable potassium and available sulphur were also high.

Title	**:**	**Characterization of *Jatropha* de-oiled cake and *Pongamia* de-oiled cake vermiwash and its effect on tomato plants in greenhouse**
Name	**:**	**A Rama Devi**
Institute	**:**	**Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist and team**
Period	**:**	**2007**

Abstract:

Soil degradation and environmental pollution due to the use of chemical fertilizers is of major concern in the present day life. This problem can be overcome by use of balanced nutrient and maximum use of available organic materials. Compost or organic manure plays an important role as plant nutrients and is therefore a sustainable alternative to chemical fertilizers.

Vermicomposting is a process by which all types of biodegradable wastes such as farm wastes, kitchen wastes, market wastes, biowastes of agro-based industries, live stock wastes etc., are converted into nutrient-rich vermicompost by using earthworms. Vermicompost improves growth, quality and yield of different crops.

Vermiwash is a lechate collected after the passage of water through a column of worm culture. It is a collection of excretory products and excess secretions of earthworms along with micronutrients from soil organic molecules, and organic matter. Vermiwash has a pH of 8.5 and N, P_2O_5 and K_2O content 200, 70 and 1000 mg/l, respectively. It is useful as a foliar spray.

The present study deals with microbial, biological, chemical analysis of vermiwash samples. The samples were collected at weekly intervals for microbiological analysis. Growth promoting and antagonistic properties were also studied using different dilutions of vermiwash samples.

Different plastic bins were filled with *Jatropha* and *Pongamia* de-oiled cake along with different concentrations of cow dung slurry, organic matter and earthworms (vermicompost). Vermiwash was collected from the bins for biological, microbial, chemical analysis, hormonal assay and also to study the antagonistic properties of plant pathogens.

The effect of vermiwash on the growth of tomato plants was studied. Vermiwash collected from the bin of *Pongamia* de-oiled cake (V W_2) was found to be more effective in stimulating the growth of tomato plant compared to other vermiwash samples (V W_1, V W_3, and V W_4). Germination efficiency of seeds (chickpea and pearl millet) was found to be more in diluted samples of vermiwash than pure samples (100%). Among the test organisms used in antagonistic properties, only one organism (*Curvularia lunata*) showed inhibition with vermiwash.

Title	**:**	**Health enhancing foods: Availability and use in Andhra Pradesh villages – a case study**
Name	**:**	**Aditi Vidyarthi**
Institute	**:**	**University of Cork, Cork, Ireland**
Supervisors	**:**	**Suhas P Wani & T K Sreedevi, Principal Scientist & Scientist**
Period	**:**	**2007**

Abtract:

Nutritive traditional food is being substituted by high calorie diet that is rich in fats and carbohydrates. However, the high calorie diet will have a slow and deteriorating effect on the human body. This trend is more prominent in developing countries like India where fast commercialization is compelling people to change their lifestyle and compromise with their own old cultural and traditional practices. The study based in Deccan region of India attempts to find out local availability and awareness of health foods, the market demand and agricultural practices of farmers in the region. The study also found out that traditional nutritious food in this region is being replaced by fast food, leading to a shift in the cropping pattern of farmers.

Title	**:**	**Community watersheds for enhancing environmental quality**
Name	**:**	**R Shilpika**
Institute:	**:**	**Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Prabhakar Pathak, Principal Scientist and team**
Period	**:**	**2007**

Abstract:

Soil plays a key role as the interface between terrestrial and aquatic ecosystems on the one hand and the atmosphere on the other. Soil is a major sink for global gases and its appropriate management affects the carbon dioxide (CO_2) balance that is important in combating global warming. If mismanaged, soil can work against us; it can pollute the air and water and lead to a fall in agriculture production. Natural resource management (NRM) interventions in terms of fertility, soil and water management practices in various farming systems have become necessary to address the problem of soil degradation. Reliable soil and water quality indicators are necessary to analyze and quantify the impacts of soil degradation. Impact assessment is essential for the development of suitable management strategies for soil and water quality.

The main objective of the present study was to evaluate the impact of watershed interventions on environmental quality - soil and water quality.

Sediment samples were collected from check dams, mini percolation tanks and soil samples were collected from its adjacent fields from nine different locations of Kothapally. The samples were analyzed for microbiological, physical, and chemical properties. Enumeration of microbes (bacteria, fungi and actinomycetes) was done by dilution plating technique; microbial biomass carbon, microbial biomass nitrogen were carried out by chloroform fumigation and incubation method and mineral nitrogen, net N mineralization were done by steam distillation method. Water samples (surface water

and groundwater) were collected from check dams and mini percolation tanks where the sediment samples were collected and groundwater from nearby wells and analyzed for chemical properties.

The results revealed that the mean microbial population was recorded higher in the sediment samples (7.8%) rather than in the soil samples. All the other physical parameters and chemical composition also showed higher values in the sediment samples than in the soil samples collected from the adjacent fields. The percentage of silt and clay were 12.5% and 11.4% higher in sediment samples to that of soil samples. The percentage of difference among all the micro and macronutrients studied, nitrogen (25.8%) recorded maximum difference in the sediment samples over the soil samples. Future research is needed for developing more effective and measurable indicators of soil and water quality for the purpose of monitoring the biophysical impacts of watershed management.

Title	**:**	**Community institutionalization and post-project sustainability in participatory integrated watershed development in semi-arid India: A case study of the Adarsha watershed in Kothapally, Andhra Pradesh**
Name	**:**	**Shinya Abe**
Institute	**:**	**Cornell University, USA**
Supervisors	**:**	**K Sreedevi, Scientist**
Period	**:**	**2007**

Abstract:

Eighty percent of the world's arable land depends on rainfall. However, rain-fed agriculture is traditionally low yielding and poverty prevails in low and unreliable rainfall areas. This also happens in India and improving productivity of rain-fed systems is of utmost importance. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) developed a farmer-participatory-consortium model for sustainable natural resource management based on its long-term experience in watershed development. It implemented an integrated program with its national partners to improve rain-fed agriculture and reduce poverty in the Adarsha watershed in Kothapally, Andhra Pradesh, from 1999 to 2004. The research outlined in this paper attempted to identify mechanisms and critical factors that determine the sustainability of natural resource management and explored a new framework to improve post project sustainability and on how to expand the program to other dryland areas of India.

First, key informant interviews were conducted to obtain basic and current information with respect to community institutionalization. The interviews ascertained significant information regarding post-project sustainability in Kothapally. It was found that most types of farmers groups (FGs) are not currently active nor do they have frequent group meetings. Proper maintenance of water harvesting structures is also a concern. On the other hand, some groups, especially self-help groups (SHGs) that manage group saving and loans and other livelihood enhancement activities, demonstrate stable sustainability. They have developed their groups and activities even though there is no major watershed project in the village. Critical factors that affect post-project sustainability were consequently identified, including regular routine work, financial activities, external linkages, honor, hierarchy, caste, and dependency.

Second, the research conducted further interviews with Kothapally farmers, key consortium persons, and NGO staff and farmers in Ponganur, Andhra Pradesh, to improve the post project sustainability

and scaling-up of watershed development. The research presents a new sustainable institutional model that is comprised of five main components. The first component suggests integrating all stakeholders into SHGs at the village level. The second component proposes the release of watershed development funds as community-based revolving funds to maintain water harvesting structures and upgrade SHGs. The third component advocates establishing area-wide federations as the umbrella organizations of SHGs to provide various revolving loans and insurance schemes for SHG members and to organize monthly and annual meetings. The fourth component proposes selecting village volunteers (VVs) for post-project phases. The last component recommends establishing watershed communication cafés in order to facilitate farmer extension and scaling-up. This component also involves utilizing the communication cafés to assist SHG meetings and mobilizing VVs for scaling-up. All the components above will be able to create synergies to accomplish enhanced post project sustainability of watershed development.

Marketing, however, is the next agenda item after water availability is increased through watershed projects and groups for sustainability are established. Even with varied social assistance in Ponganur, villagers still grow the same crops as second crops with the increased water supply. Farmers are affected by market conditions in decision-making even when new crops and initiatives could be considered. This paper also deals with marketing interventions that can be integrated into the new sustainable institutional model of watershed development for farmers to benefit and improve their livelihoods.

Title	**:**	**Biological studies in rhizosphere soil of *Jatropha* and *Pongamia***
Name	**:**	**P Suneeta**
Institute	**:**	**Gitam College of Science, Andhra University, AP, India**
Supervisors	**:**	**T K Sreedevi, Scientist**
Period	**:**	**2007**

Abstract:

National Planning Commission of India has decided to have a multi-dimensional program to replace 20% of the diesel consumption through bio-diesel by integrating the Ministries of Petroleum, Rural Development, Poverty Alleviation, Environment and others. *Jatropha curcas* and *Pongamia pinnata* have been identified as potential species for bio-diesel. In ICRISAT, study is in progress on the plants of *Jatropha* and *Pongamia* for the extraction of bio-fuels. The rhizosphere can be described as the longitudinal and radial gradients occurring with expanding root growth, nutrient and water uptake, exudation, and subsequent microbial growth. With this background, the present study has been attempted to compare the microbial population, microbial biomass and soil enzymes activity (dehydrogenase) between the rhizosphere and non rhizosphere soils of *Jatropha* and *Pongamia* plantations collected from Kothapally (Rangareddy), Kadapa (Rangarajupally, Chitakommadinne mandal) and Kurnool (Sudepally, Veldurthy mandal) districts of Andhra Pradesh. Experimental design was a 2 X 3 factorial design with two soil treatments beneath and outside the influence of the root and three locations. Microbial counts were done by serial dilution and plate method. The microbial population density was 50% more in rhizosphere than in non rhizosphere, which was also confirmed by higher values of soil respiration (17.6%), biomass C (18.3%), biomass N (15.5%) than to that of the non-rhizosphere soil samples collected from all three locations. This may be due to the higher amount

of roots, higher amount of amino acids in root secretions, extra matricular mycelium as in the case of fungi, inorganic matter, roots and root tips, nitrogen-fixing bacteria, more root exudation or rhizo deposition, root peelings, quantity of carbon release of enzymes from plant roots in the rhizosphere soils. From Kadapa, microbial population of $55.5x10^3$ cfu g^{-1} soil was recorded, which was two fold higher to that of microbial population found in Kothapally and Kurnool ($30.8x10^3$ cfu g^{-1} soil). In *Jatropha* plantations, microbial population of $31x10^3$ cfu g^{-1} soil, soil respiration of 93.40 μg CO_2 g^{-1} soil, biomass of C of 174.10 μg C g^{-1} soil , biomass of N of 12.68 μg N g^{-1} soil, mineral N of 7.71 μg N g^{-1} soil, net N mineralization of -0.40 g^{-1} soil 10 d^{-1}, dehydrogenase activity of 40.69 μg TPF g^{-1} 24 h^- were found. In *Pongamia* plantations, microbial population of $46x10^3$ cfu g^{-1} soil , soil respiration of 121.69 μg CO_2 g^{-1} soil, biomass of C of 191.72 μg C g^{-1} soil, biomass of N of 13.27 μg N g^{-1} soil , mineral N of 8.02 μg N g^{-1} soil, net N of -0.45 g^{-1} soil 10 d^{-1}, dehydrogenase activity of 45.87 μg TPF g^{-1} 24 h^- were found. The results obtained were in turn correlated with the treatments to know the soil samples that have the better biological activity. Rather than the results showed at Rangarajupally (Kadapa) and Sudepally (Kurnool), rhizosphere soil samples of *Pongamia* at Rangareddy (Kothapally) have been found to have better treatment by the high values recorded for all the parameters than that of the non rhizosphere soil of *Pongamia* and as well as the rhizosphere and non-rhizosphere soil samples of the *Jatropha* plantations of all the three villages studied. In Kadapa, microbial populations and biological parameters were found to be higher than the population recorded in the other two locations - Kothapally and Kurnool.

Title	**:**	**Impact of management strategies for enhancing soil quality in Vertic Inceptisols**
Name	**:**	**Vincent Richer**
Institute	**:**	**CAH, Dronten, The Netherlands**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**2007**

Abstract:

Rain-fed areas constitute about two-thirds of the total 142 million hectares cultivated in India. These areas represent only 45% of Indian agricultural productivity and allow low livelihoods for farmers. Furthermore, Vertic Inceptisols cover 60 million ha out of 72 M ha of Vertisols in central peninsular Indian landscape. That is why it is important to develop and test new ways of growing higher yields. This report assessed the impact of the ICRISAT improvement package as compared to traditional management during a long-term experiment. The study focused on the biological (microbial biomass nitrogen and carbon, net nitrogen mineralization and soil respiration), physical (particle size distribution and bulk density) and chemical properties (pH, EC, the different plant available form of nutriment and micro-nutrient and the total nitrogen and phosphor).

The long-term field experiment was initiated in 1995 rainy season at the ICRISAT research station, Patancheru (78 16' longitude, 17 32' latitude and 540 m elevation), Andhra Pradesh, India. The experiment was conducted on Vertic Inceptisols from the Kasireddipally series with a general slope of 2% and a variation in soil depth from 30 cm to 90 cm (depth of black soil). After many years of grassed-fallow, the land was developed in a 15 ha watershed. For this experiment, four hydrological units were selected, depending on soil depth (90 cm to 50 cm and <50 cm) and system management (improved and traditional) : 1) medium depth improved management, 2) medium depth traditional management, 3) shallow depth improved management, 4) shallow depth traditional management.

Results from this 11-year long-term experiment indicated that improved management options allow a higher TOC content in medium depth soil. Those results cannot be confirmed on shallow deep soil because of leaching phenomena. The TOC content was directly or indirectly contributing to several available forms of nutrients and micronutrients. These findings have demonstrated that by adopting holistic approach with legume, land, water and nutrient management options potential of Vertic Inceptisols can be harnessed for increasing soil quality and productivity for sustainable livelihoods.

Year 2006

Title	**:**	**Carbon and nitrogen stocks of the soils of varying climates and landuses, Golestan Province, Iran**
Name	**:**	**Farhad Khormali**
Institute	**:**	**Gorgan University of Agricultural Sciences and Natural Resources (GUASNR), Iran**
Supervisors	**:**	**C L L Gowda, Suhas P Wani, Principal Scientists & Ch Srinivasa Rao, Scientist**
Period	**:**	**2006**

Abstract:

Selected biological soil quality indicators i.e. soil respiration, microbial biomass, biomass nitrogen, C: N, net mineralization, population of the microorganisms together with total carbon, organic carbon, inorganic carbon and total nitrogen were studied to investigate their variability in soils of different climatic regions and also to evaluate the role of landuse change and deforestation on their dynamics. Twenty soil profiles, ten as a climosequence and ten pedons from different geomorphic units of a hillslope (summit, SU, shoulder, SH, backslope, BS, footslope, FS and toeslope, TS) of both forest landuse (FO) and an adjacent deforested cultivated land (DeF) were dug and described. The results of analyses of soil samples showed that OC, TC, TN increased with increasing precipitation, while inorganic C (IC) decreased. Mineral N did not show any significant difference with rainfall variation. Leaching of IC as carbonate was responsible for the decrease of IC with the increase in rainfall. IC in the subsurface horizons therefore had accumulated. OC, TN and mineral N in the subsurface horizons did not show any significant differences. In the studied forest and cultivated landuse systems, OC, TC, TN and mineral N were higher in forest in all the different geomorphic surfaces. IC was absent in all the different geomorphic surfaces of forest indicating its downward leaching due to higher infiltration of rainfall in this landuse. In addition, analysis showed that soil respiration values were significantly different between two land uses in all geomorphic positions, in the 0-30 cm soil layer.

Title	:	**Is short-duration pigeonpea the right choice for poor farmers in *bundi* watershed?**
Name	:	**Jørgen Hugo Jensen SLing**
Institute	:	**Forest & Landscape, Nødebo, Denmark**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Period	:	**2006**

Abstract:

Pigeonpea is one of the five mandate crops of ICRISAT. Improvement in varieties has been done since 1972. In Rajasthan, it has not been cultivated traditionally. ICRISAT and partners are trying to transfer their knowledge to poor farmers of the semi-arid tropics through integrated watershed management approach. They are interested in up-scaling cultivation of short duration pigeonpea in the Eastern Rajasthan watershed area, because it is suitable for the agroecological conditions in the area; and the crop fits in the present double cropping pattern and has multipurpose potential as risk minimizing by crop diversification.

The potential advantages and disadvantages of SDP were assessed through literature and a questionnaire study of twenty-eight local farmers. The study also revealed farmers' willingness to adopt previously introduced agricultural technologies and improved crops/varieties. Calculations on four farmers' field were made, comparing the possible net profit of SDP with maize, sesame or soybean cultivation.

Many farmers wanted to try this crop, even though they do not consume pigeonpea regularly. Some other major constraints identified were that farmers' seed bank has no seeds, they have little knowledge of cultivation practices and their expectations also seem unrealistic.

Title	:	**Enumeration of microorganisms and characterization of enzyme**
Name	:	**Jyoti Agarwal**
Institute	:	**Indian Institute of Technology, Kharagpur, India**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Period	:	**2006**

Abstract:

Microorganisms perform a key role in nutrient cycling for sustaining the productivity of the soils. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has been working on biodiesel plantations of *Jatropha curcas* and *Pongamia pinnata*. In addition to this, different experimental trials were conducted at ICRISAT (special, manurial trials with and without irrigation, pruning) for *Jatropha*. The experiments were conducted to find a strategy to adopt suitable soil and water conservation measures for growing bio-diesel plantations and management practices that can increase the yield and oil content. With this view, soil samples were collected from *Jatropha* plantations at ICRISAT with different fertilizer applications. In order to compare the microbial population and enzyme activities, soils from three different districts (Kadapa, Medak and Kurnool) that have bio-diesel plantations without fertilizer application, were collected. It was observed that microbial population was higher in soil samples at ICRISAT with fertilizer application. High counts

of microbial population were recorded in Medak district, followed by Kurnool and Kadapa. Soil samples collected from ICRISAT showed maximum dehydrogenase activity with applied fertilizer. The lowest level of activity was observed when no fertilizer was applied. A significant relationship was also established between dehydrogenase activity and microbial population in soil samples collected at ICRISAT farm.

Title	**:**	**Estimation of carbon sequestered in *Jatropha* and *Pongamia***
Name	**:**	**Lukhamlu Golmei**
Institute	**:**	**Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Year	**:**	**2006**

Abstract:

The increase in atmospheric concentration of CO_2 from fossil fuel combustion and landuse change necessitates identification and implementation of strategies for mitigating the threat of the global warming. Forests absorb CO_2, and convert it to carbon that is stored in its wood, thus acting as carbon sinks. Estimation of aboveground biomass is an essential aspect of studies of carbon stocks and the effects of deforestation and carbon sequestration on the global carbon balance. Hence, carbon sequestration is increasingly advocated as a potential strategy for mitigating global climate change and at the same time reclaiming degraded lands, particularly in semi-arid regions of the developing world. This study attempted to estimate carbon sequestered by bio-energy plantations for rehabilitating degraded lands and for providing livelihood opportunities to farmers. The central objective was to estimate the carbon sequestered in bio-diesel plants, *Jatropha curcas* and *Pongamia pinnata*. The study was conducted for Kothlapur and Velchal villages in Rangareddy district of Andhra Pradesh. The methodology involved sampling of plants, which were one-year-old, by random branch sampling for the estimation of carbon concentration.

The results showed that more carbon was sequestered in *Jatropha* plants in Kothlapur village when sole *Jatropha* plants were grown as compared to Velchal village, where its plantations was mixed with *Pongamia* plants. The results were extrapolated for *Pongamia* plants of varying ages and it was found that the carbon sequestered was low during early growth, followed by exponential increase with growth until a plateau was reached.

Title	:	**Simulating carbon sequestration at micro-watershed scale with changes in cropping pattern and management systems**
Name	:	**Monika Shrivastava**
Institute	:	**TERI School of Advanced Studies, New Delhi, India**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Year	:	**2006**

Abstract:

Carbon sequestration is known to be the potential win-win strategy, as it is an option to mitigate the climate change as well as the solution to soil degradation problem by decreasing the C concentration in atmosphere and increasing the organic carbon in soil, which in turn increases soil fertility. This report explained the need of carbon sequestration, focusing on semi arid regions. It described different management practices and cropping patterns, which increase the carbon sequestration potential in soil. These practices were found to be crop residue application, no tillage organic manure addition, crop rotation, fallowing, stubble grazing, etc.

A simulation study was also conducted for Kothapally village, under different management practices (referred as eight scenarios in the report) and best management practices were identified. The results were also extrapolated for Kothapally to assess the effects of management practice and cropping pattern. The crop and the duration for which model has simulated were pigeonpea and 30 years, respectively. The model used was century (version 5), initially developed for temperate regions.

The result of simulation study had shown that there is significant increase in SOC from initial to final under four scenarios: no tillage practice, low intensity grazing, double organic manure addition (including vermicompost) substituting inorganic fertilizer and the fourth that included all the improved practices. The century model had also simulated the N in soil organic matter. The trend for N was also in correspondence with the SOC, though not completely. The inter-annual variability was difficult to explain as data for initialization were not sufficient. Two landform systems - flat and BBF were also compared for the ICRISAT campus. Simulation result showed that BBF system was more efficient in sequestering carbon in soil than flats system. From the result, it can be predicted how much carbon would be sequestered in 30 years under different agricultural practices, which will help in formulation of strategies for the future.

Title	:	**Influence of peri-urbanization on rural livelihoods**
Name	:	**Priyanka Kapoor**
Institute	:	**TERI School of Advanced Studies, New Delhi, India**
Supervisors	:	**T K Sreedevi, Scientist**
Period	:	**2006**

Abstract:

Peri-urban regions are areas of exchange of people, goods, money and information. They act as essential entities since they are mediators between urban and rural areas. Rural areas are dependent for job opportunities, transportation, distribution and marketing systems, health and education services, private services and household consumption goods on peri-urban areas. They act as direct market for agriculture produce.

But the development of the peri-urban areas and extensification of urban areas impact the livelihood of rural people, who not only depend on the availability of natural resources but also on a number on services provided by such areas in order to earn a living. Urban and peri-urban areas add to intensification on extensification of agriculture by acting as centers for technological innovation, leading to livelihood diversification and acting as centers for migrants.

A qualitative study was conducted for two villages: Kothapally and Channa Reddy Guda in Andhra Pradesh. Lack of community participation and initiatives, absence of knowledge about agricultural practices and over-exploitation have often led to degradation of natural resources in rural areas. Pressure on such resources is increasing due to increase in expansion of urban areas. Integrated watershed management taken up by government agencies, national and international organizations and NGOs play a vital role in bringing community together and reviving water and land resources. Both Kothapally and Channa Reddy Guda were extremely poor villages in Telangana region of Andhra Pradesh. With ICRISAT's intervention at Kothapally and watershed program under APRLP, and other attempts to improve the natural resources had enhanced the income levels and improved the livelihood of the villagers. Watershed programs have acted as engines of growth for villages, resulting in increased income and higher standards of living. It was found more rural people have access to better job opportunities, medical services, higher education opportunities and social networks. The access to resources and services are dependent on several factors, gender being one of them. The improved standards of living impacted women differently. It was seen during this project that watershed management under APRLP was not able to deliver the desired result.

All of the above, raises the issue of sustainability of natural resources that play an integral part in the development of rural as well as urban centers. With the ever-increasing food demand in the urban centers, the agricultural production is also increasing every year to feed the growing population. Agriculture has become more intensive as is the case in Kothapally. Relevant policy measures should be taken by the government in order to maintain a balance between improving livelihoods, sustainability of natural resources and equitable access to resources by men and women.

Title	**:**	**Effect of amendments (Mo, P and fungicides) added through seed priming on chickpea-*rhizobium* symbiosis**
Name	**:**	**Ch. Sravanthi**
Institute	**:**	**Jawaharlal Nehru Technological University, Hyderabad, A.P., India**
Supervisors	**:**	**JVDK Kumar Rao, Special Project Scientist**
Year	**:**	**2006**

Abstract

Rice, the most extensively grown crop in South Asia, is cultivated on approximately 50 M ha. Despite growing demand for food production because of increasing population in South Asia, there is little scope for expansion of cropping into new areas and therefore, there is need to increase cropping intensity, along with rising of yields on existing agricultural lands. Rice fallows, covering an area of 14.3 M ha, present considerable scope for crop intensification and diversification along with likely improvement in soil fertility for the succeeding cereal crop with the introduction of second crop such as chickpea during post-rainy (*rabi*) season and the application of appropriate technology.

The present study has examined some aspects of growing chickpea in rice fallows, particularly the occurrence of native chickpea *rhizobia* vis-à-vis determine the need for seed inoculation with effective *rhizobium* and the interaction of *rhizobium*, molybdenum, phosphorus and seed dressing fungicide (captan) that are added through seed priming on chickpea-*rhizobium* symbiosis.

The native chickpea *rhizobial* populations of selected rice fallow soils of different states of India were estimated using bacteriologically controlled plant infection technique. The study examined selected rice fallow soils where there were either no previous chickpea cropping history or with a recent legume history i.e. for the last 2-3 years. The soil profiles of chickpea *rhizobia* in rice fallows varied across states of eastern India: Chattisgarh ($3.1x10^2$ to $1.7x10^5$) g^{-1} dry soil; Orissa (0.0 to $1.7x10^5$) g^{-1} dry soil; West Bengal ($3.1x10^3$ to $5.9x10^5$) g^{-1} dry soil; Madhya Pradesh ($1.0x10^2$ to $3.1x10^5$) g^{-1} dry soil and Uttar Pradesh 0.0. These results suggest the need for *rhizobium* inoculation on chickpea *rhizobia* for obtaining good nodulation and nitrogen fixation, which in turn influence the final yields. Correlations between MPN counts of chickpea *rhizobia* and corresponding soil chemical parameters such as pH, E.C, Olsen – P, total – N, organic – C, B, Zn and Mo were not significant.

In conclusion, the study provided a better understanding of rice fallow soils in terms of fertility and *rhizobial* status and the need for micro and macronutrients like molybdenum, phosphorus and fungicide (captan), *rhizobium* inoculation for growing chickpea, the bénéficial effect of phosphorus, molybdenum on chickpea nodulation and growth and also the possibility of combining seed priming, *rhizobium* inoculation and seed treatment with fungicide (captan) into a simple operation so that it can be adopted by resource-poor farmers.

Title	**: Assessing the impact of technological and policy interventions for micro-watershed management in semi-arid India: A bio-economic modeling approach**
Name	**: S Nedumaran**
Institute	**: Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India**
Supervisors	**: Bekele Shiferaw, Suhas P Wani & MCS Bantilan, Principal Scientists**
Year	**: 2006**

Abstract:

A watershed level, dynamic and non-linear bio-economic model, incorporating both economic and biophysical aspects, was developed to assess the impact of technological and policy interventions on social wellbeing of rural poor and condition of natural resource base in a micro-watershed of SAT region of India. For the study, socio-economic and biophysical data was collected from Adarsha watershed in Kothapally village, Rangareddy district, AP. This watershed model was developed by ICRISAT and its consortium partners to evaluate new integrated watershed development approach. The model maximized the income of the whole watershed, which included three types of households based on land endowment (small, medium and large) that were spatially disaggregated into six different segment in the watershed landscape, namely shallow, medium and deep based on soil depth under two types of land (dryland and irrigated land). The model maximized the aggregate net present value of incomes of three household groups in the watershed over a 10 year planning horizon.

The model used simplified production function to represent farmers' response to different factors of production. The crop production in the model was affected by change in soil depth, which was reduced by soil erosion. The erosion level in the watershed was estimated by using USLE model. The yield-soil depth response for different crops grown in the watershed was estimated by using econometric method.. The bio-economic model was used to assess the impact of alternative scenarios like change in the yield of dry land crops, irrigated area in the watershed, output price policies, output based water charges, improving non-farm employment opportunities and high population pressure.

The model predicted that the increase in the yield of dryland crops can lead to increase in area under sorghum/pigeonpea and maize/pigeonpea intercropping systems and reduce the area under cotton, resulting in higher income for all the household groups. The increase in yield of dryland crops will have positive effect on conserving land, resulting in less soil erosion and the nutrient mining in the watershed.

This study can be useful to policy makers and other development professionals seeking to improve the welfare of farmers and natural resource base in SAT rain-fed region in India and other countries

Year 2005

Title	:	**A study of ICRISAT's Adarsha consortium model of watershed development as initiated at Kothapally, Andhra Pradesh, India. Its contribution to watershed development in India and its potential for scaling-up**
Name	:	**Stephen NB Waldron, BA (Hons) Barch ARB**
Institute	:	**International and Rural Development Department, The University of Reading, UK**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Period	:	**8 – 30 June 2005**

Abstract:

Watershed Development (WD) has since 1994 been the Government of India's principal agricultural development strategy in its effort to assist poor rural farmers. Complementary to 'The Green Revolution', it concentrates more on marginal rainfed lands, rather than irrigated, and works with an entire rural community rather than a set of fields. Its central focus is water. Amongst many models of watershed development, ICRISAT'S Adarsha consortium model (ACM) emerged from 1999–2001 with a unique feature of a team of backstopping scientists rather than a single agency. As with many other schemes, intertwined with its apparently straightforward 'water+soil' focus, was the creation of simple livelihoods, capacity-building, and institutional support. It has been relatively easy for WD to improve productivity in the short-term, but maintaining this has proved more elusive.

To sustain new livelihoods and community institutions has been a challenge once again. Beyond these, over time, have emerged a whole set of less 'scientific' challenges such as accessing 'fair' markets for farmers' improved crops. The ACM has also sought to tackle these. The fact that it has been invited to scale-up its model across India and into China, Thailand, Vietnam and the Philippines suggests that major funding organizations see the ACM as an exemplar. This work analyses the history and philosophy of WD, focusing on the ACM, viewed both from within and without. Time was spent in India, interviewing ACM team members and visiting ACM watersheds in Andhra Pradesh, Rajasthan and Karnataka. The field trips enabled direct discussion with senior politicians through farmers in these states. The study examines how the ACM has fared, and how it is viewed. It lists the challenges that ICRISAT now faces and concludes with a raft of measures for improved performance. Above all it finds that there is a need for a clear strategy as to the extent the ACM will diversify away from its core strengths, and in doing this whether it will bring in specialist partners or continue to try to develop these skills in-house. It sees dangers in the latter course of action.

Title	:	**Impact of integrated watershed management on water availability and uses: A case study of Kothapally, Andhra Pradesh, India**
Name	:	**Kyota Lizuka**
Institute	:	**International Agriculture and Rural Development at Cornell University, Cornell, USA**
Supervisors	:	**Prabhakar Pathak and Suhas P Wani, Principal Scientists**
Period	:	**4 July – October 2005**

Abstract:

Increasing population pressure mostly taking into consideration the developing countries, imposes an enormous drain on our ecosystem today, especially the fresh water resource, which is one of the most important natural resources on this planet. Water scarcity prevailing in arid developing areas is a huge obstacle for increasing agricultural productivity to feed this growing population and to suppress chronic malnutrition in the areas. However, the major measures that have been taken to cope with the situation before construction of large-scale water harvesting structures to secure water availability have caused a significant impact on the ecosystem. It has decreased productivity and greatly influenced large amounts of water to flow into downstream areas. Efficient utilization of water resources to recharge aquifer without further environmental degradation would improve the livelihood of poor rural households in the drought-prone regions. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and its partners evaluated a new science-based farmer participatory integrated watershed management program in a model watershed in the semi-arid tropics of India.

The integrated watershed management implemented by ICRISAT and the partners at Kothapally village has turned out to be a success story. The program has improved and optimized utilization of rainfall water with minimized environmental degradation and secured water availability for domestic and agricultural use. The villagers have successfully risen from a miserable penurious situation by taking advantage of water resource betterment programs. One aspect that draws a clear distinction between this project and other community development measures is the accomplishment that raised the standard of living of the lower strata of society. Usually, relatively wealthy people derive maximum advantage from such type of assistance and the poorer sections are not aware of the benefits. However, though there is still a huge gap between rich farmers (large land owners) and the poor (marginal land owners) in terms of income in the Kothapally village, the benefits that have been brought about from the program to the poor are proportionate to that of the rich farmers or more. The livelihood amelioration on the whole that took place in Kothapally is not only due to physical or structural advancement in the village, but also due to the efforts of the persons involved and the participation of the locals.

Title	**:**	**Sujala watershed project: Analyze diagnostic and prospects regarding the institutional mechanisms**
Name	**:**	**Paul Arsac**
Period	**:**	**23 June – 31 August 2005**
Institute	**:**	**Institute of National Agronomique Paris-Grignon**
Supervisor	**:**	**Suhas P Wani, Principal Scientist**

Abstract:

Watershed management is well-recognized and accepted approach for sustainable development of dry and wetlands. The overall objective of this study is to enhance the impact of watershed programs on a sustainable basis. The specific objectives are to study in detail the existing institutions and their functioning in Sujala watershed and to study their functioning and their assessment by the stakeholders and possible ways to enhance the impact of Sujala project further. The study was undertaken at micro and macro levels, ie, at community, civil society district level and at state level. The existing institutions and their functioning in respect to the expected roles/function, their feedbacks and their suggestions were to impact their functioning based our interactions with the stakeholders one level below and one level above the particular institution.

Links between different levels of institutions are personal and structural. The current operation of the institutions and the institutional mechanisms installed to manage the project has been successful. The execution of the project does not seem to suffer from gaps as for the organization of the institutions that frame it. However, if the system set up around the project seems on ground, the future of the mechanisms of management and valorization of the territory by the communities remains rather dubious and vague. Actually, the current functioning of self-help-groups does not allow them to do "heavy" investment in order to become more autonomous compared to agencies, which gives them money currently. Otherwise, it appears that a better interaction based on a better communication in particular between Lead Non-Governmental Organization (LNGO) and Field Non-Governmental Organization (FNGO) could improve the effectiveness of the undertaken action. It seems that the sustainability of community-based organizations (CBOs) depends on their aptitude to generate money and to manage it in a sustainable manner.

Title	**:**	**Estimation of carbon sequestered in *Pongamia pinnata* and *Eucalyptus* spp.**
Name	**:**	**Arun G Nair**
Institute	**:**	**Forest Research Institute, Deemed University, Dehradun, UP, India**
Supervisor	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**1 February – 30 June 2005**

Abstract:

In an era in which, increasing temperature and changing climate is becoming one of the major concerns of humanity, methods and means which can help in reducing or slowing down the rate of an increase temperature or change in climate carries immense importance. One of the major means of reducing this effect is to identify and carry out means to sequester carbon. The present study was one such attempt to find out the amount of carbon or carbon dioxide sequestered by two main tropical species, which is being planted in a large scale in India, ie, *Pongamia pinnata* and *Eucalyptus* spp. The study was carried out in the Adilabad district, Andhra Pradesh in India. Through this study an attempt was made to identify the actual amount of carbon sequestered across different age groups in these species, which was estimated at about 1.79 kg in 3rd year *Pongamia* tree to 331 kg in 15th year old tree. Similarly, in the case of *Eucalyptus* spp. the carbon sequestered was estimated to be about 9.5 kg at 5th year to 94 kg in its 19th year. Also the study tried to estimate the density values of *Pongamia pinnata*, which was calculated at about 0.65 m^3/t. Thus this study attempted to open the gateway for earning the much valued carbon credits and provide the rural poor a better way to enhance their income by planting and protecting these species.

Title	**:**	**Training on integrated watershed management**
Name	**:**	**Ali Heshmatpoor**
Institute	**:**	**Gorgan University of Agricultural Sciences and Natural Resources, Iran**
Supervisors	**:**	**Suhas P Wani and Prabhakar Pathak, Principal Scientists**
Period	**:**	**4 January – 4 February 2005**

Abstract:

The researcher was working as faculty in Watershed Management Department at Gorgan University of Agricultural Sciences and Natural Resources, Iran. He was interested in learning and developing latest technologies in the field of watershed management. Learnt many topics such as topographic survey, watershed planning, basic on contour map, runoff and soil loss measurement methods, rain water harvesting structures, improved land and water management systems, agroclimatic data collection and analysis, integrated nutrient management, crops and about the cropping systems which were covered at ICRISAT. Visited Adarsha watershed Kothapally and CR Analytical laboratory at ICRISAT. His training program covered field practice and lectures. According to him, it was useful and a great learning as most of the IWM techniques learned were appropriate to Iran situation and to teach undergraduate students at Gorgan University, Iran.

Title	:	**Remote sensing and GIS for assessing the impact of integrated watershed management**
Name	:	**Leya Sathyan**
Institute	:	**Centre For Environment, Institute of Science and Technology, Jawaharlal Nehru Technological University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**5 January 2004 – 25 June 2005**

Abstract:

The ever-growing population and the resultant demand led to over exploitation of the finite natural resources in most parts of India in general and in Madhya Pradesh and Rajasthan in particular. The Indian economy is largely a rural one, hence the development of rural areas depends upon the optimum management of natural resources particularly the water resources. A drainage basin or water shed can be considered as a preferable unit for initiating water conservation and management practices. Watershed management is an integration of technology within the natural boundaries of a drainage basin for land, hydrological, biotic and vegetative resources development to fulfill the population needs on sustainable basis. In the present work an attempt is made to create resource information system and to make an impact assessment study of watershed activities in selected watersheds spread in two states of India using the satellite data interpretation technique and GIS tools.

In the study area ICRISAT with Bharatiya Agro Industries Foundation (BAIF) initiated watershed treatment activities in the year 1998, consisting of structures – earthen check dam, permanent check dam, farm ponds and stop dams. This work created a database both spatial and non-spatial with the help of Survey of India (SOI) topo sheets and Indian remote sensing satellite imageries for the period 2004. The data base consisted of drainage map (representing all the streams up to 4th order, landuse/ land cover map, etc. All the thematic layers are integrated with socioeconomic attribute information detailing the socioeconomic status of the area. To evaluate the impact of the structures constructed, the Remote Sensing Technology (ERDAS Software 8.7) and GIS tools (Arc-Info 8.0) were used to create the Normalized Differential Vegetative Index (NDVI) to understand the change in terms of vegetative indices. Satellite imageries of 1997 prior to the commencement of watershed treatment activities and images of 2004 (that is after five years of initiation of watershed treatment), are interpreted adopting digital image processing concept to generate the NDVI. The positive and negative impacts can be clearly established with this approach. In terms of socioeconomic status also the impact created is examined considering the parameter, basic amenities, literacy rate, migration of labor, per capita income etc., for the same periods.

A cursory examination of the water level data along with change in number of wells demonstrates that in spite of significant increase in the number of open wells, tube wells and hand pumps from 1997–2004, there was a remarkable increase in the groundwater table level though there was no considerable change in the average annual rainfall. The NDVI study also reveals that there was a significant drift towards the positive value conveying an increased greenness index. The yield impacts of certain identified crops like jowar, maize and *bajra* express an average increase from five to ten quintals per hectare

The impact assessment indicators developed in this study will serve as a model to be replicated elsewhere under similar environments.

Title	:	**Planning of water resources in an agricultural watershed at Devanakonda, Kurnool District, Andhra Pradesh**
Name	:	**K Rama Satyanarayana**
Institute	:	**Centre For Water Resources, Institute of Science and Technology, Jawaharlal Nehru Technological University, AP, India**
Supervisor	:	**Prabhakar Pathak, Principal Scientist**
Period	:	**10 October 2004 – 31 August 2005**

Abstract:

Low and erratic rainfall, frequent droughts, low productivity, high risk and uncertainty, low level of technological changes and degraded natural resources generally characterize the semi-arid tropics (SAT). These regions are home for sizable poverty–stricken and undernourished populations and the unemployed. They face harsh climatic conditions and the majority (about 75%) of the population depend on agriculture. To combat the problems faced by such harsh areas, watershed programs are recognized as the ideal approach for integrated natural resources management in rainfed areas. About 51% of India's geographical area (329 million ha) is degraded, most of which occurs in rainfed agroecosystems.

Due to frequent droughts in Andhra Pradesh, the Government of Andhra Pradesh launched different programs, for example, Andhra Pradesh Rural Livelihood Programme (APRLP) and Drought Prone Area Programme (DPAP) as an integrated area development program. During 2002, watershed development activities were initiated under APRLP project involving Government of Andhra Pradesh and ICRISAT, Hyderabad.

A scientifically sound watershed planning requires the analysis of the present status (or) condition of its natural resources such as soils, topography, climate, drainage, land use pattern and water resources and the extent of land degradation, which improves the effectiveness of watershed development program. But unfortunately in most of the watersheds, the important information required for planning such as hydrological and soil related data area is not available. In such cases, due to difficulty in actual measurement by installing runoff and soil loss measuring equipment, calibrated simulation models play a vital role in getting hydrological data, which provides basic information for planning and development of a watershed.

Title	:	**Assessment of runoff water harvesting potential in an agricultural watershed at Devanakonda, Kurnool District, Andhra Pradesh**
Name	:	**B Satyanarayana**
Institute	:	**Center For Water Resources, Institute of Science and Technology, Jawaharlal Nehru Technological University, AP, India**
Supervisor	:	**Prabhakar Pathak, Principal Scientist**
Period	:	**10 October 2004 – 31 August 2005**

Abstract:

Rainfall is the only source of water in the semi-arid tropics (SAT). The rainfall data, evaporation, humidity and soil properties are easily available but hydrological data is not available for every area. This necessitated the use of runoff simulation models for hydrological analysis in a watershed. In the present study Soil Conservation Services (SCS) curve number runoff simulation model is used to assess the harvesting potential of a watershed. The model is developed at ICRISAT, Hyderabad. The runoff simulation is helpful for planning a watershed, improve crop productivity and for proper planning of crops.

The present study mainly concentrates on assessment of runoff water harvesting potential of Devanakonda watershed of Kurnool district, Andhra Pradesh, India. This watershed is spread over 564 ha at latitude 15°30´N to longitude 77°15´ E. To assess the runoff water harvesting potential, past hydrological data of runoff of the watershed is not available. Only daily rainfall data is available for the past 19 years. Along with the help of this, assessing the runoff water harvesting potential of watershed, the SCS curve number runoff model is applied for the past 19 years of daily rainfall data. This model was developed at ICRISAT, Hyderabad, for small and medium watersheds.

Soil samples are collected from the watershed to find soil parameters. To use the SCS curve number runoff model, rainfall data, pan-evaporation and soil parameters are taken as inputs. Calibration is done for last two years of seasonal actual runoff data (available) and seasonal predicted runoff. The regression coefficient (R^2) value of the runoff data is obtained as 0.8636 for polynomial correlation. The 'SCS curve number runoff model' is applied for 19 years (1986–2004) of daily rainfall data to predict runoff. With the help of predicted runoff data, the harvesting runoff potential is assessed. Using statistical analysis, the probability of run off is also assessed.

Mean annual rainfall of Devanakonda watershed is 617.54 mm. From the present study, the mean annual runoff is found to be 59.47 mm for predicted runoff data (1986–2004). Runoff harvesting potential of watershed is 335410 m^3. The probability of occurrence of 59.47 mm of mean annual runoff is 47.37%. From the statistical analysis it is established that the maximum runoff is likely to occur between last week of May and October second week.

Title	:	**The present situation and current transfiguration of farming system of indigenous people in Andhra Pradesh: A case study in Koya villages**
Name	:	**Tsunashima Hiroyuki**
Institute	:	**Graduate School of Asian and African Area Studies Kyoto University, Japan**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**September 2004 – May 2005**

Abstract:

Most of the ethnic minorities in India have been making their livelihood by agriculture. Studies on the Koya community's unique culture or poverty refer to aspects of their agriculture too. An agroeconomical study about Koya in Warangal district precisely describes their problems of cultivation. The study village, Chalampalem belongs to Bhadrachalam *mandal*, Khammam district, Andhra Pradesh. The village consists of three hamlets named Erragattu, Chalampalem and Bandarigudem. The first and the second fieldwork were conducted from December 2002 to August 2003 and from September 2004 to April 2005, respectively.

These fieldworks consisted of various components: Observation of farm works, casual interviews with the villagers, soil profile observations, land exploration and household survey. Based on the all-household survey, there were 188 households or 856 people totally in the study village, of which 183 households or 838 people were Koyas. However, most of them were small-scale landholders, 30% had no cultivated land area or were sharing lands with relative households, and another 60% were marginal or small-scale farmers, whose cultivated land area was less than 2 ha. Lands were leased out rather than leased in and considerable amount of cultivable lands were leased out to outsiders.

The main cropping patterns adopted in the study site were paddy rice, sorghum + green gram, chilli, red gram and red gram+upland rice. Cotton, black gram, pearl millet and little millet were also cultivated. Chilli and cotton were the main commercial crops and harvests of those were entirely sold. Rice and millets were domestically consumed. Economical land productivity of chilli is overwhelmingly higher than those of other crops, considering its selling price and yield. Grouping all the crops into 4 categories (ie, staple, leguminous, oil and commercial), combination of crops in each household farming were summed up according to their operational land size. Most households combined staple and leguminous. Only some of the small-scale farmers concentrate on crops of one single category. As for chilli cultivation, larger the operational land size, the proportion of farmers who cultivate chilli is also larger. However, the larger farmers assigned less proportion of their lands for chilli cultivation.

Title	:	**Groundwater prospecting using remote sensing and GIS in agricultural watersheds in Madhya Pradesh and eastern Rajasthan, India**
Name	:	**B Shruthi**
Institute	:	**Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Period	:	**5 January 2004 – 28 June 2005**

Abstract:

Groundwater not only supplements canal irrigation but also serves as a source of drinking water and is used for other domestic usages. Since the groundwater occurrence is controlled by lithology, geo-morphology, structures, soils, land use/land cover, recharge condition and rainfall, its development calls for a multi disciplinary and holistic approach. Space borne multi-spectral measurements offer immense potential in deriving information on lithology, geo-morphology, structures, soils and land use/land cover. Geographic information system (GIS) provides an ideal platform for integrating information on above mentioned features with a rainfall on recharge condition and to arrive at the groundwater potential zones. In the study reported here, an assessment of groundwater resources of parts of Bundi watershed, Bundi District, eastern Rajasthan, Guna and Milli watershed, Guna and Lalatora District, Madhya Pradesh was made using Indian Remote Sensing Satellite (IRS-P6), Linear Imaging Self-Scanning Sensor (LISS-IV) data and ancillary information like published geological maps from Geological Survey of India (GSI), topographic maps from Survey of India and other legacy data. Initially, information on lithology, geomorphological, structures, soils and land use/land cover was derived through monoscopics visual interpretation approach. Subsequently such information was integrated with the slope, drainage and recharge conditions in a GIS environment to delineate (i) groundwater potential zone and (ii) suitable site for groundwater recharge.

Bundi watershed was categorized into four land forms/geomorphic units. Valley fill, pediplain moderate, pediplain shallow, pediment inselberg complex, pediplain with moderate weathering, pediplain with shallow weathering and valley were most prominent units in Bundi watershed. Groundwater occured in these geomorphic units under confined and semi-confined conditions from the weathered and fractured/jointed rocks. Rainfall is the principal source of recharge in the study area. The drainage was sparse in the watershed and represents dendritic pattern. The land use land cover analysis indicated that more than 50% was wasteland. Soil and water conservations measures, optimal land use patterns were suggested for the overall sustainable economic development of the watershed. Desilting of tank and check dams was recommended based on the slope, land use/land cover and hydrogeomorphological criteria, to obstruct the surface water flows and thereby increasing its influence over the command area and the groundwater levels.

Guna watershed was categorized into 5 land forms/geomorphic units. Plateau moderately weathered, plateau slightly dissected and Mesa were the most prominent units in the Guna watershed. Groundwater occured in these geomorphic units. Recharge conditions were moderate and of low priority, percolation tanks/check dams and dry wells were recommended.

Milli watershed was categorized into Valley and Pediplain with moderate weathering. Valley was the most prominent unit in this watershed. Groundwater prospects were good to very good; recharge structures like check dam and percolation tanks were of high priority.

Title	**:**	**Estimation of runoff from small agricultural watersheds using remote sensing and GIS (Geographical Information Systems)**
Name	**:**	**BH Sandhya Rani**
Institute	**:**	**Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**5 January 2004 – 27 June 2005**

Abstract:

In this study Remote Sensing technology (ERDAS Software 8.7) and GIS tools (Arc-Info 8.0) are used to estimate the runoff. The base maps, slope maps, drainage maps were prepared from Survey of India (SOI). Toposheets, land use/land cover maps which are an important input for Soil Conservation Service model (SCS) were prepared from IRS P6-LISS IV satellite images. GIS, which has been designed to restore, manipulate, retrieve and display spatial and non-spatial data, is an important tool in analysis of parameters such as land use/land cover, soils, topographical and hydrological conditions. The Digital Elevation Model (DEM) was generated in this study with the topographic information and 20 m interval contours have been used.

The type of soil present in Lalatora (Milli) and Guna watersheds Vertisols and Bundi watershed consist of silt clay/sandy clay. With the help of SCS model, in conjunction with Remote Sensing and GIS it is possible to make management plans for usage and development of a watershed.

Runoff and consequent soil erosion are inevitable under a tropical monsoon. These need quantification for the design and adaptation of control measures, which can be done by monitoring the soil and runoff losses on watershed basis. Watershed is an area that drains to a common point. It may be managed for various objectives, depending on local needs, including capturing runoff, minimizing erosion and reducing non point source pollution.

In the present study the runoff is modeled using SCS Curve Number, which is best estimated for agricultural watersheds. This study area revealed that predicted runoff values are under-estimated compared to the observed values in the three watersheds (Bundi, Guna and Lalatora) for normal green cover. The predicted runoff values are from smaller area, ranges from 20 to 500 ha. The measured runoff value is for a larger area (9000 ha). Remote Sensing and GIS are used to spatially visualize the runoff estimates over the whole watershed. Using conventional methods, it becomes highly difficult to collect the data from remote and inaccessible places. Remote sensing and GIS provides an alternative. Black soils are more prone to runoff compared to red soils – hence effort should be made to take up short duration cover crops so as to minimize the raindrop impact or runoff in the *kharif* season.

Title	:	**Modification of microcontroller unit of automatic pumping type sediment sampler**
Name	:	**Jayashree Kulkarni**
Institute	:	**Vardhaman College of Engineering, Jawaharlal Nehru Technological University, AP, India**
Supervisors	:	**Prabhakar Pathak, Principal Scientist**
Period	:	**9 January – 9 February 2005**

Abstract:

Soil erosion is one of the major problems confronting agriculture worldwide. The measurement of soil erosion is one of the important components of studies aimed for effective management practices for controlling soil erosion. Therefore, a sediment sampler is made available for monitoring sediment loss from watershed/plot depending upon the specific needs of the location.

The sediment sampler was devised to take the samples at a fixed sampling interval for estimating the soil loss. Farmers were facing a lot of difficulty in choosing the control unit of time span for switching on and off the motor and pump. They were not aware about which one to choose among different time spans, ie, 7s, 10s, 13s and 15s, which were provided in the same control unit in the project. The researcher provided a toddle switch to select the appropriate pumping duration depending on section head of drain/*nala*. This facilitates the user to have a control unit which suits a location where the sample suction head varies 1–2 m depth and allows user to collect sufficient quantity of runoff water sample for sediment analysis.

Title	:	**Practices in soil microbiology**
Name	:	**R S Anand**
Institute	:	**Bharatiya Vidya Bhavan New Science College, Hyderabad, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**16 May – 15 June 2005**

Abstract:

Two varieties of soil samples (Vertisols and Alfisols) were collected from the fields of ICRISAT and were enumerated for microbial populations and colonies with different morphologies of bacterial and fungi to be studied further. *Rhizobium* from the root nodules of *Pongamia* was isolated and preserved. In the soil samples collected from fields of ICRISAT Vertisols recorded high counts of bacteria ($64*10^3$ cfu/g soil), fungi ($13*10^2$ cfu/g soil) and then Alfisols. Fungi isolated from the soil sample were identified as Alternaria, Penicillium, Aspergillus and Cladosporium. The bacteria (15 isolates) with different morphologies were isolated and were exposed to different staining techniques and IMViC test.

Five isolates out the 15 were reported to be Gram positive and the rest were negative. All the isolates were negative for capsule formations. Majority of the organisms were cocci and few were bacilli. Almost all the isolates were negative for IMViC test except one or two isolates. The *Rhizobium* from the root nodules of *Pongamia* plant was also isolated and was preserved in 20% glycerol solution at –18° C temperatures. If further studied this has scope to be used as a biofertilizer from the nodule formation of *Pongamia* plant through which the yield can be increased.

Title	**:**	**Microbiological studies on soil samples from rice fields using SRI method of cultivation**
Name	**:**	**M Kranthi**
Institute	**:**	**Centre For Environment Institute of Science and Technology Jawaharlal Nehru Technological University, AP, India**
Supervisors	**:**	**OP Rupela, Principal Scientist**
Period	**:**	**February 2005 – September 2005**

Abstract:

SRI (system of rice intensification) is an innovative method of rice cultivation developed in 1980s in Madagascar by Father Henri de Laulanie. It is different from the normal method of cultivation of rice mainly in three ways. This system includes transplantation of young seedlings (8–10 days), wider spacing between plants (25 × 25 cm) and in non-flooded conditions. The study was done to understand the soil microbiological and biological parameters and examine if these were associated with the high yields of rice generally reported with this method.

Soil samples were collected from three districts of Andhra Pradesh (West Godavari, Medak and Anantapur), India during postrainy season 2004, in SRI and conventional rice plots of 21 farmers' fields at vegetative and harvesting stages of rice using appropriate sampling methods. All the soil samples were processed for six microbiological (total bacteria, total fungi, plant growth promoters, Pseudomonas fluorescence, P-solubilizers) and three biological (biomass carbon (MBC), biomass nitrogen (MBN), dehydrogenase activity) parameters.

It was apparent that the mean data values of all the six microbiological parameters were similar in SRI and control plots except for the population of plant growth promoting bacteria which was significantly higher for SRI than in control plots at harvesting stage. This was the major difference observed between SRI and control plots for the microbiological studies.

Soil biological properties were significantly higher for SRI plots than that of relevant control plots. On mean basis, dehydrogenase activity was higher in SRI by 14% at vegetative and 7% at harvesting stage when compared to that of control plots. Microbial biomass carbon was significantly more by 7% at vegetative and 11% at harvesting stage than that of control plots. Microbial biomass nitrogen was significantly higher by 25% at vegetative stage than that of control plots. Since the study has been carried out for only one season, further studies are needed to substantiate the present findings.

Title	:	**Efficacy of microorganisms and botanicals for managing *Helicoverpa armigera***
Name	:	**J Rama**
Institute	:	**Dept. of Biotechnology, Bharathidhasam University, TN, India**
Supervisor	:	**OP Rupela, Principal Scientist**
Period	:	**January 2005 – October 2005**

Abstract:

A best-bet protocol of crop protection was one of the factors under evaluation in an ongoing (since June 1999) long-term field experiment at ICRISAT. Bacterial (*Bacillus subtilis* BCB 19) and fungal (*Metarhizium anisopliae*) strains were the two important components of the protocol along with two botanicals (*Neem* and *Gliricidia*) and traditional knowledge products. The protocol was evaluated on-farm to protect vegetables (tomato, bitter-gourd and ridge-gourd) from insect-pests. Nine farmers of Adarsha watershed, village Kothapally, Ranga Reddy district, Andhra Pradesh agreed to participate in the evaluation. Each farmer had two treatment plots, one using biopesticides (= 'Bio', involving the protocol) and the other using chemical pesticides (= 'Chem', decided by farmers). The experiment was conducted during January 2005 to June 2005 and cost of products provided by the ICRISAT project was charged on a no-profit no-loss basis.

Area for the treatment plots was decided by farmers. It ranged from 308 to 2450 m^2 in the case of 'Bio' and 316 to 1850 m^2 in 'Chem'. The 'Bio' plots received a total of ten (a mean of nine farmers) sprays inclusive of products (example - wash of compost of *Neem* and/or *Gliricidia*), which were noted to have plant growth promoting bacteria and Chem plots received four sprays. Mean (tomato, bitter-gourd and ridge-gourd) yield of the nine farmers (treated as replication) was 37% more in the 'Bio' than that of the 'Chem' (0.84 t ha^{-1}) plots. The mean expenditure of the nine farmers for protecting the crops in 'Chem' plots was Rs 1054/- per ha (range Rs 949/- to 1186/-) and that of 'Bio' plots was Rs 833/- per ha for the whole season.

Sixteen products representing 14 botanicals were evaluated for efficacy to kill neonates of *Helicoverpa armigera*, in three different batches. Commercially available oil of *neem* seeds (*Azadirachta indica*) was used as reference. Washed and boiled water-extract of seven botanicals (*Annona*, *Calotropis*, Chilli, Chrysanthemum, *Parthenium*, *Pongamia* and *Prosopis*) killed the neonates at levels close to or better than *neem* oil (3% suspended in water). Storability of the wash of compost and hot water-extract of 29 products involving 25 botanicals in clear bottles of glass was measured by turbidity of the liquid and was indicated by growth of microorganisms and/or growth of fungi on surface of the liquid in bottles. Wash of all the 29 products remained clear for whole duration of the study (90 days) without any growth on their surface while only 19 were clear when prepared as hot-water extracts. B. subtilis (BCB 19) survived well for eight days in all the three botanicals (*Nerium*, *Pongamia* and *Dhatura*) that were studied, when mixed with their compost-wash hot-water extract. But *M. anisopliae* survived well for eight days only in the compost-wash of the three botanicals. This compatibility between microorganisms and botanicals has implications on reducing the total number of sprays on a crop and/or enhancing their efficacy. Also, freshly collected wash of four of the five botanicals (Calotropis, Chilli, *Nerium*, *Parthenium*, *Prosopis*) that were studied had 2.5 to 3.8 $\log_{10}$ mL^{-1} siderophore producing bacteria, indicated their ability to promote plant growth. Such bacteria were absent in the hot water extracts of these botanicals.

Even though the studies are preliminary, effective protection of crops by using eco-friendly materials at low-cost was achieved. Further studies are recommended.

Title	**:**	**Biological analysis of *Pongamia* and *Jatropha* cake conventional compost and vermicompost**
Name	**:**	**P Jyothsna**
Institute	**:**	**Chaitanya PG College for Women, Vishakapatnam, Andhra University, AP, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**April – November 2005**

Abstract:

The hike in fuel consumption, increasing air pollution, environmental degradation demands a multidisciplinary research approach in different countries of the world today. The measures taken to promote the use of biofuel or any other renewable fuels to replace diesel or petrol for transport purpose can to some extent achieve sustainability and bring down public health problems.

In ICRISAT, study is in progress with the plants (*Jatropha* and *Pongamia*) and their extraction for preparation of biofuels. Research is also in progress for the utilization of the waste materials obtained after the biodiesel extraction from the seeds. The present study deals in utilizing and standardizing the deoiled cakes of *Pongamia* and *Jatropha* using conventional composting and vermicomposting methods. Different cement bins were filled with *Pongamia* (1 to 4 bins) and *Jatropha* (5 to 8 bins) deoiled cake along with different concentration of rock phosphate, dung slurry and earthworms (for vermicompost), which resulted in different treatments. The composting as well as vermicomposting methods were in progress for 3 months from May to August for *Jatropha* deoiled cake and from April to July for *Pongamia* deoiled cake. The samples for the analysis of biological (soil respiration, biomass C) as well as microbiological (enumeration of bacteria, fungi and actinomycetes) parameters were collected at monthly intervals along with the control sample.

Soil respiration was estimated according to the method of Anderson (1982) and biomass C was estimated using chloroform fumigation and incubation method. The results obtained were in turn correlated to know the best treatment as well as the composting method. The results showed that vermicomposting method recorded high values of all the parameters than the conventional composting method. Biomass C as well as microbial populations were more in *Pongamia* cake vermicomposting than the *Jatropha* cake vermicomposting, which may be because of the alkaloid called jatrophin present in the *Jatropha* seeds which was proved to be a toxic chemical.

Title	**:**	**Medicinal and aromatic plants: Potential and efficient use of distillation methods**
Names	**:**	**Prakash Nijalingappa Mylar and Amit K Soni**
Institute	**:**	**Dept. of Chemical Engineering, Rural Engineering College, Bhalki, Visweswaraiah Technological University, Belgaum, Karnataka, India**
Supervisors	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**20 April – 10 June 2005**

Abstract:

Natural essential oils extracted from the Medicinal and Aromatic Plants (MAPs) are extensively used in fragrance, flavor, aromatherapy and pharmaceutical industries and are widely grown in semi-arid tropics. The main constituents of the oils extracted from these plants are 75–80% citral, 10% neral, up to 25% myrcene and few carbonyl compounds (aldehydes & ketones), alcohols and esters. Some of the Mass Transfer Operations are used to extract the oil like Distillation, Extraction and Fractional Distillation and the main oil removed is only 80%.

In the present work, Steam Distillation is used for the extraction of oil from lemongrass C*ymbopogon citratus*, which is a medicinal and aromatic plant. The cost and time required for the extraction of oil is less when compared to other processes. Steam distillation of lemongrass, in a commercial way, is done by using the 450 kg of lemongrass leaves and the pressure and temperature were respectively 2 Psi and between 95° C to 100° C. The recovery of primary oil is up to 3l with consumption of 2–3 hrs of time. By steam distillation 92% of oil is extracted. The major byproducts from this distillation are deoiled grass and condensate or distillation water. In condensate water nearly 8% of oil is mixed and this is removed by Hexane method (Method 1664). The solvent recovery is 4 to 7% and analysis and comparison of the primary and secondary oil is then done. De oiled grass is used in preparing vermicompost.

The use of steam distillation will increase the recovery of oil up to 92% and is cost effective. The obtained oil using steam distillation consists of all the essential chemicals. The citral percentage is about 90% and 10% neral. The sample of vermicompost was analyzed for N, P, and K compositions. The difference between compost and vermicompost is being demonstrated to the farmers. Research has been initiated on water analysis to detect any harmful chemicals that affect plant growth.

Year 2004

Title	:	**Low cost materials for managing insect-pests in farmer's fields: A case study on cotton**
Name	:	**Jagarlapudi Sri Sasi Jyothsna**
Institute	:	**Environmental Biotechnology, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisor	:	**OP Rupela, Principal Scientist**
Period	:	**21 July 2003 – 31 May 2004**

Abstract:

Crop production and protection strategies developed during the Green Revolution depended mainly on chemicals like fertilizers, fungicides, pesticides and herbicides. During the subsequent years problems of insect-pests, diseases and weeds emerged in different forms. Alternative pest management strategies, using microorganisms and plant products, have long been proposed. Using these alternatives, organic farmers (the farmers dependent on non-chemical means of crop production and crop protection) have been reported to protect their crops efficiently and even harvest good yields. Researchers at ICRISAT, Patancheru, identified several microorganisms, plant products and items of traditional knowledge of farmers to manage insect-pests.

A protocol of crop protection using six different items was assembled and evaluated at research station for three years. At least four (cow urine, wash of neem (*Azadirachta indica*) foliage, wash of Gliricidia foliage and curd-based recipe) of the six items of protocol, can be prepared at village level while the other two (microorganisms as biopesticides and biofertilizers (bacillus strain BCB 19, and *Metarrhizium anisopliae*) have to be prepared by a biopesticides industry. In 2003–04, this protocol was evaluated in the village Kothapally, Ranga Reddy district, Andhra Pradesh, India. The focus of the study was to evaluate: whether chemical pesticides could be replaced by low cost, non-chemical means for effectively protecting crops.

All the families in the village (Kothapally) were informed of ICRISAT's experience of protecting crops by non-chemical means at research station through two different meetings in the village. Twenty farmers registered their names to evaluate the crop protection protocol and agreed to put one-acre under the experiment having two treatments on about 2000 m^2 (=1/2 acre each). Chemical pesticides were used as 'control' treatment, normally used by the farmers and was called 'CHEM' in the first treatment. Biopesticides (provided by ICRISAT) were used in the other treatment and was called 'BIO'.

CHEM plots received nitrogen and phosphorus (as DAP, 36 kg N and 92 kg P ha^{-1} by different farmers) while the BIO plots received 5.9 kg P ha^{-1} (as SSP). Both the plots of all farmers received boron (as borax powder 4.9 kg ha^{-1}). A bacterial strain CDB 35 *(Pseudomonas* spp.*)* having properties to promote plant growth and solubilize the insoluble phosphorus in soil was applied as sand coated inoculum, at 12 to 15 days after sowing. Pigeonpea cultivar ICPL 88039 was sown (only in the BIO

plots) as trap crop after every eight rows of cotton. Pigeonpea seeds were placed along with cotton because farmers did not wish to reduce the population of cotton plants. Despite no application of nitrogen to cotton in the BIO plots, the Spadmeter reading (a measure of photosynthetic activity that gets adversely affected by N deficiency) was similar in both the treatments (CHEM-29.3 and BIO-29.0). In most fields, growth of cotton was generally slow in the BIO plots.

Visual observations suggested that except in four fields (field no. 1. Balwanth Reddy 2. Mahipal Reddy 3. Manik Reddy and 4. Hanumanth Reddy) the growth of cotton was visibly less in the BIO plots at least up to 60 days after sowing (DAS). Flower count, bolls count and number of internodes per plant were measured at 90, 75 and 60 DAS respectively and were similar in both the treatments at 21 (19 in CHEM and 22 in BIO plots). Plants in the BIO plots in all the fields continued growing longer than in the CHEM plots and yielded one additional picking in most cases. On mean basis BIO plots yielded 30% more cotton than the CHEM plots that received chemical pesticides (1.87 t ha^{-1}) which was statistically significant at 5% probability level (LSD=0.238). Eleven of the 17 farmers harvested significantly more cotton in the BIO plots than that in the relevant CHEM plots. In addition, all the participant farmers saved at least Rs 5000/- ha^{-} (1US$ =Rs 45/- approximately) in the BIO plots, even if cost of the material was charged. This was because, on an average, 17 farmers spent Rs 14250/- ha^{-1} (range Rs 8500 to Rs 19850 ha^{-1} includes the cost of chemical fertilizers) on the CHEM plots.

A questionnaire was prepared to study the present status of using synthetic pesticides and fertilizers (especially for cotton), socioeconomic status, awareness regarding biopesticides and potential health implications of synthetic pesticides used by the partner farmers. Average holding of the partner farmers was 2.5 ha. Most (95%) knew about major pests of crops (particularly of cotton) but not of agriculturally beneficial predators and parasites of insect pests. The choice of chemical pesticides used was generally decided on the advice of pesticide dealers (in 50% cases) and peers plus dealers (in 67% cases) and the decision to spray did not follow any threshold levels for insects. Pesticides were invariably purchased on credit and were used on all crops by all farmers. Application of NPV (nuclear polyhedrosis virus) in the past was tried by 5.5% and handpicking of leaves as a pest-management practice was practiced by 5.5% as the other potential non-chemical means of protecting crops. Skin rashes and eye irritations were the most observed effects after using chemical pesticides. No protective clothing/gears were used while spraying chemicals by any of the farmers. No noticeable adverse effect of biopesticides was reported at the end of experiment in March 2004.

Most of the farmers (72%) were completely satisfied with the BIO method while 17% wished to try once more before they were convinced of the method, and 11% were not convinced at all. The study also included laboratory and glasshouse experiments to learn the larvicidal, ovicidal and plant growth promotion properties of some herbal extracts, besides those supplied to the participant farmers. Six herbs (each as compost wash and as hot-water extract) were included in the study. Wash of *neem* compost only marginally improved total plant weight of millet cultivar (ICMV 155) used as a test crop in a glasshouse experiment. The need for some more studies on this subject is suggested.

Title	:	**Approaches for increasing crop productivity in semi-arid tropics of India**
Name	:	**P Sundeep Tagore**
Institute	:	**Allahabad Agricultural Institute (Deemed University), Allahabad, Uttar Pradesh, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**1 June – 1 July 2004**

Abstract:

The semi-arid tropics (SAT) are generally characterized by highly variable and low rainfall, low productive soil and poor development infrastructure. Moreover the fragile ecosystem of the dry area is prone to degradation. Water and soil are important natural resources required for crop production. In order to enhance and sustain productivity in the soils of semi-arid tropics (medium to high levels of production), the integrated use of various components such as farmer evaluated improved crop management practices like use of INM, (Integrated nutrient management) IPM, (Integrated pest management) soil management, water management and watershed management together with various other factors are essential. The following are the strategies used by resource management group to improve land productivity of semi-arid tropics.

The broad-bed-and-furrow system of cultivation prepared by an animal-drawn ridger, mounted on a tool carrier (eg, Tropicultor or Agribar), or by tractor-drawn implements with ridgers is more suitable for Vertisols (deep black soils) since it optimizes water use, where furrows drain away excess water, yet allowing enough water to soak into the soil. Integrated Soil Fertility Management is an approach for sustainable and cost-effective strategy which attempts to make the best use of inherent soil nutrient stocks, locally available soil amendments and mineral fertilizers to increase land productivity while maintaining or enhancing soil resource base. Non Pesticidal Management (NPM) is a recent concept in pest management in which indigenous technical knowledge is fully utilized in a participatory mode. The importance of biological control and inputs has made bio-diversity an essential component in this approach. Crop diversification has also proved to be an attractive option for restoring soil fertility, increasing farm income and improving the nutrition of farm families in watersheds of semi-arid tropics.

Title	:	**A brief report on the hands-on training on Agricultural Production Systems sIMulator (APSIM)**
Names	:	**VS Bhatia, NRCS, Indore (MP); SK Krishnamurthy, Sr Scientist, ARS, Anantapur (AP); P Munirathnam, Sr Scientist, RARS, Nandyala (AP) and G Srinivas, Scientist, ARI, Acharya N G Ranga Agricultural University, Hyderabad**
Institute	:	**NARS, India**
Supervisor	:	**Suhas P Wani (Principal Scientist) and team**
Period	:	**19 – 23 January 2004**

Abstract:

Four scientists from different parts of the country came together and undertook a course on 'Hands–on Training' in the use of APSIM (System simulator) for cropping systems modeling from 19th to 23rd January 2004 at systems modeling/GT-Agroecosystems, ICRISAT, Patancheru. During this training, they were introduced to systems modeling and APSIM framework and taught the basics of handling the model through APSFRONT. Creation of new met files, soil, crop, and management input templates were taught and practical exercises were given. Along with the APSIM simulator, they were also trained in the use of different editors/viewers for APSIM. These editors/viewers were used for creation of APSIM input/management template files such as *.ini, *.par, *.man and *.con files. In a general way the working of the model, the inputs that go into the model and the outputs generated as summary files and in graphic forms were explained and discussed.

Besides the theoretical lectures on the above aspects, the scientists also spent quality time in handout practices on APSIM model. During this practical training they were able to modify the existing input files and derive desired output files as per the conditions at their respective locations. The above training would be useful in research efforts aimed at understanding the constraints to productivity potentials, to develop effective management strategies and forecasting the future scenario at their respective centers. The keen interest with which Mr V Nageswara Rao conducted the training was appreciated. The discussions they had with him were thought-provoking.

Title	:	**Vermicomposting: A boon to the farmers**
Name	:	**Punyakishore Maibam**
Institute	:	**Allahabad Agricultural Institute Deemed University, UP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**1 June 2004 – 30 July 2004**

Abstract:

Earthworms play a vital role in the process of nutrient recycling in soils. However the use of chemicals in modern agriculture drastically reduced the activities of earthworm in soils. The realization of ecologically sound sustainable farming practices in reversing the decline of global productivity brought back the earthworms (vermicomposting) to be an integral part of soil fertility management. Vermicomposting is the process wherein earthworms convert solid organic wastes into nutrient rich worm casts. The project is carried out at Adarsha watershed, where a self-help group (SHG) consisting of four members is undertaking vermiculture technology by acquiring training on vermicomposting from ICRISAT. SHG set up vermicomposting enterprise using farm wastes with an output of 400 kgs compost/month by availing loans from local *panchayat* and earn Rs 2000 and Rs 450/month through selling of vermicompost and worms respectively. This venture by SHGs earned the self-respect of society and also contributed to the family income. Vermicomposting technology help women to empower themselves through their earning and moreover, application of vermicompost enhances soil quality as a whole.

Title	:	**Methods of soil, plant and water analysis using ICP-AES Autoanalyser and Atomic Absorption Spectrophotometer**
Author	:	**Vishakha Panchbhai**
Institute	:	**College of Agriculture, Nagpur, Dr PDKV, Akola, Maharashtra, India**
Supervisors	:	**Suhas P Wani and KL Sahrawat**
Period	:	**21 July – 20 October 2004**

Abstract:

The training taken at ICRISAT was on soil, plant and water analysis using Inductively Coupled Plasma Argon Emission Spectrophotometer (ICP-AES), Autoanalyser and Atomic Absorption Spectrophotometer (AAS). ICP-AES is high quality multi-element simultaneous analyzer, where refractory elements like P, B, Zr and U can also be determined with an overall excellent limit of elements upto 0.1 to 10 ppb. The sample in ICP-AES is aspirated through a stream of argons towards nebulizer, where it is atomized and excited which are then detected through ICP spectroscopy. Autoanalyser is a continuous flow method of analysis where many analytical measurements can be made simultaneously. The consumption of chemical reagents in autoanalyser is reduced, when it is compared with manual analysis. The analytical results are accurate and provided in a single report. Atoms in particular element emit radiation of characteristic wavelength when they are excited and intensity of radiation is measured with and without the sample in terms of absorption, which is the underlying principle of AAS. The concentration of elements can be obtained by calibrating instrument against standards. AAS is highly specific for the particular element and there are no spectral interferences.

Title	:	**Enumeration of native chickpea rhizobial populations with reference to growing chickpea in rice-fallows**
Name	:	**Padma Parvathi**
Institute	:	**Centre For Environment, Institute of Science and Technology, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisors	:	**JVDK Kumar Rao**
Period	:	**July 2003 – May 2004**

Abstract:

Rice, the most extensively grown crop in South Asia, is cultivated on approximately 50 million ha. Despite growing demands for food production because of an increasing population in South Asia, there is little scope for expansion of cropping into new areas and therefore an increase in cropping intensity, along with rising of yields, needs to take place on existing agricultural lands. Rice fallows covering an area of 14.3 m ha, present considerable scope for crop intensification and diversification along with likely improvement in soil fertility for the succeeding cereal crop, by introducing second crop such as chickpea during postrainy (*rabi*) season if the appropriate technology is applied.

The present study has examined some aspects of growing chickpea in rice fallows, particularly the occurrence of native chickpea rhizobia vis-à-vis determine the need for seed inoculation with an effective *Rhizobium*; chemical properties of rice fallow soils and their correlation with chickpea rhizobia; effect of micronutrients, eg, molybdenum on chickpea growth and nodulation, and seed dressing fungicides on chickpea rhizobia.

The native chickpea rhizobial populations of selected rice fallow soils of different states of India and High Barind Tract of Bangladesh were estimated by using bacteriologically controlled plant infection technique. Soils were classified depending on rhizobial population g^{-1} dry soil as high (above 10,000), medium (100 to 10,000), low (below 100) and nil (no populations). In Chattisgarh, 70% of soils at 0–15 cm depth and 90% of soils at 16–30 cm depth showed the absence of native chickpea rhizobia, while 10% of soils had low populations at 0–15 cm depth. In Jharkhand, 37% of soils at 0–15 cm and 42% of soils at 16–30 cm depth had no native chickpea rhizobia, while 10.5% soils had low populations at 0–15 cm depth. In Madhya Pradesh, 34% of soils at 0– 15 cm depth and 28% of soils at 16–30 cm depth had no native chickpea rhizobia while 12.5% of soils had low populations at both depths. In Orissa, 46% of soils at 0–15 cm depth and 50% of soils at 16–30 cm depth did not have native chickpea rhizobia. In West Bengal, native rhizobial populations were completely absent. In Bangladesh, 26% of soils at 0–15 cm depth and 20% of soils at 16–30 cm depth showed the absence of native chickpea rhizobial populations while, 20% soils at 0–15 cm depth and 13.3% of soils at 16–30 cm depth had low populations.

These results suggest the need for *Rhizobium* inoculation of chickpea with effective chickpea rhizobia for obtaining good nodulation and nitrogen fixation, which in turn influence the final yields. Even in soils where the populations were high, seed inoculation with effective rhizobia is recommended as insurance for good nodulation. The MPN counts of chickpea rhizobia were correlated against various soil chemical parameters such as pH, E.C., Olsen-P, total-N, organic-C, B, Zn and Mo of the corresponding soil to know their interrelationships and no significant correlations were found. It is

assumed that factors such as soil pH; previous cropping history and clay content, etc, might have some influence on the native rhizobia.

As most of the rice fallow fields are acidic in nature, where the availability of Mo is limited, a pot experiment was conducted in glass house using two soils with a pH 4.9 and 5.0 to confirm the beneficial effect of Mo added through seed priming on chickpea. At pH 4.9, where usually the chickpea rhizobia were not capable of forming nodules, were able to form nodules successfully by the interaction with added molybdenum. But the formed nodules were not capable of fixing atmospheric nitrogen significantly. On the other hand, at pH 5.0 where the chickpea rhizobia formed relatively less number of nodules, showed an increase in number of nodules and a significant increase in acetylene reductase activity due to the interaction with the added molybdenum. In addition to this, a significant increase in the biomass yield, nodule weight and the ability to fix nitrogen at pH 5.0 indicated that the soil pH must be above 5.0 in order to obtain good nodulation and nitrogen fixation. The experiment also indicated that the optimum pH for growing chickpea must be above 5.0. The results were also supported by two laboratory experiments in which an increase in *Rhizobium* population in molybdenum added treatments was observed which may be attributed to their interaction with molybdenum. The ultimate aim is to combine seed priming, rhizobial inoculation along with Mo in a single operation, which can be easily adopted by the resource poor farmers.

The relative sensitivity of chickpea rhizobial strains IC 59 and IC 76 was evaluated against commonly used/recommended fungicides, namely thiram, benlate, bavistin, captan and dithane M45, for chickpea seed treatment. The ultimate aim of this study was to explore the possibility of combining seed priming, *Rhizobium* inoculation and seed treatment with fungicide all into one operation so that the farmers can safely adopt it. IC 59 strain was relatively more compatible with the fungicides tested than IC 76. Further, IC 59 exhibited good compatibility with the fungicide bavistin, very less sensitivity to Benlate. Mere compatibility based on growth alone cannot confirm the use of the strain (IC 59) at the time of seed priming. It is also necessary to test the effect of fungicides on nodulation and nitrogen fixation ability of chickpea inoculated with IC 59 before they can be effectively used during seed priming.

In conclusion, the present study has provided a better understanding of rice fallow soils in relation to the need for *Rhizobium* inoculation of chickpea, possible soil pH limits for growing chickpea, the beneficial effect of molybdenum on chickpea nodulation and growth and also the possibility of combining seed priming, *Rhizobium* inoculation and seed treatment with fungicides into one simple operation so that it can be adopted by the resource poor farmers.

Title	:	**Role of legumes in the semi-arid tropics of India**
Name	:	**Vaidurya Pratap Sahi**
Institute	:	**College of Agriculture, Allahabad Agricultural Institute (Deemed University), Allahabad, Uttar Pradesh, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**1 January – 1 June 2004**

Abstract:

Farming of pulses is an integral part of subsistence and sustainable production systems in the semi-arid regions of India as they are cheap and an excellent source of dietary proteins. They are also feed and fodder for animals besides their capability of restoring soil fertility through N fixation. However, there was a paradigm shift towards chemical fertilizer dependant - cereal based cropping systems during green revolution era in India to meet the demand of food grains resulting in an imbalanced production of pulses and cereals. The important consequences of shift in cropping systems, devoid of legumes, results in widespread decline of organic matter, depletion of nutrients and alteration in rhizosphere activities. The inclusion of legumes in cropping systems has become imminent, as N dependant agriculture in India has deteriorated soil resource base reflecting decreased factor productivity.

The ability of legumes to fix atmospheric N and the addition of significant amount of organic matter to the soil through leaf fall and root biomass are distinct characters of legume culture, which help in reversing soil deterioration. Pulses can utilize N from atmosphere for their growth through Biological Nitrogen fixation (BNF) involving a symbiotic relationship between pulses and rhizobia that lives in root nodules. The quantity of N fixed by legumes varies and runs up to several hundred kgs per ha, depending on legumes/cultivar, soil type and texture, soil pH, soil nitrate level, soil temperature and water regimes. Many soils do not have the sufficient numbers of appropriate rhizobia for effective symbiosis. Hence the practice of seed inoculation with species-specific rhizobia while sowing ensures maximal N fixation. Pulses also have the ability to reduce soil pH making the favorable condition for nutrient availability. Legumes facilitate recycling of nutrients from deep soil layers through deep rooting and have greater mobilization of insoluble P in soil through root exudates, which in turn serve as a substrate for microbial proliferation influencing biological properties of the soil. Crop rotations having legumes also influence soil physical properties such as the aggregate stability, hydraulic conductivity, bulk density, etc.

Title	:	**Techniques in molecular biology (molecular techniques in gene transformation)**
Name	:	**Amruta Prakash Barhanpurkar**
Institute	:	**University of Pune, Pune, Maharashtra, India**
Supervisors	:	**Suhas P Wani and KK Sharma (Principal Scientists)**
Period	:	**14 June – 9 July 2004**

Abstract:

Biotechnology offers a wide potential for application of molecular biology techniques for human welfare. The development of improved crops includes those conferring resistance to fungal pathogens, virus and the nutritional improvement, eg, the golden rice. The objectives of plant biotechnology is to identify the agricultural problems that can be solved by complementing classical plant breeding and thus, reducing the time scale required to produce a genetically enhanced germplasm. The development of the transgenic plants depends upon plant transformations that rely on introduction of the plasmid construction or segments of plasmid constructs into the genome of plant cell that confers resistance to disease. Transgenic plants are generated from the transform cells, as most of the plant cells are totipotent and hence posses the ability to generate the whole plant from a single cell. In this project different techniques (natural methods of DNA transfer) like isolations of plant DNA, isolation of plant total RNA, amplification of the gene of interest by using PCR/RTPCR, restriction analysis of the DNA, and southern blot were studied. These techniques can provide knowledge regarding the molecular methods used in plant biotechnology.

Title	:	**Role of biofertilizers and their impact on productivity of field crops in the semi-arid tropics**
Name	:	**Kunal Ranjan Tiwari**
Institute	:	**College of Agriculture, Allahabad Agricultural Institute (Deemed University), UP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**1 June – 25 June 2004**

Abstract:

Chemical fertilizers used on a large-scale result in leaching and volatilization and are the main cause for ground water pollution and environmental degradation. In dryland agriculture inadequate moisture is also a limitation in the use of inorganic fertilizers. Biofertilizers can be a big boon for our country where the farmers are marginal having smallholdings. Use of organic and biofertilizers offer a great opportunity for sustainable crop production. Sustainable agriculture means, to sustain or stabilize the agro system and to minimize the industrial input demands. There are several reports of free living and symbiotic bacteria, which fix atmospheric nitrogen and are used as biofertilizers as a supplement for nitrogenous fertilizers.

Biofertilizers are better alternatives for reclamation of wasteland when compared with chemical fertilizers. For most of the crops and soil condition up to 20%of the nitrogen requirement can be met through biofertilizers, which can be the best replacement for chemical fertilizers. It may help to reduce the cost on chemical fertilizers and avoid soil problems. The use of biofertilizers (although not spread on a wide scale for all crops) is dominantly seen to respond in case of groundnut, brinjal, onion and sugarcane. Many researchers have proved that there is an increase in yield of field crops by 7–17.86% due to use of biofertilizers. Biofertilizers cannot replace chemical fertilizers, but certainly are capable of reducing their inputs. The response of application varies with various agro-ecological conditions suggesting evolving region-specific quality biofertilizers. Therefore by assessing their potentials this cheap and ecofriendly technology need to be transferred to farmers.

Title	:	**Modification of microcontroller-based sediment sampler**
Names	:	**G Narasimha and M Yugandar**
Institute	:	**Vignan Jyothi Institute of Engineering and Technology, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisor	:	**P Pathak, Principal Scientist**
Period	:	**December 2003 – March 2004**

Abstract:

The sediment sampler was developed to take soil samples at a fixed sampling interval for estimating soil loss. The sampling periods required to be changed manually. There was a need to improve this instrument, which could give more accurate data. Three more sensors were required to be installed and the sampling period to change the accordance with the sensors sensed. As the flow rate of runoff water increases the height of water level also increases. Hence taking more samples during runoff rates could give us more reliable data for soil loss estimation. The control unit is the heart of the sediment sampler and a 12v car battery is used to give the necessary power supply to it. The battery is charged automatically by using a solar panel, which consists of about 36 solar cells. But when we use these solar panels in rural areas, it is quite difficult to protect them from strangers. It is unfavorable to use the costly collar panels in the rural areas and an indication of the battery voltage is required to judge whether the battery is fit to be used. We have designed a battery monitor to get an indication of battery voltage so that we can recharge a battery whenever its voltage falls below a selected cut off value.

Title	:	**Interaction of micronutrients with beneficial microorganisms – *Rhizobium* and *Azospirillum***
Name	:	**G Deepika**
Institute	:	**Jawaharlal Nehru Technological University, Kukatpally, Hyderabad, AP, India**
Supervisors	:	**Suhas P Wani, Principal Scientist**
Period	:	**23 July 2003 – 22 January 2004**

Abstract:

Human interventions for increased agricultural productivity through introduction of high-yielding varieties and increased fertilizer use, has resulted in land degradation. Chemical fertilizers played a major role in the past two decades, mainly as a source of macronutrients and thereby offsetting the use of organic manures, resulting in deficiencies of nutrients that are required for plant growth and productivity. As a result there is a gradual decline in crop yields and fertilizer productivity and subsequent depletion of soil fertility. This concern has led to an ever-increasing emphasis upon means of conserving the limited supply of nutrients and also on sustaining soil fertility. Therefore the processes that regulate nutrient release and plant uptake in soil are considered as an essential prerequisite for sustainable agricultural management. Hence, more recently there has been increased interest in studies concerning the roles of beneficial soil microorganisms in enhancing soil productivity.

Studies conducted by ICRISAT on soil samples collected from watershed areas of Nalgonda and Mahbubnagar districts indicated micronutrient deficiencies especially B, Zn and secondary nutrient S. Amendments of these nutrients have shown increased growth and yield of the rainfed crops grown in the respective districts. In regard of this hypothesis that amendments of deficient micronutrients enhanced the yields of the crops the present study has been conducted.

The present investigation was conducted to study the effects of micronutrients on growth and yield of short-duration pigeonpea through process mediated by beneficial microbes like *Rhizobium* and Azospirillum under controlled and field conditions. Observations on bacterial populations, nitrogenase activity, biological activities in the soil, total dry matter were recorded at flowering and total dry matter and grain yield were recorded at maturity for the pot culture experiment. Field observations were made at vegetative for medium-duration pigeonpea and groundnut in Nalgonda and Mahabubnagar districts.

Application of boron equivalent to 2.5 kg/ha resulted in highest numbers of rhizobia and azospirilla in the soil, maximum TDM and grain yield (117%). Enhanced biological activity was observed with the application of optimal rate of boron. Sulphur application enhanced the nitrogen fixing potential for the pot culture experiment. High concentration of zinc in the soil might have rendered a toxic effect on the yield of pigeonpea. Application of micronutrients to the soil in field trials resulted in higher responses over control, in terms of microbial colonization, nodulation status while varied response among treatments was observed. Increase in grain yield and total dry matter was observed in the treatment All+NP followed by All, B, S and Zn in both the districts. Practices that sustain crop productivity and soil fertility should be implemented for long-term benefits.

Title	:	**Interaction of micronutrients with beneficial soil organisms – *Mycorrhiza, Azotobacter* and *Azospirillum***
Name	:	**N Linthoingambi Devi**
Institute	:	**Jawaharlal Nehru Technological University, Kukatpally, Hyderabad, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**23 July 2003 – 22 January 2004**

Abstract:

Anthropogenic reductions in soil health and individual components of soil quality are a pressing ecological concern and also influence crop production. Soil is the base for agricultural benefits. Improving soil fertility is a means of developing sustainable crop management systems. Although soil's contribution to plant productivity is widely recognized, present cultivation practices have a great impact on maintaining the soil's fertility. Amendments of soil with major fertilizers (NPK) are no longer the only means of enhancing soil fertility. The role of micronutrients in crop production is often neglected. An attempt was made in this study to have a perspective of the dynamic interactions between micronutrients and the soil beneficial populations, which aid crop growth and development.

In order to establish a comparative study with the field trial conducted by ICRISAT, short duration maize was selected as the host crop for the greenhouse experiment. Treatments of the red soil (RW2 of ICRISAT) with tripartite inoculation of VAM fungi, *Azotobacter* and *Azospirillum* along with micronutrient amendments (B, Zn and S) indicated an advantage in terms of grain yield over the control where the micronutrients were not supplied. Treatments consisted of a single application of each micronutrient at optimal and sub optimal dosages, combination of all the three optimal dosages and also the combination of all the sub optimal dosages. Optimal dosage of boron and sub optimal dosage of sulphur were observed to favor the VAM fungi colonization along with increased populations of beneficial organisms such as *Azotobacter* and *Azospirillum*. There was also an indication of enhanced biological activities with maximum response in the amendment of sub optimal dosage of sulphur (T6). When overall plant growth response was estimated, higher improvements were recorded in the sub optimal dosages of the micronutrients. Though maximum grain yield was obtained in the soil amendment of optimal dosage of boron (T2), a considerably high yield could be obtained with sulphur treatment. Zn definitely indicated an improved soil condition with improved crop yield but marked response was not noticed which could be attributed to its excessive availability in the soil. This study enabled us to partially unravel the synergistic interactions of micronutrients and the three beneficial inoculants. The outcome of this experiment necessitates further studies in exploiting the complex processes, which regulate the dual impacts of micronutrients and beneficial soil organisms to derive a technology for sustainable crop production.

Title	**:**	**Evaluating the ability of microorganisms to kill larvae of *Helicoverpa armigera***
Name	**:**	**B Vidya Suman**
Institute	**:**	**Dept. of Microbiology, St. Francis College for Women, Osmania University, AP, India**
Supervisor	**:**	**OP Rupela, Principal Scientist**
Period	**:**	**1 June – 16 July 2004**

Abstract:

Three different experiments focusing on evaluating microorganisms for its ability to kill young larvae (neonate or 3rd instar larvae) of *Helicoverpa armigera* (Hübner) were conducted as part of this project. *H. armigera* or legume pod borer is a polyphagous insect attacking more than 182 host plants. Considering the harmful effects of chemical pesticides, widely used by farmers, microbial pesticides should be an eco-friendly option. Of the seven bacterial isolates, which killed *H. armigera* in previous studies, four isolates namely HIB 19, HIB 28, LS 12 and SB 17 were compatible with *Metarrhizium anisopliae*, a fungus with ability to kill insect pests. This was determined by co-habitation (growing together on a given medium) studies. In another experiment *M. anisopliae*, multiplied in potato dextrose broth, killed neonate larvae of *Helicoverpa* more strongly (100% mortality) than the 3rd instar larvae (75% mortality), indicating their susceptibility. Maximum mortality (83.3%) of 3rd instar larvae was recorded due to *M. anisopliae* multiplied on rice straw powder+rice grain at 10^{-3} dilution when compared to that multiplied in PDB (10^{-1} dilution), in the third experiment. *M. anisopliae* was re-isolated from the dead larvae in order to maintain its virulence. Its identity was confirmed by microscopic examination.

Year 2003

Title	**:**	**WEB page designing**
Name	**:**	**Mridula Cherukuri**
Institute	**:**	**Villa Marie Post Graduate College for Women, Osmania University, AP, India**
Supervisor	**:**	**Piara Singh, Principal Scientist**
Period	**:**	**18 March 2002 – 15 February 2003**

Abstract:

In line with the new vision of ICRISAT, and consequent changes of research priorities organized into global themes, there is a need to reflect those changes on their web site at http://www.icrisat.org. Among several research and administrative divisions, some research components of Natural Resource Management Program (NRMP) have been regrouped into Global theme 3 – research, water, soil and agro biodiversity management for eco system health. Accordingly the web pages on Internet and

Intranet versions of the ICRISAT web site would need modifications. This includes new additions, modifications to existing pages on both the versions of the web site.

The web pages are designed as per the requirements specified by the global theme team. We have designed the page with the combination of rich text and a bit of graphics. The graphic file types used are*.GIF,*. JPEG. The page is designed with tables. The reason tables are so popular with web page designers is that they let you arrange the elements of a web page in such a way that the brower will not rearrange them. Often, it is good to let the browser do the rearranging, especially when it reformats text to fit the available display area.

Title	:	**Watershed development program: Communication systems**
Name	:	**B Sivakumar**
Institute	:	**Patnam Rajender Reddy Memorial Engineering College, Shabad, (RR Dist.) Affiliated to Jawaharlal Nehru Technological University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**6 January – 5 April 2003**

Abstract:

The project was aimed at improving communication between the groups of ICRISAT through network software systems. The communication system was developed using ASP (Active Server Pages), VBScript (Visual Basic) and Oracle. The front end of the module consists of log on page with user id and password, which was created using ASP. The back end of the module consists of two WebPages indicating role and responsibilities, work schedule and work progress of the user logged. The developed pilot runoff model on communication system was tested and validated.

Title	:	**Interactive communication network**
Names	:	**K Vanaja and K Neeraja**
Institute	:	**Post Graduate college, Mahabubnagar, Osmania University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**3 March – 31 May 2003**

Abstract:

The project was aimed at developing Interactive Communication Network on tour programs for NRM group, ICRISAT. This has been achieved by using software, in which all individuals of the group are interconnected through intranet. The front end of the module consists of user log on to the site, which was created by ASP. The back end of the module developed by MS-Access have WebPages indicating the proposed tour by user in group detailing about name, place of visit, starting and ending date of the tour, number of days, persons accompanied and objective of the tour and information about completed tour with observations and recommendations. This software allows authorized users to add/modify the information on tour programs. The developed system has been tested and implemented on a pilot scale.

Title	:	**Hydrological and economical assessment of water harvesting structures at Adarsha watershed**
Name	:	**K Srinivasa Raju**
Institute	:	**Faculty of Agricultural Engineering, Indira Gandhi Agricultural University, Raipur, Chattisgarh, India**
Supervisors	:	**Suhas P Wani and Prabhakar Pathak, Principal Scientists**
Period	:	**17 February – 29 August 2003**

Abstract:

The hydrological aspects and cost evaluation of different water harvesting structures, viz, masonry and earthen check dams and sunken pits, as constructed at Adarsha watershed in Rangareddy district of Andhra Pradesh, were investigated. The modified SCS Curve Number runoff model developed by Pathak et al. (1987) had been modified to suit the topographic conditions of Adarsha watershed. From the runoff simulation studies over the past 15 years, it has been observed that there is a 59% probability of getting run off of more than 1,32,000 m^3 which can be generated taking into account, the existing capacity of 11,000 m^3. Numerical modeling of tank had been used for making an estimate of artificial groundwater recharge. From the water balance studies of a 255 m^3 capacity check dam, the contribution of water harvesting structures to ground water was assessed as 26000 m^3 and 15000 m^3 in the years 2000 and 2001 respectively.

Analysis of cost and storage capacity of water storage structure at Adarsha watershed revealed that, on an average, one cubic meter of water storage capacity cost Rs 8 for earthen check dams, Rs 27 for sunken pits and Rs 112 for masonry check dams. The high unit costs of masonry check dams outweigh the benefits of durability and stability. On the other hand, sunken pits have the limitation of storage capacity. Earthen check dams prove to be the most cost effective method, if precautions against overtopping are taken care. Earthen check dams are simple and easy to construct and hence can be implemented on a large scale, also without any hassles resulting in direct benefit to the local community. However, other aspects such as suitability, equity for harvested water and the purpose of a particular type of storage structure need to be further considered along with the economic assessment.

Title	:	**Prospects of water harvesting in three districts of Andhra Pradesh**
Name	:	**P Sireesha**
Institute	:	**Center for Water Resources, Institute of Post Graduation Studies and Research, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisor	:	**Prabhakar Pathak, Principal Scientist**
Period	:	**24 February – 28 August 2003**

Abstract

Lack of water at times of need is the dominant constraint to increasing productivity in most of the rainfed areas. In India tanks are traditional method for water harvesting to mitigate the drought problem. Three watersheds – Kacharam (red soil), Nandavaram (black soil), and Sripuram (red soil) have been selected from Nalgonda, Kurnool and Mahabubnagar district, Andhra Pradesh. Twenty-six years daily rainfall and evaporation data for each watershed have been collected. Soil samples from each watershed have been collected and analyzed in the laboratory for texture analysis and soil moisture at field capacity and wilting point.

Information on soils, long-term rainfall amounts and open-pan evaporation measurements from three watersheds has been used as input to water harvesting model developed at ICRISAT. It calculates daily net inflow and outflow from the tank by subtracting daily evaporation and seepage losses from the watershed runoff. Water harvesting model has been used for a year that has produced twenty-six years mean annual runoff based on simulated runoff data using runoff model developed at ICRISAT.

Each watershed has been tested for two soil types (A and B) taking spatial variability of soil into account. Statistical analysis has been done for simulated runoff for 26 years. Probabilities of getting 20, 40, 60 and 100 mm runoff have been estimated. Catchment area of 10 ha and three seepage rates in the range of 18–8.8 L m^{-2} day^{-1} (red soil) and 4 –1.3 L m^{-2} day^{-1} (black soil) have been used for water harvesting structures in the model. Tank capacity was estimated based on the inflow for each watershed. In each watershed two soil types (A and B) showed variation in producing runoff that in turn affects the net inflow to the tank. Red soil watersheds have high potential for harvesting runoff than black soils. In black soils seepage losses are low whereas in red soils losses are high and need lining material for control. A series of such tanks can be proposed for watershed regions based on the area under irrigation and requirement.

Title	:	**Native *Cicer-Rhizobium* populations of rice fallows**
Name	:	**M Srikanth**
Institute	:	**Nagarjuna University, Andhra Pradesh, India**
Supervisors	:	**JVDK Kumar Rao**
Period	:	**February 2003**

Abstract:

Rice fallows are lands used to grow rice in *kharif* (rainy season) and then left uncultivated (for no crop to grow) during *rabi* season (postrainy season). These rice fallows hold promise to grow a short-duration legume, eg, chickpea, on residual moisture. Chickpea is nodulated by a host of specific *Rhizobium*. The present study aims to study the population of chickpea rhizobia in some rice fallows of Chattisgarh, Jharkhand states of India and Nepal. The native chickpea *Rhizobium* populations were estimated by serial dilution-plant infection and most probable number methodology using chickpea genotype K 850 as test legume.

A total of 52 soil samples were analyzed. Two samples from Nepal, four samples from Jharkhand, and 14 samples from Jagdalpur, had no chickpea rhizobia, while the remaining 32 soils had fairly good number of chickpea rhizobia. The population ranged from 0.38×10^2 to 1.43×10^5 chickpea rhizobia per gram dry soil. These results indicate that chickpea is to be grown in rice fallows, and then it needs to be inoculated with an effective chickpea *Rhizobium* strain, ie, that the plant can fix atmospheric nitrogen and thereby increase grain yield and income to the farmers. It might also contribute to soil fertility thus enhancing the sustainability of the rice-based systems.

Title	:	**Enumeration of microflora in vermicompost and its impact on different crops**
Name	:	**G Naveen**
Institute	:	**University College of Science, Osmania University, Hyderabad, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**23 June – 22 August 2003**

Abstract:

Vermicomposting is a process involving a wide array of microorganisms, converting organic wastes into valuable organic fertilizers. In this process microorganisms initiate the composting process. Earthworms when added, act as catalyst to the process and affix the nutrients that are readily available for the uptake of the plant in the form of castings when applied as manure. The present study was aimed at minimizing the use of the compost by adding organic manure in suited proportions to the crop.

The studies carried out are mainly based upon the biological and applied aspects of vermicompost. The experiment mainly emphasized upon the microbial enumeration (fungi, bacteria, actinomycetes) with contrast to soil microflora that resulted in the higher counts such as, in vermicompost 57×10^6 bacteria per gram and in soil samples collected from *godown* and fields of ICRISAT have shown

45 × 10^6 bacteria per gram respectively. These experiments were carried out in two sets that had application of vermicompost in one set and vermicompost water in another. In the first set, vermicompost was applied at the rate of 2, 3, 4 and 5 t ha^{-1} [T-1, T-2, T-3, T-4 respectively] and the effect of treatments on plant growth in vegetable and cereal crops in a green house was studied. The results showed a positive response with treatments T-3 and T-4 over control. In the second set, vermicompost water was used for irrigating the plants at the rate of 1, 5, 10% (10 g of vermicompost in 100 ml water) [V-1, V-2, V-3 respectively]. The results showed that V-2 (5%) treated plants had better growth over control and comparative control (where vermicompost treatments was used), than the best treatment having vermicompost alone [T-4] added at a rate of 5 t ha^{-1}. The impact of the addition of vermicompost water on plant growth and chlorophyll content, when irrigated with concentrations containing high dose (10%; 10g vermicompost in 100ml water), (5%) moderate dose and (1%) low dose, 5% dose gave good response compared to the other treatments. An experiment was conducted to know the presence of the plant growth promoting substances in vermicompost and the results showed a positive confirmation.

Title	**:**	**Making collective action work in the watershed development program in India**
Name	**:**	**Raul Abreu-Lastra**
Institute	**:**	**Kennedy School of Government, Harvard University, Cambridge, UK**
Supervisor	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**9 June – 30 August 2003**

Abstract:

The Watershed Development Program implemented by the Ministry of Rural Development in India aims to increase productivity in rainfed agriculture, reduce land degradation and combat rural poverty in small villages in drought prone areas. Currently it is implementing the program under a participatory approach. Beneficiaries are considered in the decision-making process and granted with the ownership of the project. They are responsible to engage in collective action for maintaining the project over time once the implementation period has finished.

This report analyses evidence from the Adarsha Watershed in Andhra Pradesh. The main findings are that in the absence of clear guidelines for creating rules to assess contributions and to share natural resources such as soil and water, the beneficiaries are not able to establish them. If this situation persists, sustainability of the project is at risk. Levels of inequality and social capital affect the likelihood and intensity of participation.

One of the most important conditions for beneficiaries to cooperate is to guarantee equal opportunity for appropriating the natural resources that the project is collecting. The main challenge for the local institution that manages the watershed is to assess the cost and amount of soil and water used and make sure that the beneficiaries contribute proportionally to their usage of the resources. Implementation of these rules depend on the ability to observe how much soil and water is being consumed and punish the defaulters.

Title	:	**Microbial variety in the watershed**
Name	:	**B Sushma Vinaya**
Institute	:	**Chaitanya College for Women, Andhra University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**8 May – 15 July 2003**

Abstract:

Soil microorganisms especially vary widely in semi-arid and desert soils compared to other climatic zones. The microbial populations in arid soils are generally low as compared to other tropical soils; mainly due to the poor vegetation, which is the result of erratic and scanty rainfall. The treatment of soil by chemical fertilizers, bio-fertilizers not only enhance soil fertility but also enriches microbial life as it would bring high population of microorganisms with it.

In this project the quantity and the type of bacteria, fungi and actinomycetes in treated soil samples (CG) from the watersheds of Gokulpura *charagah* were studied. Enumeration of microbial population was done with these samples. Diversity in the colony morphology was recorded and different staining techniques and bio chemical tests were performed and the results were recorded.

Soil samples were grouped according to the area and the plots from where the soil samples were collected. From these groups colony morphology with diversity were recorded and different staining and biochemical tests were performed and results were recorded.

Title	:	**Spatial variability of beneficial organisms in rehabilitated common grazing lands in the watersheds, isolation and evaluation of microorganisms**
Name	:	**Y Srujani**
Institute	:	**Chaitanya College for Women, Andhra University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**5 May – 10 August 2003**

Abstract:

Due to low rainfall and low organic matter content microbial biomass of tropical soil is more varied in comparison to semi-arid tropical soil. This is a preliminary study of beneficial microorganisms in response to various treatments given to the soil.

Treatment with various agents not only enhances soil fertility but also enriches microbial activity. The presence of microorganisms will help for better vegetation especially in semi-arid tropics, in which cultivation is watershed dependent. This is by the presence of microbial biomass at rhizosphere, which can influence the vegetation on a particular soil. Similarly the growth of microbes will also be influenced by vegetation, as nutrients required will be met by roots of the plants in the soil and the litter.

This study emphasizes that the presence of beneficial microorganisms is due to enhancement of soil fertility as a result of better conservation methods. After enumeration, isolation and evaluation of microorganisms of treated soil samples, the results were compared with the results of non-treated soil samples, which were also studied. High variation was observed between these two types of soil samples.

Title	:	**Hands-on training using 'Agricultural Production Systems sIMulator (APSIM) for Cropping Systems Modeling'**
Name	:	**MV Venugopalan**
Institute	:	**NBSS & LUP, Nagpur, Maharashtra, India**
Supervisor	:	**Suhas P Wani (Principal Scientist) and team**
Period	:	**7 – 11 April 2003**

Abstract:

The training program arranged on Venugopalan's request was a unique learning experience. It exposed him to the facilities offered by APSIM in comparison to other contemporary models like DSSAT and INFOCROP. The central concept of APSIM with soil as the base and weather and crop altering its properties is an exemplary feature. Since it considers the system as a whole without bias to soil, water or crop simulations, it aroused keen enthusiasm in the researcher throughout the training sessions.

The sessions on basic APSIM framework, APSFRONT interface and data needs and format were well structured. The hands on session through the tutorial, for performing simple simulations followed by exercises were very handy in getting a feel of the model. The following sessions on the preparation of new met, w2soil and w2 water files were thoroughly covered. Modifications that can be made in cultivar parameters for simulating new cultivars were interesting.

These sessions induced confidence and infused enthusiasm for making simulations using our own experimental data. The structure for preparing .obs (observed data) and its utilization for comparing it with simulated outputs was lucidly explained. This is a commendable feature of the model. The time available was adequate not only for creating meaningful simulations using simple management options but also to study their long-term impact using historical met data.

Title	:	**A project report on sustainable integrated watershed management by using remote sensing and GIS**
Name	:	**K Samatha**
Institute	:	**Centre for Environment, Institute of Postgraduate Studies and Research, Jawaharlal Nehru Technological University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**3 February – 25 September 2003**

Abstract:

The study deals with sustainable management of Malleboinpalli watershed, a part of drought prone area of Mahabubnagar district using the resource database acquired from IRS-1D PAN and LISS-III merged data. To aid, drainage morphometry, hypsometry and the quantity of sediment yield and socioeconomic data from survey of the Malleboinaplli of this watershed was also used. Base map, contour map, slope map, drainage network and watershed boundary were prepared from Survey of India toposheets. The remotely sensed data in the form of geocoded false color composite of IRS-1D PAN and LISS-III satellite sensing system, obtained from National Remote Sensing Agency was used to prepare thematic maps of drainage network and watershed boundary, slope, land use/ land cover, geology, hydrogeomorphology, groundwater prospect, soil, land capability and land irrigability and transport network. Settlements and village boundaries were also surveyed by using ARC/GIS 8.1.2.

The drainage morphometry including hypsometric analysis was applied on the study area for deriving the erodability characteristics of the watershed based on the contour and drainage maps. The sediment yield was computed for the watershed by using Garde's formula. An attempt was also made to study the status of groundwater potential by the success of wells in contraction with slope and hydrogeomorphology of Malleboinpalli suffering from drought during the summer season. It was suggested that this could be achieved by constructing the suggested water harvesting structures for the augmentation of groundwater potential. The integrated study of all this led to the preparation of erosion intensity zone map. Finally master action plan was prepared for both land and water resources development by integrating the entire theme maps in conjunction with the results acquired from drainage morphometry, hypsometry, sediment yield and socioeconomic data of the Malleboinpalli village.

Title	:	**Evaluation of spatial and temporal changes in groundwater levels using RS and GIS – A case study of Malleboinpally area, Mahabubnagar district, AP, India**
Name	:	**V Ramalakshmi**
Institute	:	**Center for Environment, Institute of Postgraduate Studies and Research, Jawaharlal Nehru Technological University, Hyderabad, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**3 February - 25 September 2003**

Abstract:

This study was carried out to delineate and characterize ground water prospect zones during the year 2002 and 1998 using PAN and LISS–III merged data, MSS geocoded data on a 1:50,000 scale. The information on geology, geomorphology, land use/land cover, slope were generated and integrated to prepare ground water prospect map for the area of Malleboinapalli in Mahabubnagar district. The information on type of well depth range, yield range, pumping time, and well position were supplemented to form a good database for identification of favorable zone. Geographical information system was used to prepare database on the above layers and composite map. On the basis of geomorphology, six categories of ground water prospect zones: excellent, good, moderate, normal to poor, poor very poor were delineated. The high prospect zones valley fills yield in 2002.15.8 bgl (m). The pediplain with moderate weathering, pediplain with shallow weathering, pediplain residual hills, inselburgs indicate good, moderate, normal to poor, very poor ground water prospects zones. In the study area ground water levels were seen to decrease compared to the years 1998 and 2002. Recommended a few ground water recharge structures and also suggested the suitable site for digging of wells.

Title	:	**Implementation of irrigation groundwater markets to increase efficiency and equity in semi-arid India**
Name	:	**Melanie Elizabeth Fedri**
Institute	:	**University of Pennsylvania**
Supervisors	:	**Bekele Shiferaw and Suhas P Wani**
Period	:	**21 January – 8 May 2003**

Abstract:

This study was an attempt to integrate all relevant issues into one coherent solution over how to practically implement water market mechanisms in a drought prone village such as Kothapally. The introduction of water market mechanisms for irrigation purposes in low potential, high utilization areas requires careful contextual integration with watershed management activities. Watershed management focuses on natural resource conservation, cost-effective agricultural techniques and

technologies, and widespread community participation. These activities increase the stability of agricultural productivity and availability of water through conservation techniques. Although these management activities play a vital role in improving the well being of villagers, they do not directly include individual decision making as a means of improving resource use and allocation. Introducing market mechanisms for irrigation water may lead to more efficient and equitable distribution among competing users.

First, scientific information on water table depth must be regularly tracked using a monitoring system. Without this information, no rational decisions can be determined regarding the amount of groundwater available for consumption in the village. Second, a monitoring group must be formed under the direction of the Watershed Committee. The monitoring group must consist of diverse community members, including members of all castes, women, and landless farmers. The diversity of the group will help to minimize favoritism and/or discrimination during the monitoring process. The group's training must be thorough and professional so as to ensure their competency and acceptance by the farmers they will be monitoring. The first task of the monitoring group should be to educate the villagers on the method of initial water rights allocation as described below.

Water rights should be initially distributed among the villagers independent of land ownership. Although incentive allocation was not the most preferred option among surveyed farmers, it seems to be the most equitable and supportive of watershed management activities. It puts all farmers on equal footing in the sense that each has the choice to engage in as many activities as they wish to earn initial rights. A one-year time frame should be specified, during which farmers have the opportunity to earn incentive points that secure initial water rights. The opportunity cost of not earning incentive points is higher for poor farmers and lower for rich farmers. In this way, poor farmers who tend to be less involved in watershed management activities may increase their participation. Landless farmers may also earn points through their involvement with self-help groups or the building of community water conservation structures. At the conclusion of the year, initial water rights should be distributed according to the points earned by each farmer.

Water rights should be granted in terms of points with no specific amount of water attached to each point. Periodically, such as at the start of each season, scientific data on water table depth should be collected to estimate the amount of available groundwater. The estimated available groundwater, estimated volume pumped per unit of time, and the total recorded number of water right points should be used to calculate the value of each water right point for that season. For example, in a drier season, one water right point may be worth 1 hour of pumping, while in a wetter season, that same water right point may be worth 2 hours of pumping. In cases of severe water shortage, the value of each water right point may become temporarily worthless. Under these circumstances, the focus of the village should be on basic survival and government intervention should prevail. Once water levels are restored to an adequate level, water rights correspondingly increase in value. Monitoring should be carried out each day during growing seasons to ensure that well owners do not pump more than their fair share. Success monitoring can be ensured if all wells are fitted with electric pumps and the amount of time electricity is provided to the pumps is carefully controlled. Regularity and reliability of electricity supply is also important, so that monitors know when they should be working and farmers know when they may operate their pumps. Control over electricity supply is one of the most important areas of government involvement in the protection of water rights.

Before initiating the trade of water rights, more extensive and reliable delivery systems must be laid down to connect well owners to potential buyers. The improvement of infrastructure benefits both parties, so that sellers have more potential buyers and buyers have more potential sellers to choose

from. The increased competition among sellers to secure buyers helps to lower prices and improve service quality. Once sufficient delivery systems are in place, water trading may be initiated. When a potential seller and buyer of irrigation groundwater come into contact, several different transactions may occur. The buyer may exercise his right to purchase his allotted amount of water for the season for a negotiated price subject to a community-wide price cap. Alternatively, the non-well owner may permanently sell his water rights to the well owner. The well owner may have an interest in buying more water rights because he no longer has unlimited rights to illustrate as much water as he pleases. Although he continues to own his well, the water drawn through his well no longer automatically belongs to him. A member of the monitoring group must record any water purchase or permanent exchange of water rights.

To encourage continued involvement with watershed management activities, the monitoring group will periodically review farmers' involvement. If farmers maintain their previous involvement, they may keep their initially allocated amount of water rights plus any more acquired through permanent rights transfers. If their involvement increases, they earn additional water rights. If their involvement decreases, they lose water rights.

Finally, conflicts over transactions must be brought before the Watershed Committee and the records taken by the monitoring group used to help determine a proper ruling. Penalties must also be determined by the Watershed Committee and consist of a combination of cash payment and community service. The legal enforcement of water rights is the other area of government involvement that is of crucial importance in the functioning of water markets.

In conclusion, the implementation of irrigation water markets to improve equity and efficiency of semi-arid India requires a careful balancing of complex, intertwined issues and integration with current watershed management efforts. The particular conditions and preferences of a given community must be considered before introducing water market mechanisms.

Title	**:**	**Report on Hands-on training using 'Agricultural Production Systems sIMulator (APSIM) for Cropping Systems Modeling' at ICRISAT**
Name	**:**	**T Giridhar Krishna**
Institute	**:**	**Regional Agricultural Research Station, Nandyala, Acharya N G Ranga Agricultural University, AP, India**
Supervisors	**:**	**Suhas P Wani (Principal Scientist) and team**
Period	**:**	**7 – 11 April 2003**

Abstract:

Introduction to the background about the need to use software in cropping systems modeling was quite good. About APSIM framework, data required for running/simulating a model situation using APSIM/APSFRONT Interface was dealt with in detail.

The data needs and formats of APSIM input and observed files, their use in creation of templates, their location identification, view/graph APSIM simulation outputs, their plotting, etc., which are highly essential to understand and run independently the simulation models were given priority and were taught thoroughly.

Modification of .ini files and creation of APSVIZ compatible .obs files and making new cultivar/soil/soil water parameters, etc, required for creating new templates as per the requirement/situation and to run them with APSIM were practiced. The exercises on already available templates, creation of new templates, creating .met files with the available weather data, use of several management options in the simulations etc. were all organized in a proper sequence for easy following and doing simulations with APSIM.

The following suggestions are made:

More time might be devoted for the creation of templates as per different management options.

All APSIM related files, their location paths and their retrieval paths etc., should be given as a hand out which help in handling the files independently.

This five-day (7th–11th April 2003) training in APSIM gave good knowledge about simulation cropping system modeling and the use of APSIM software confidently for simulating crop/soil related management conditions and to understand the research results better.

Title	**:**	**Computer Program of water harvesting model for small agricultural watersheds**
Name	**:**	**K Sushma Kiran**
Institute	**:**	**Rural Engineering College, Bhalki, affiliated to Visweswaraiah Technological University, Belgaum, Karnataka, India**
Supervisor	**:**	**Prabhakar Pathak, Principal Scientist**
Period	**:**	**24 March – 4 July 2003**

Abstract:

In the semi-arid tropics (SAT) timely availability of water to crops is a major problem. As a consequence, crops suffer low and unstable yields. A suitable water source can be provided during the season by harvesting the runoff emanating from high intensity, short duration storms to augment the crop yields. The knowledge for runoff harnessing is crucial in deciding the type and design of water-harvesting structures.

A runoff water-harvesting model was developed by ICRISAT, which could be used for assessing the prospects of water harvesting and its utilization for agriculture in the SAT. The model originally was developed in Turbo Basic, a DOS based language used in early 1980s. This works for a single year and one set of input parameters such as soil depth and seepage rate. The model can estimate the probability of runoff and water availability in a tank when long-term daily climatic data are available. Using this model the probabilities of getting different amounts of water from the runoff water harvesting system during the drought stress at critical periods can be determined. It was found that considerable information on various aspects of runoff water harvesting could be obtained. The chances of adequate stored water being available for supplemental irrigation during moisture stress periods can also be determined.

As the present model in Turbo Basic has its own limitations of not being user friendly, the researcher was assigned to convert the model to a user friendly, window-based application using CPP language in which suitable modifications were incorporated so that it works for multiple set of input parameters facilitating the user to enter any number of years, soil depths and seepage rates. By virtue of its simplicity and physical concept, it is convenient to use the model for various other purposes besides the calculation of net store in the tank. It can also be used for scheduling irrigation, determining effective rainfall and determining the overflow from the tank.

Title	:	**Sediment sampler modifications**
Name	:	**M Venkateshwara Rao**
Institute	:	**Madras University, TN, India**
Supervisor	:	**P Pathak, Principal Scientist**
Period	:	**November 2002 – January 2003**

Abstract:

The sediment sampler was devised to take the samples at a fixed sampling interval for estimating the soil loss. The sampling periods had to be changed manually. There was a need to improve this instrument, by which more accurate data could be obtained. Three more sensors were required to be installed and the sampling period to change the accordance with the sensors sensed. Hence taking more samples during runoff rates could give more reliable data for soil loss estimation.

The researcher modified the system unit by adding two new switches to the existing circuit. At present the pump ON time period is with the time span of 15 seconds, which is a constant one. By using these two switches one can select the required time span as per the positions of the switches given in the table. By this arrangement, required amount of samples can be collected in the sampler unit.

Title	:	**Microbial diversity in watersheds**
Name	:	**Charu Rani**
Institute	:	**Dept. of Microbiology, Kanaya Gurukula Mahavidhyalaya, UP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**7 February – 11 April 2003**

Abstract:

Soil microorganisms especially in number vary widely in semi-arid and desert soil than in any other climatic zone. The microbial populations in arid soil are generally low as compared to any other tropical soil mainly due to poor vegetation, which is the result of erratic and scanty rainfall. The treatment of soil by chemical fertilizers, bio-fertilizers not only enhance soil fertility but also enriches microbial life as it would bring high population of microorganism with it.

This project studied the quantity and types of bacteria fungi and actinomycetes in non-treated soil sample (NTGC) of the Gokulpura *charagah* in Rajasthan. Almost five to twelve different types (based on colony morphology) of bacteria were identified from each of the nine different soil samples. Representative of each type from each of the nine samples were picked up for further studies. A total of 101 isolates were assembled. All 101 isolates were characterized morphologically. However only thirty-eight isolates underwent-gram staining, spore staining, acid–fast staining and catalase test. Only sample NO. 6-NTGC was characterized biochemically by casein hydrolysis test. Maximum population of bacteria was in sample NO. 2-NTGC (82×10^3). Minimum population of bacteria was in sample NO. 9-NTGC (47×10^2). Maximum population of fungi was in sample NO. 2-NTGC (8×10^3). Minimum population of fungi was in sample NO. 10-NTGC (0). Maximum population of actinomycetes was in sample NO. 7-NTGC (42×10^3). Minimum population of actinomycetes was in sample No. 9-NTGC (11×10^2). Of the thirty-eight bacteria twenty-two were gram-negative rods and sixteen were gram-negative cocci. Out of twenty-two rods only sixteen were gram-negative spore forming rods and six were gram-negative non-spore forming rods. Apparently, all the bacteria were aerobic. Occurrence of gram-negative spore forming and aerobic rod forming bacteria seem to be a unique finding.

Year 2002

Title	:	**Understanding requirements of in-situ decomposition of rice–straw**
Name	:	**Kesapragada Sujatha**
Institute	:	**College of Science and Technology, Vishakapatnam, Andhra University, AP, India**
Supervisor	:	**OP Rupela, Principal Scientist**
Period	:	**1 June 2001 – 15 September 2001 and 18 January 2002 – 15 March 2002**

Abstract:

Most farmers in intensively cropped areas of at least four Asian countries burn rice and/or wheat-straw. Composting of any plant biomass (including rice and wheat-straw) is possible. It would require collection of biomass at composting point and is an expensive step particularly when a crop is harvested by combine. Composting of rice-straw as spread in a field after combine harvest, if possible, is an attractive proposition. Focus of the experiments reported here was to understand how to achieve moisture, temperature, humidity as required for efficient decomposition of rice-straw if spread in a field. Nine fungal isolates from decomposing plant materials were evaluated for this interaction between and among each other before their use as mixed inoculants in the two pot experiments that were conducted.

The interaction test indicated that seven cellulose degrading fungal strains (*Aspergillus awamori*, CDF 1, CDF 2, CDF 3, CDF 4, CDF 5, CDF 8) grew well on plate culture even in the presence of the other isolates and were used as mixed inoculant in both the experiments. *Trichoderma viridae* was suppressed by four of the nine fungi (CDF 2, CDF 3, CDF 4 and CDF 5) that were included in the test, and was not included in the mixed inoculant for the two experiments. All the fungal cultures remained pure in the inoculant packets (70 g each) for at least one month. *Trichoderma viridae* and *Aspergillus awamori* were pure even for two months of the study.

Experiment 1 evaluated four different materials as covers ('black polyethylene', transparent polyethylene, 'black polyethylene' with lower layer of white cloth, transport polyethylene with lower layer of black cloth) and uncovered (control) for their ability to retain moisture in the rice-straw placed on top of moist soil in pots. Moisture in rice-straw reached less than 50% in 24 hrs in all except in the pots covered with 'black polyethylene' and 'black polyethylene with lower layer of white cloth. About 20–23% moisture remained in the rice-straw in pots covered with 'black polyethylene with lower layer of black cloth up to 5 days. Temperatures above rice-straw during the day (for at least 6 hours per day) was above 40° C. Maximum temperature on the 15 days ranged 40–46° C inside pots while in the glasshouse it ranged from 36.5–45.9° C and was close to the long-term average (maximum 33.9–35.3, minimum 17.5–23.9 in Ludhiana) of the maximum ambient temperatures during September and October (when rice is harvested and its straw is burnt) in Punjab. Therefore temperature inside the pots was unfavorable for decomposition for at least six hours per day and moisture in the rice-straw was unfavorable for most of the 15 days of the experiment. As a result the researcher did not notice any good growth of fungi at end of the experiment, ie, on day 15 in any treatment. Humidity inside the pots covered with 'black polyethylene' sheet was generally above 50%

(range 51–100%) for whole of the experimental period suggesting that for microbial growth wetness of the straw was essential.

Microbial population in the straw at end of the experiment ranged from 4.60-log10 g^{-1} rice-straw. Marginally reduced microbial population in rice-straw covered with polyethylene than control also indicates unfavorable conditions inside with polyethylene than control also indicates unfavorable conditions inside covered pots. Five of the seven fungi were very apparent in the plates used for counting due to their characteristic color of colonies. Their population in the rice-straw covered with 'black polyethylene' ranged from 4.31-log10 g^{-1} dry rice-straw of strain CDF 5 to $\log_{10} g^{-1}$ dry rice-straw of strain CDF 3.

The second experiment studied if partial burying of rice-straw, with or without inoculation would result in decomposition of the rice-straw in pots covered with 'black polyethylene'. Rice –straw (15 g per pot) was sprayed by a suspension (600 ml per pot) of the 6 fungal strains. 0.5% of methyl cellulose (as a wetting agent) was sprayed on rice-straw in the soil surface place. Rice straw was sprayed with 25 ml of deionised water per pot on day 6 and on every third day subsequently. Moisture percentage measured at different days indicated that rice-straw had 31.5 to 60.9% moisture about 24 hrs after spraying. Partially buried straw had less water (range 31.5 to 40.3%) and moisture in surface placed straw ranged between 44.4 to 60.9% on one day after spraying. Much of the moisture seemed to have been lost within 5 days after spray despite cover of 'black polyethylene' (28% in surface and 37.2% in partially buried straw remained on day 5. Humidity was retained inside pots in the glasshouse. Temperature of rice-straw inside pots ranged from 31.2–32.73 during the day (1000 hrs to 1600 hrs) (measured by micro logger) and was similar with or without burying of rice-straw. Air temperature in glasshouse was about 25–30° C during day and about 22–24° C during nights.

Temperature recording by HOBO data logger inside pots indicated maximum temperature range of 30–57° C and minimum of 23–27° C during the experiment period. Microbial population measured at the termination was marginally higher in surface placed rice-straw. Most of the recovered population of bacteria was on ¼ PDA (mean population 10.43–14.51 $\log_{10} g^{-1}$) in dry rice-straw. Similar was the case with the fungal population. Still on day 10, there was not much visible growth of fungi on the rice strands. It may have been due to very high temperature inside pots at least for significant parts of day on the 10 days of the experiment. This suggests that microorganisms survived the conditions but did not function. Representative colonies of each type of bacteria, actinomycetes and fungi on all the four media were pocked up and purified for further studies. A total of 50 bacteria, 17 actinomycetes and 19 fungi were assembled. Morphological characters of bacteria and actinomycetes were studied on ¼ PDA and cellulose bacterial medium (CBM) and fungi on ¼ PDA and cellulose fungal medium (CFM with antibiotic streptomycin). Their growth on ¼ PDA was generally abundant and rapid than on cellulose-based media.

Further studies on understanding the environment for in-situ degradation for rice-straw may be done in field and not in pots. Holding 50–70% moisture considered desirable for rice straw degradation may not be possible in pots particularly when one is trying to use the external environment close to what exists in areas that burn rice-straw.

Title	:	**Developing procedure for effective sterilization of rice-straw compost**
Name	:	**P Syama Chand**
Institute	:	**Dept. of Microbiology, GVR and S Degree College for Women and Post Graduate Courses, Nagarjuna University, AP, India**
Supervisor	:	**OP Rupela, Principal Scientist**
Period	:	**2 May – 31 July 2001 and 1 January – 31 January 2002**

Abstract:

Preparation of compost from rice-straw for field application may not be economically viable. But its uses as carrier of agriculturally beneficial microorganisms may be a viable proposition**.** For long-shelf life of the inoculants use of sterilized carriers is a must and was the focus of this project. A series of five experiments were performed to arrive at a protocol for effective sterilization. The variables attempted in these experiments involved, a range of moisture levels (0%, 20% and 30%) in the compost (added before autoclaving), number of cycles of autoclaving (1 to 4), incubation period between cycles (12, 24 and 48 hrs) and duration of autoclaving (20 and 60 minutes). At start of the study, the researcher hoped that sterilization of compost by autoclaving might be very easy. But with every next experiment, this proved wrong. The autoclaving protocol was modified with minor changes (in the variables indicated above), in an exigent manner. Future experiments have to study the variables more systematically to develop a protocol of autoclaving for effective killing of all microorganisms in the rice-straw compost.

Focus of the project was to evaluate rice-straw as a carrier for *Aspergillus awamori* a fungus known to solubilize insoluble form of phosphorus in soil. As it was accepted that the researcher failed to effectively sterilize the carrier, the focus of the study was shifted to effective sterilization of the rice-straw compost. One experiment where the compost was used as a carrier for *A. awamori,* the fungus did survive well for 15 days of the study.

Title	:	**Microbiological and enzyme studies for characterization of APRLP watersheds**
Name	:	**M Vijaya Lakshmi**
Institute	:	**Dept. of Microbiology, Montessori Mahila Kalasala, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**13 May – 14 July 2002**

Abstract:

Soil samples (total of 55 samples) from watersheds of Nalgonda district (WS 1 and 2) and Mahabubnagar district (WS 3 and 4) were collected and were analyzed for total microbial populations, spores counts, alkaline phosphatase and acid phosphatase activity. High counts of fungi were recorded in WS 2

(17*10^3 cfu/g soil) and low counts were observed in WS 4 (3*10^3 cfu/g soil). Bacterial populations were high in WS 3 (11*10^4 cfu/g soil) and low counts of bacteria were recorded in WS4 (39*10^3 cfu/g soil). Counts of actinomycetes were more in WS 2 (24*10^3 cfu/g soil) and low counts were recorded in WS1 (2*10^3 cfu/g soil). High counts of *Rhizobium* were recorded in WS 3 (10*10^3 cfu/g soil) and low counts were recorded in WS 4 (3*10^3 cfu/g soil). Spore counts were more in WS 2 (34 spores/g soil) when compared with other locations. Alkaline phosphatase activity was more in WS 1 (784.5 μg g^{-1} of soil) and low was recorded in WS 3 (10.52 μg g^{-1} of soil). Acid phosphatase value was high in WS 4 (533.5 μg g^{-1} of soil) and low in WS 3 (81.04 μg g^{-1} of soil). Results in the four watersheds recorded a great diversity in microbial populations and enzyme activity. These studies explained the biological status of the soil in that area which is helpful to understand the soil health which in turn is related to plant growth.

Title	**:**	**Biological characterization of APRLP watersheds**
Name	**:**	**K Nagadeepika**
Institute	**:**	**Dept. of Microbiology, Montessori Mahila Kalasala, AP, India**
Supervisor	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**13 May – 13 July 2002**

Abstract:

Soil samples (total of 55 samples) from watersheds of Nalgonda district (WS 1 and 2) and Mahabubnagar district (WS 3 and 4) were collected and were analyzed for total soil respiration, biomass C, mineral N, biomass N, net N and dehydrogenase activity.

High value of soil respiration was recorded in WS 1 (153 mg of C Kg^{-1} of soil) and low value was recorded in WS 3 (79 mg of C Kg^{-1} of soil). Biomass C was high in WS 1 (446 mg of C Kg^{-1} of soil) and low value was observed in WS 4 (141 mg of C Kg^{-1} of soil). Mineral nitrogen was high in WS 1 (29.7 mg of N Kg^{-1} of soil) and low value was recorded in WS 2 (2.9 mg of N Kg^{-1} of soil). High value of biomass N was recorded in WS 1 (27.6 mg of N Kg^{-1} of soil) and low value was recorded in WS 4 (6.6 mg of N Kg^{-1} of soil). Net N was high in WS 3 (6.7 mg of N Kg^{-1} of soil) and low value was observed in WS 4 (0.5 mg of N Kg^{-1} of soil). De hydrogenase activity was high in WS 3 (396.79 μg) and low value was recorded in WS 2 (11.04 μg). By studying these parameters the nutritional status of the soils can be estimated and their effect on the other soil parameter like microbial populations can be studied which in turn will help in improving the crop yield and will also be helpful in developing various biofertilizers for healthy crops.

Title	:	**Biological and enzyme studies for characterization of APRLP watersheds**
Name	:	**T Swamy Krishna**
Institute	:	**Dept. of Biotechnology, Nagarjuna University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**6 May – 23 July 2002**

Abstract:

Soil samples from watersheds of Nalgonda district (WS 5 and 6) and Mahabubnagar district (WS 7 and 8) were collected and were analyzed for soil respiration, mineral N, biomass C, biomass N, net N, dehydrogenase activity. Soil respiration was high in WS 5 (186 mg C Kg^{-1} soil) and low value was recorded in WS 7 (79 mg C Kg^{-1} soil). High value of mineral N was recorded in WS 6 (22.6 mg N Kg^{-1} soil) and low value was recorded in WS 5 (1.7 mg N Kg^{-1} soil). Biomass N was high in WS 6 (9.2 mg N Kg^{-1} soil) and low value was recorded in WS 8 (6.6 mg C Kg^{-1} soil). Biomass C was high in WS 7 (576 mg C Kg^{-1} soil) and low in WS 8 (141 mg C Kg^{-1} soil). High value of net N was recorded in WS 7 (6.7 mg N Kg^{-1} soil) and low value was recorded in WS 6 (4.7 mg N Kg^{-1} soil). High value of dehydrogenase activity was recorded in WS 5 (430.3 μg) and low value was recorded in WS 7 (52.8 μg).

These results give us the characteristic of soils in these watersheds, if worked out further can be used to increase the crop yield. The microbial activity can also be studied as all these parameters are directly or indirectly related to the population counts of the microorganisms in the soil.

Title	:	**Microbiological and enzyme studies for characterization of APRLP watersheds**
Name	:	**A Sai Lakshmi**
Institute	:	**Dept. of Biotechnology, Nagarjuna University, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**6 May – 23 July 2002**

Abstract:

Soil samples from watersheds of Nalgonda district (WS 5 and 6) and Mahabubnagar district (WS 7 and 8) were collected and were analyzed for microbial activity (bacteria, fungi, actinomycetes, *Rhizobium*) and acid and alkaline phosphatase activity. High counts of bacteria were recorded in WS 7 (10×10^5 cfu/g soil) and low bacterial populations were recorded in WS 6 (3×10^3 cfu/g soil). Fungal populations were high in WS 6 (46×10^4 cfu/g soil) and low counts were recorded in WS 5 (1×10^3 cfu/g soil). Counts of actinomycetes were high in WS 7 ($81x10^3$ cfu/g soil) and low counts were recorded in WS 6 (1×10^3 cfu/g soil). *Rhizobium* populations were high in WS 7 (16×10^4 cfu/g soil) and low populations were recorded in WS 6 (1×10^3 cfu/g soil). Spore count was high in WS 5 followed by WS 6, WS 7 and WS 8. Alkaline phosphatase activity is high in WS 6 (1050.3 μg) followed by WS, WS 5 and low were recorded in WS 7 (41.43 μg). Acid phosphatase activity was high in WS 6 (1431.1 μg) and low activity was recorded in WS 8 (53.80 μg).

Soil microbial and enzymatic studies help us in understanding the soil health and they help in indicating the nutrient availability for plant growth and increase plant production.

Title	**:**	**Enumeration of microbial populations in different carbon sequestering systems in the semi-arid tropics.**
Name	**:**	**C Vineela**
Institute	**:**	**Andhra University, AP, India**
Supervisor	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**18 June 2001 – 25 March 2002**

Abstract:

The project on 'Microbial Status in Different Carbon Sequestering Systems in the Semi-Arid Tropics' deals with the influence of cropping system and management practices on microbial activity and its role in carbon sequestration in soils. The specific objectives of this investigation were: To study the relationship between soil microorganisms and management practices and their role in the SAT systems.

Elevated counts of microbial populations were recorded with the treatments where both organic and inorganic sources of nitrogen, phosphorous and potassium were applied. Individual addition of organic or inorganic fertilizers did not record high counts of microbial populations as in the combination of organic plus inorganic fertilizers. Microbial population counts were more in Vertisols than in the Alfisols. High counts of microbial population were observed in the pH range 6.5–8.0 than under highly acidic or alkaline soil pH. It was observed that highly acidic conditions were tolerated by fungi as a result in soils where population of fungi were more and the counts of bacteria and actinomycetes were low. It was observed that the counts of actinomycetes were more in the treatments with farmyard manure (FYM), Crop Residue and Green Leaf Manure than with chemical fertilizers.

Further studies on these may help in improving the soil carbon pool for better sequestering systems.

Title	:	**Estimation of biological properties in BW–7 watershed**
Name	:	**Padma Madham**
Institute	:	**Central Research Institute for Dryland Agriculture (CRIDA), AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**27 August – 10 October 2002**

Abstract:

Soil samples from different plots of BW-7 were collected and were analyzed for different parameters like soil respiration, biomass C, mineral N and net N and enzymatic activity.

Variations of values in the parameters with different depths were observed. These experiments provide information on different methods used for analyzing biological parameters.

Title	:	**Training on integrated watershed management**
Name	:	**Vu Ngoc Thang and Vu Van Ba**
Institute	:	**Vietnam Agricultural Sciences Institute (VASI), Vietnam.**
Supervisor	:	**Suhas P Wani (Principal Scientist) and team**
Period	:	**10 January – 9 February 2002**

Abstract:

We researchers participated in the training course on integrated watershed management during 11th January 2002 – 8th February 2002 at ICRISAT, Patancheru, Andhra Pradesh, India.

The training was on the following issues:

- General watershed layout, management, runoff and sediment sample and data collection.
- Agroclimatic data management and analysis and soil moisture measurement.
- Crop growth and yield measurement.
- Soil and plant sampling and nutrient balance.
- Integrated nutrient management vermicomposting, composting and visit to Kothapally watershed.
- IPM and NPV production.
- Introduction to statistical field designs and data analysis.

Year 2001

Title	:	**Effect of soil type, cropping system and seed treatment on vesicular – arbuscular *mycorrhiza***
Name	:	**V Asha Jyothi**
Institute	:	**GVR and S Degree college, Guntur, Andhra University, AP, India**
Supervisor	:	**JVDK Kumar Rao**
Period	:	**2 May – 31 July and 1 October – 31 October 2001**

Abstract:

Studies on VA mycorrhizal spore count of selected soils and root colonization of pigeonpea, chickpea and millet crops were conducted to know the effect of soil type, cropping system and seed treatment (seed priming and *Rhizobium* inoculation) on VAM during May 2001 and July 2001 at ICRISAT, Patancheru, India. The native VA mycorrhizal population was less in Vertisol as compared to Alfisol. The soil collected was at the beginning of *rabi* (postrainy) crop as compared to the soil collected at the beginning of the *kharif* (rainy season) crop. The VAM spore count decreased with increasing soil depth. Effect of cropping system was tested in two different Alfisol fields (RP9B and RCE3) at ICRISAT Centre. Fallow decreased the spore count in RP9B but not in RCE3. Millet did not affect the native VAM spore count in RP9B while it increased in the RCE3.

The study on the effect of seed priming and *Rhizobium* inoculation on VA mycorrhizal infection of chickpea genotypes ICCV2 and ICCC37 was made in pots and at farmer's field conditions. There was a significant difference in treatment effect on both cultivars. The cultivar and treatment also affected the percentage VAM infection. ICCC37 showed higher percentage of VAM infections than that in ICCV2. In pot and field trials the control treatments, ie, T4 and T6 where there was no seed priming and *Rhizobium* inoculation, showed higher percentage of VAM infection than that of *Rhizobium* inoculated treatment.

In a different study on the effect of pigeonpea based cropping system on VAM infection of pigeonpea roots, sole pigeonpea showed higher percentage of VAM infection compared to the pigeonpea intercropped with sorghum. In another study on the effect of plant density on VAM infection of nodulating and non-nodulating pigeonpea genotypes it was observed that there was no significant change between nodulating and non-nodulating genotypes. However, the treatment having 4 plants/m^2 showed highest VAM infection and 8 plants/m^2 showed least VAM infection while the treatments having 33 plants/m^2 and 16 plants/m^2 had infection levels in between the former two.

Title	:	**Participatory evaluation of land and water management system at Kothapally watershed**
Names	:	**Raphaelle Devemy Deleau and Peyra Emilie**
Institute	:	**Institut Superieur d'Agriculture Rhone –Alpes, 30eme Promotion, and ISTOM promotion 90, France**
Supervisor	:	**Prabhakar Pathak, Principal Scientist**
Period	:	**June - October 2001**

Abstract:

The objective was mainly to help the farmers increase their field production by proposing to use best-bet techniques with best advices. For two months the researchers worked in Kothapally, located 40 km south of ICRISAT Center, Patancheru.

Their objective was to establish an agricultural and economic listing and compile the results. The idea was to know the structure of the different crops sown in the three different land management techniques, to understand the market's perception and to judge the farmer's perception about the new initiatives. A questionnaire was prepared with a list of farmers growing similar types of crops and a comparison was prepared in three parts; (a) comparison with the same technique in different soils, (b) comparison between the traditional and the ICRISAT techniques and (c) a comparison between the ICRISAT techniques and different soils. After dividing the work different reports were individually submitted.

Title	:	**Program for the analysis of rainfall data**
Name	:	**G Arun Kumar**
Institute	:	**HRD Degree and PG College, Osmania University, AP, India**
Supervisor	:	**KPC Rao, Sr Scientist**
Period	:	**21 March – 31 July 2001**

Abstract:

This program contained information about the rainfall recorded in different districts and their corresponding stations.

If the rainfall is not recorded then the RFALL field is kept as negative value. There are 46 tables in one mdb file, 23 tables corresponding to the recorded rainfall, 23 tables to rainfall that are not recorded. The table structure follows the guidelines. This application is:

- Used to retrieve the information.
- Used for searching data by selecting options.
- Monthly selection is used to calculate the monthly totals and the yearly rainfall.
- Seasonal selection is used to calculate the rainfall between the two dates.
- Kartes selection helps you to get the data when you select the kartes corresponding to traditional

calendar and displays according to Christian calendar.
- Saving the required information either to a text file or to an excel file.
- Taking the print of the required information.

A Program for the Analysis of the Rainfall Data system has been developed, using Visual Basic 6.0 environment along with activex data objects. The backend database has been stored in MS Access 97. Users cannot access this database as this was provided with a password protection. The user can view the details only by running the application.

Title	:	**Crop database management system**
Name	:	**Murali Krishna**
Institute	:	**Makhanlal Chaturvedi Rashtriya Patrakarita Vishwa Vidyalaya, MP, India**
Supervisor	:	**Piara Singh, Principal Scientist**
Period	:	**19 March – 18 August 2001**

Abstract:

Crop database management is a web-based system and is designed completely to be menu driven. This system provides the required information about the details of all the crops. It is user friendly, easy to access, retrieve and manipulate data. This system is designed in such a way that all the new and latest information will be immediately available to the researchers.

Title	:	**Watershed management at ICRISAT and Kothapally – A microbiological perspective**
Name	:	**Xavier Sarda**
Institute	:	**ISTOM, Cedex, France**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**6 July – 7 September 2001**

Abstract:

In the watersheds, the runoff water carries along with it the finer fractions of soil – the silt and clay which get deposited in the tanks and reservoirs as sediment. The sediment at the bottom of the tanks reduces the storage capacity of the tank and could affect the water quality. Also the sediment is reported to contain high nutrient status and this in turn could affect the environmental quality. The sediment if found to be fertile, could be used as a natural fertilizer by adding it back to the field.

This study was conducted to have a clear insight into the sediment quality and its effect on the environment in the microbiological perspective and carbon dioxide emission from the sediment deposited at different sites of Kothapally watershed tanks. Regarding bacteria, fungi and actinomycetes, the bacterial population was found to be higher in comparison to fungi and actinomycetes. The CO_2

emission studies indicate that the increasing level of sediments did not significantly alter the rate of CO_2 emissions and also was not very different from the control treatment where no sediment was added to the experimental setup. This indicates that the water in the tanks do not alter the rate of respiration of biological life.

Title	:	**Effects of vermicompost amendments on soil microbiological properties, growth and yields of soybean and chickpea crops in Vertic Inceptisols under semi-arid tropical conditions**
Name	:	**Bhavna Priyanka Pershadi**
Institute	:	**Dept. of Biology, RD University, MP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**5 February – 7 September 2001**

Abstract:

There is a need to improve soil fertility by using available resources on the farm for increasing crop yield in SAT. Some of the obnoxious weeds and crop residues can be converted into value added farm compost through enrichment with rock phosphate (RP) and biological agents such as phosphate solubilizing microorganisms, eg, *Aspergillus awamori*, free living nitrogen fixing bacteria such as azosprillum species, fungi and earthworms which can convert farm residues to value added vermicompost. This study was conducted for assessing the potential of using vermicompost for increasing soil fertility in terms of biological, physical and chemical properties, which would consecutively lead to increase in crop yield. On the whole the effect of vermicompost alone was not that beneficial for crops in terms of yield, nutrient uptake and soil biological properties. However, when applied in combination with chemical and biological fertilizers it was found to be highly beneficial in enchaining soil health, yield attributes and nutrient value of crops both qualitatively and quantitatively.

Title	:	**Improvement of farmyard manure for a sustainable agriculture**
Name	:	**Burel Benoit**
Institute	:	**ISTOM, 32, Boulevard du port, 95094 Cergy-Pontoise Cedex, France**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**21 June – 19 September 2001**

Abstract:

Burel Benoit participated in a research work on Natural Research Management Program, on 'On-farm integrated nutrient management and quality of manure/compost used in Kothapally watershed'.

During the training period, he learnt the farming systems in the village by doing a survey on farmyard manure (FYM) with the active involvement of 20% of Kothapally farmers. It was observed that as the years progressed, the number of animals per farm decreased, and as a consequence, the nutrient value

of FYM declined This hypothesis is unfortunately proved right after a comparison with the manure used at ICRISAT.

The farmers have now realized the potential of FYM on their cash crops and are out to find ways of enhancing their production, for example by integrating weeds residues in their farmyard manure pits and by making vermicompost.

Title	**:**	**Simulation of the effects of manure quality, soil type and climate on N and P supply to sorghum and pigeonpea in semi-arid tropical India**
Name	**:**	**R Sucharitha**
Institute	**:**	**Dept. of Agronomy, Sri Venkateshwara Agricultural College, Acharya N G Ranga Agricultural University, AP, India**
Supervisor	**:**	**RJK Myers, Principal Scientist**
Period	**:**	**18 May 1998 – 20 February 2002**

Abstract:

The semi-arid tropics cover almost 20 million km^2 in 55 developing countries, and are home to one-sixth of the world's population. Crop yields in semi-arid tropics fall short of their potential because of inadequate nutrient supply from the generally poor and infertile soils of SAT, inappropriate quality of the organic materials and inefficient combinations of organic and inorganic nutrient inputs. The farmers in this region are left with few options for investing on soil fertility. They would benefit from access to alternative cropping systems like including legumes in the rotation and by using quality manures that could reduce the rate of soil fertility decline, or even raise soil fertility.

Simulations play a key role in resolving the problems of intensive farming since, they can simulate long time periods and large numbers of alternative situations. Of the different models used, APSIM (Agricultural Production Systems Simulator) acts as a tool to improve the effectiveness of research by taking into account the long-term seasonal variability and by filling gaps in the experimental period. APSIM is a state of art modeling package that has been developed in and for tropical farming systems. This study attempted to understand the best way of managing the manure inputs in SAT cropping systems taking into account the manure quality, cropping systems, two major soil types (Alfisols and Vertisols) and climatic risk. The simulation was done within the APSIM framework package for use in agriculture.

The experiments were carried out during the *kharif* and *rabi* seasons of 1998 and 1999 on shallow Alfisols and medium-deep Vertisols at ICRISAT, Patancheru near Hyderabad, India. Manures were classified as low and high quality based on different quality parameters, viz, NO_3^--N, NH_4^+-N, total nitrogen, total phosphorus, Olsen-P, organic carbon, polyphenols, lignin, and acid-detergent-fiber (ADF). Manures with high N and P content, low lignin, low C:N ratio, and low polyphenols are designated as high quality and vice versa. Though the manures were characterized on different parameters, the important factors controlling N release from manure considered in the present study were the carbon and nitrogen contents (C:N ratio only).

Of the two cropping systems examined viz., the pigeonpea - sorghum and sorghum – sorghum system, the amount of available – N (NH_4^+ + NO_3^--N) remaining in the soil after *kharif* pigeonpea was more

than after *kharif* sorghum. This was readily available at the beginning of the cropping season for the subsequent crops. The apparent benefit of legumes in crop rotations may be due to the legume 'sparing' soil N by fixing the majority of the N removed at harvest, rather than the legume directly contributing N to the soil.

In field experimentation the sorghum after sorghum was not grown owing to resource constraints. This gap in the experimental treatments for cereal - cereal rotation was filled using APSIM-maize model as a surrogate. The contribution (or) beneficial residual effect of extra-short-duration pigeonpea to the succeeding sorghum when compared with simulated cereal - cereal rotation, was equivalent to 22 kg N ha^{-1} in the Alfisol and 14 kg N ha^{-1} in the Vertisol. Though it is not large, even a moderate input is valuable for a crop such as sorghum in semi-arid tropics. The study also proved that the response of pigeonpea to manure inputs was more than that of sorghum. It was more by 28% in the Alfisol and 16% in the Vertisol. The improved efficiency of applying manures to the legumes might be attributed to quality manures acting not only as a source of nutrients, but probably stimulating biological nitrogen fixation activity of the legume. The simulated results indicate that the higher water holding capacity of the Vertisol, in conjunction with *kharif* rainfall pattern, make legume-cereal rotation a reliable option for this environment. For Alfisol, with a relatively higher risk of moisture stress for the legume-cereal rotation, the yield benefit to the following cereal is much less.

The inclusion of extra-short duration variety in the system was preferred over short duration varieties because the former matures two weeks earlier, which enables earlier sowing of *rabi* - sorghum. Thus legumes in a cropping system can improve a strategy of integrated soil fertility management aiming at an optimal recycling of nutrients via crop residues, manures, and biological nitrogen fixation.

Pigeonpea responded well to P application at 20 kg ha^{-1} (P20) in Alfisol and Vertisol. The manure treatments also influenced the total biomass, yield, N and P uptake than control at flowering and harvest in both soils. Of the manure treatments, the response to high quality was more compared to low quality. The crop's response was more in Alfisol than in Vertisol. The positive interaction between Alfisol and P20 application during *kharif* 1999 indicates the synergistic effect of the treatment and a considerable response from the soil to the added P.

The response of *rabi*-sorghum in terms of its biomass, yield, and N and P uptake was more in the plots applied with high quality manure (MB) followed by P application at 20 kg ha^{-1} and low quality manure (MA). The P application to pigeonpea might have activated the development of P solubilizing organisms in the root zone of this crop and also to Fe_3PO_4 - solubilizing activity of certain components of their root exudates, namely piscidic acid and its derivatives, thus increasing the available P pool. Consequently, succeeding sorghum in the rotation may access such P.

The N fertilizer substitution value of high quality manure was 28 kg ha^{-1} and low quality was 15 kg ha^{-1}. This has significantly influenced the biomass, yield, and N and P uptake. The higher lignin and polyphenols concentration in low quality manure resulted in poor decomposition of this manure, thus affecting the release of nutrients. However, the model suggests little residual benefit of manure for *rabi* cereal. This might be due to little rainfall in *rabi* to drive further decomposition and N release (since manure is in surface layer that is seldom re-wet by rain in rabi). Addition of nitrogen to *rabi* sorghum was associated with significant increase in growth, N and P uptakes and yield. Quantitatively the benefits preceding from high and low quality manures in both soils were equivalent to 40–80 kg N ha^{-1} applied. The low fixation or adsorption of phosphorus (both applied and manure P) in Alfisol than that of Vertisol has improved the P status of the soil, thereby resulting in the increase of biomass, yield and N and P uptake of sorghum grown.

The simulations slightly overestimated the total biomass for the control and P treatments because the model was not P aware. Nevertheless, the model ensured the best representation of the legume effects on soil N and residue inputs (roots and leaf litter) for the legume with subsequent effects on N supply to the *rabi* cereal crop.

Higher biomass, yield, N and P uptake was obtained in the irrigated plots of sorghum than rainfed plots during *rabi* 1999. Irrigation at critical stages of crop growth increased water use and nutrient uptake over rainfed thereby increasing the biomass production and grain yield. The response of sole sorghum to combined application of N+P was more compared to other treatments at flowering and final harvest in both soils. The increase in N and P uptake due to N+P application could be attributed to the favorable effect of nitrogen application on dry matter production. The reduction in soil nitrate N from flowering to harvest indicates higher uptake of N and P by the crop thus resulting in higher biomass production and yields.

The response of sorghum to high quality manure (MB) indicates that the higher N and P concentration and low C:N ratio of MB increases the decomposition rate, resulting in the quick release of available nutrients to the plant throughout the growth period.

The response of sorghum to manure and fertilizer applications was more in Alfisols compared to Vertisols. The apparent lack of fertilizer responses on Vertisols has been attributed to their high fixation (adsorption) of added P, caused by their high clay content, dense and compact nature, and low porosity.

As the APSIM sorghum module is not P aware, the maize module was used as a surrogate for sorghum. It was assumed here that the maize surrogate behaved similarly to the sorghum used in the field. The model was better at predicting the responses of sorghum to organic and inorganic fertilizer application in terms of its biomass. The accuracy of prediction was 88%, which explained that the experimental data was in error of 12%, which was quite feasible (or acceptable) for a field experiment. The slope of close to 1.0 suggests little bias in the model for simulating low or high yields. The regression equation indicates that APSIM was adequate for simulating the biomass yields of maize or sorghum. The results of the present study help us to develop guidelines for fertilizer/manure applications for farmers in semi-arid tropics by combining field research and simulation

Title	**:**	**Technology development for the degraded Himalayan slopes based on VAM and some useful herbs of Central Himalayas**
Name	**:**	**Poonam Mehrotra**
Institute	**:**	**Center for Scientific and Industrial Research (CSIR), New Delhi, India**
Supervisor	**:**	**Suhas P Wani, Principal Scientist**
Period	**:**	**10 September – 12 October 2001**

Abstract:

The study area chosen was situated at the vicinity of Nainital Township. Four sites were selected, ie, two under dense forest cover and the other two are degraded slopes, located at 1900–2200 m altitude, 29° 22'–23' N' latitude and 79° 26'–79° 29' E longitude. The hill slopes were moderate to steep (25° and 40°).

The plant species selection was done by phytosociology of a site, by randomly placing 20 quadrats (1 × 1 m). Species richness was studied at all sites, ie, two forest sites (Canopy of *Querqccus leucotrichophora,* (Oak) and two at degraded sites. The phytosociology of herb layers was done during postrainy season because of optimum conditions of environment. Total 49 species were reported and 27 were common at both sites. These herbs belonged to 19 different families, ie, *Labatae*, *compositae*, *Poacease*, *Polygonacene*, etc.

The maximum number of species was observed in composite family (14 species/at both sites). The selected species contained a wide range of uses for local as well as for outsiders. They were not only a valuable source for medicines but also used as raw material, for different industries, eg, in preparing fibre, paper and perfume (data not given here). More than 50% species present at each site provided various chemical compounds for manufacturing of different pharmaceutical products. All 48 plants species were examined for VAM status and all of them resulted in positive and showed a wide range of percentage of colonization in their roots. The extent of colonization differed within family/ genus. None of single species showed similar colonization values in same families. A significantly higher number of vesicles were present in the inner and outer layer of root cortex and some showed arbusculares. It may be related to leaf life span of a plant. Long leaf life span may cause delay in the formation of vesicles and a long active exchange stage arbuscules remained for a considerable period. The present study reports the association of AM fungi in these plants of central Himalayas tropical regions.

This extent shows considerable promise for selection of suitable endomycorrhizal fungi for improving the establishment and productivity of economically important herbs, especially in nutrient deficient soils. Further studies of characterization of VAM fungi in herbs are needed. To combat land degradation, better management of natural resources is essential to achieve sustainable development. There is a need for models, which interact with scientific and traditional practices to prevent land degradation. It is essential therefore to analyze local indigenous knowledge of the environment, land and plant resources and to integrate it with existing technologies for conservation of hill biodiversity. The aim of this research is a development of new agro-medicine forestry techniques on the basis of the indigenous knowledge of the hill people.

Title	**:**	**Development of a computer program /model for designing the check dams**
Names	**:**	**D Naga Jyothi and T Naga Mallika**
Institute	**:**	**Vignana Jyothi Institute of Engineering and Technology, Hyderabad, affiliated to Jawaharlal Nehru Technological University, AP, India**
Supervisor	**:**	**Prabhakar Pathak, Principal Scientist**
Period	**:**	**February – June 2001**

Abstract:

The program/model was for developing and designing check dams (one of the most popular structure in watershed development project). A most user-friendly application, which will not only serve the needs of the people at ICRISAT but watershed implementing agencies nationally and internationally. Watershed management involves a combination of practices, which include agriculture, forestry and

engineering measures to achieve certain objective of land and water management on a regional basis. The objectives could be flood control, water conservation or sediment reduction. The total application was divided into two modules. Initially the first module involves the development of hydrologic model to predict the runoff (ie, excess water or the overflow of rain water) based on SCS–curve number technique which involves various formulae to calculate runoffs based on the rain water on a particular day considering the rain pan evaporation constant coefficient as inputs from text files.

The second module involved linking of GIS (Digital Elevation Model) to the hydrologic model (first module) to determine the check dam's water storage capacity. Once the application is developed it will help the engineers to identify the proper location for constructing the check dams. This will help them to work out the designing details effortlessly with the help of the output and graphs provided by the application. The application is developed in such a manner that it can estimate the check dam's effectiveness in harvesting water and ground water efficiently.

Title	**:**	**Microcontroller-based sediment sampler for agricultural watersheds**
Name	**:**	**Mukesh Tomar**
Institute	**:**	**Deccan College of Engineering and Technology, Hyderabad, affiliated to Osmania University, AP, India**
Supervisor	**:**	**Prabhakar Pathak, Principal Scientist**
Period	**:**	**January – June 2001**

Abstract:

The sediment sampler was devised to take the samples at a fixed sampling interval for estimating the soil loss. Earlier the sampling periods had to be changed manually. There was a need to improve this instrument, which could give one a more accurate data. Three more sensors were required to be installed and the sampling period to change in accordance with the sensors sensed. As the flow rate of runoff water increases the height of water level also increases. Hence taking more samples during high runoff rates could give us more reliable data for soil loss estimation.

The researcher improved the sampling unit by adding three new sensors and thereby changed the sampling period for each sensor. These sensors were placed at different heights. The device is programed in a manner where it chooses a different sampling period for different sensor, and represents different flow rates. As the flow of water increases the height of water in flume increases and when the sensor comes in contact with water it automatically shifts to a timing cycle assigned for that particular sensor. Thus, we obtain different sampling periods for different flow heights. As the runoff water height increase the sampling intervals are reduced. This helps in estimating soil loss with greater accuracy.

Title	:	**Watershed database management system**
Name	:	**G Naga Satish Reddy**
Institute	:	**Nizam Institute of Computer Sciences, AP, India**
Supervisor	:	**Suhas P Wani, Principal Scientist**
Period	:	**September – October 2001**

Abstract:

The project was carried to develop Data Management System (DMS) for watershed research for Kothapally village, Ranga Reddy district, Andhra Pradesh. The project was aimed at saving data under various modules, access for updating and validating the data and retrieving the data in the form of reports. DMS was developed using Visual Basic programming for Windows Operating System incorporating SQL server 7.0. A developed DMS consists of four modules, viz, data entry module (farmer details, climate, hydrological details, cropping system, soil) utilities module (adding/updating, data back up and update data base), report module (farmer details and weather details) and help. The DMS developed was tested and validated with the data collected from watershed project. The system was incorporated with online processing, aiming at maintaining the data collected under different categories from various locations and making the data available for different users and retrieving the same in a well formatted form.

Year 2000

Title	:	**A survey of farmers and land degradation**
Name	:	**Christian Gruhlich**
Institute	:	**Dept. of Geography, University of BONN, Germany**
Supervisor	:	**Prabhakar Pathak, Principal Scientist**
Period	:	**1 August – 31 October 2000**

Abstract:

The target of this apprenticeship was 'Study of land degradation' in the Adarsha watershed, Kothapally. Christian Gruhlich studied soil and water conservation technologies, which helped to increase productivity of rainfed agriculture and maintain the natural resource base. Integrated pest management (IPM) is another aspect of this project. Watershed management is an approach of area planning of natural resources, especially land, water and plants to subserve the socioeconomic needs of human society of community concerned. Sustainability in terms of ecosystem principles, meetings sustenance and trade-off needs of the household or livelihood of its members require to be guaranteed.

Title	:	**Practical and analytical procedures of parameters – protein, oil by NMR and Soxhlet, fatty acid composition, sugars and starch, fiber, lignin, ash, moisture, minerals and trace elements**
Name	:	**Bishnu Pada Lahiri**
Institute	:	**Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh**
Supervisor	:	**Prabhakar Pathak and P V Rao**
Period	:	**May – July 2000**

Abstract:

Bishnu acquired good practical knowledge on the modern methods of quality assessments of crops through this training. After gaining knowledge of biochemical analyses, some chickpea, groundnut and millet fodder samples were taken for analysis of their chemical composition such as protein, starch, soluble sugars, oil, fatty acids, fibers, ash, minerals and trace elements by the modern methods of respective parameters.

About ICRISAT

ICRISAT
Science with a human face

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

Company Information

ICRISAT-Patancheru
(Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

ICRISAT-Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India
Tel +91 11 32472306 to 08
Fax +91 11 25841294

ICRISAT-Nairobi
(Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550
Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey
(Regional hub WCA)
BP 12404
Niamey, Niger (Via Paris)
Tel +227 20 722529, 20 722725
Fax +227 20 734329
icrisatsc@cgiar.org

ICRISAT-Bamako
BP 320
Bamako, Mali
Tel +223 2223375
Fax +223 2228683
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776,
Bulawayo, Zimbabwe
Tel +263 83 8311 to 15
Fax +263 83 8253/8307
icrisatzw@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi
Tel +265 1 707297/071/067/057
Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
c/o IIAM, Av. das FPLM No 2698
Caixa Postal 1906
Maputo, Mozambique
Tel +258 21 461657
Fax +258 21 461581
icrisatmoz@panintra.com

270-2008