TECHNICAL REPORT ON

CURRENT ORGANIC AGRICULTURAL PRACTICES IN

ANDHRA PRADESH

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ABBEVIATIONS

ANGRAU : Acharya NG Ranga Agriculture University
AP : Andhra Pradesh
APSSARA : AP Society for Sustainable Agriculture in Rainfed Areas
BGA : Blue Green Algae
BIRDS : Bharathi Integrated Rural Development Society
CARE : Center for Applied Research and Extension
CARVE : Collective Activity for Rejuvenation of Village Arts and Environment
CH₄ : Methane
CIG : Common Interest Group
CMSA : Community Managed Sustainable Agriculture
CO₂ : Carbon –Di-Oxide
COAPCL : Chetna Organics Agriculture Producing Company Ltd
COFA : Chetna Organics Farmers Association
CRIDA : Central Research Institute for Dry land Agriculture
CSA : Centre for Sustainable Agriculture
DDS : Deccan Development Society
DIPA : Development Initiatives and People’s Action
FAO : Food and Agricultural Organization
GA : Gibbarellic Acid
GEF : Global Environment Facility
GHG : Green House Gases
gm : Grams
GoI : Government of India
GVS : Gram Vikas Samstha
Ha : Hactare
IAA : Indole Acetic Acid
IARI : Indian Agriculture Research Institute
ICAR : Indian Council of Agriculture Research
IEC : Information, Education, Communication
IFSA : Integrated Farming Systems Approach
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<thead>
<tr>
<th>Acronym</th>
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<tr>
<td>IKP</td>
<td>Indira Kranti Padam</td>
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<td>INCCA</td>
<td>Indian Net Work for Climate Change Assessment</td>
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<td>INM</td>
<td>Integrated Nutrient Management</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>IPM</td>
<td>Integrated Pest Management</td>
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<tr>
<td>Kg</td>
<td>Kilo grams</td>
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<td>LEISA</td>
<td>Low External Input Sustainable Agriculture</td>
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<td>L or lit</td>
<td>Liters</td>
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<td>MGNREGS</td>
<td>Mahatma Gandhi National Rural Employment Guarantee Scheme</td>
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<td>ml</td>
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<td>Nitrous Oxide</td>
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<td>NGOs</td>
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<td>NPK</td>
<td>Nitrogen, Phosphorous, Potassium</td>
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<td>NPM</td>
<td>Non-Pesticidal Management of Pests</td>
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<td>NPOP</td>
<td>National Program for Organic Production</td>
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<td>OFAI</td>
<td>Organic Farming Association of India</td>
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<td>PARTNER</td>
<td>People’s Activity and Rural Technology Nurturing Ecological Rejuvenation</td>
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<td>PGS</td>
<td>Participatory Guarantee System</td>
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<td>Project Management Office</td>
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<td>PNGOs</td>
<td>partner Non Governmental Organizations</td>
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<td>ppm</td>
<td>parts per million</td>
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<td>PTD</td>
<td>Participatory Technology DEvelopment</td>
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<tr>
<td>PSB</td>
<td>Phosphate Solubilizing Bacteria</td>
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<tr>
<td>RKVY</td>
<td>Rashtriya Krushi Vikas Yojana</td>
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<tr>
<td>SAFE</td>
<td>Society for Sustainable Agriculture And Forest Ecology</td>
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<td>SAID</td>
<td>Social Awareness for Integrated Development</td>
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<td>SERP</td>
<td>Society for Elimination of Rural Poverty</td>
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<td>SHM</td>
<td>State Horticulture Mission</td>
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<td>SLWM</td>
<td>Sustainable Land and Water Management</td>
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<td>SPACC</td>
<td>Strategic Pilot on Adaptation to Climate Change</td>
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<td>SYA</td>
<td>Star Youth Association</td>
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EXECUTIVE SUMMARY

The Modern Agriculture practices promoted during the green revolution period and irrational use of chemical inputs over the last four decades resulted in development of vast stretch of degraded lands, loss of natural habitat balance, loss of soil health and caused many hazards like soil erosion, decreased groundwater table, soil salinity, pollution due to fertilizers & pesticides, genetic erosion, effect on environment, food contamination with heavy metals, reduced food quality and increased cost of cultivation, making the agriculture unviable and uneconomical. Further, Green revolution technology is also one of the causes and accelerator of today’s Climate Change issue, the major threat to the mankind and economy. Climate Change impacts on Agriculture are more likely to arise from increased Climate Variability and increased frequency and intensity of extreme events, rather than from changes in mean climatic conditions (Padgham 2009). Higher temperatures resulted due to excess accumulation of GHGs eventually reduce yields of most crops while encouraging weed and pest occurrence, drying of soil demand more water and frequent irrigations, faster decomposition of organic matter due to high temperature which has cascading effect such as loss of fertility, loss of microbial biomass, soil become more susceptible for erosion, increased transpiration in plants cause moisture stress with in plants, reduced growing period which again decreases dry matter accumulation and yield in plants. Although there will be gains in some crops in some regions, the overall impacts of Climate Change on Agriculture are expected to be negative, threatening global food security.

In the context of visible adverse impact of green revolution technology coupled with negative impact of Climate Change on Agriculture production, there is growing interest among the scientific community and also farmers, in finding alternative farming systems. One approach is to build upon age old traditional methods of crop production which are purely organic in nature, largely excludes chemical inputs. Organic Agriculture is gaining importance in all over the world as it offers a viable option to ill effects of Modern Agriculture and provide adaptation and mitigation scope against Climate Change. Organic Agriculture is a form of sustainable Agriculture system that aims for conservation of resources and protection of natural environment, defined as “a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of on-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using wherever
possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system’ (FAO 1999)

Agriculture, specifically Organic Agriculture has the potential to make a cost effective contribution to the mitigation of Climate Change, since, it realizes sequestration of Carbon-di-oxide (CO₂) in an effective way. The IPCC estimates that Agricultural Green House Gas mitigation options are cost competitive with non-agricultural options in achieving long term climate objectives. Organic Agriculture systems are highly adapted to Climate Change due to the application of traditional skills and farmers’s knowledge, which is a key to adaptation to Climate Change. The highest mitigation potential of Organic Agriculture lies in carbon sequestration in soils and enhancing crop biodiversity, restoring natural ecosystem. The carbon sequestration is increased by practicing poly-cropping techniques such as intercropping, mixed cropping, strip cropping, Agroforestry, promoting tree based farming systems etc. The main organic strategies are diversification and an increase of soil organic matter, both could enhance resilience against extreme weather events and are recommended by the IPCC. Further, GHG emissions are reduced in organic systems by avoidance of mineral fertilizers and relies on only organic sources for soil fertility and crop nutrition management by using leguminous crops for Nitrogen source, incorporating crop residues, green manures/cover crops, compost, vermicompost, oil cakes, biofertilizers etc. This leads to stabilization of soil organic matter and sequestration of carbon dioxide into the soil. This in turn increases the soil's water retention capacity, thus contributing to better adaptation of Organic Agriculture under unpredictable climatic conditions coupled with uncertain precipitations. Thus Organically managed soils because of high organic matter content absorb and retain significantly more rain water. Thus, organically managed soils are better adapted to weather extremes and are in good position to maintain productivity in the event of drought, irregular rainfall events even with floods and rising temperature. Further, the high level of crop diversity maintained at organic farms enhances farm resilience to climate variability. Positive influence of enhanced diversity on pest management is also been proved by many researches (Zehnder et al., 2007, Wyss et al., 2005). Diversified Agro-ecosystem has positive effect on diseases and better utilization of soil nutrients and water (Altieri et al., 2005).

Organic Farming in AP is gaining good momentum in Andhra Pradesh. In view of increasing demand for Certified Organic products in the national and International market and to benefit the farmers, the department of Agriculture, Government of India and Andhra Pradesh had also taken up the Certified Organic Farming program under ‘National Program for Organic Production
program for Pulses and Paddy crops since 2006. Similarly, the Horticulture Department of AP is also implementing the Certified Organic Farming scheme under the State Horticulture Mission (SHM) from the financial year 2008-09. Acharya NG Ranga Agricultural University has been conducting comparative research studies on Organic Farming since 2007 at all its research stations in the state. Central Research Institute on Dryland Agriculture (CRIDA), Hyderabad since 2005-06 is also engaged in developing Organic Agriculture package of practices for Redgram the important Rainfed crop. Besides Government agencies, NGOs are also promoting Organic Farming in Andhra Pradesh. The Deccan Development Society (DDS) an internationally popular NGO in AP is promoting Organic Farming through women based Self Help Groups and Community Based Organizations. Similarly, Centre for Sustainable Agriculture (CSA) a Hyderabad based NGO has experimented and promoted Non-Pesticidal Management of Pests (NPM) in 2004. The efforts of NPM program resulted in 124 pesticide free villages in AP by 2011. Society for Elimination of Rural Poverty (SERP) through Federation of Women Self Help Groups (Mandal Mahila Samakhyas) has taken scaling up of Non Pesticidal Management (NPM) practices in collaboration with a consortium of Civil Society Organisations. Timbaktu Collective (www.timbaktu.org) is another voluntary organization which has been promoting Organic Farming practices since long time in highly drought prone Ananthapur district of AP. The organization has promoted ‘Dharani Farming and Marketing Mutually Aided Cooperative Society Ltd.’, which is now promoting, procuring, processing and marketing the organic produce of its farmer members, if possible at a premium price. Chetana Organics, a NGO in AP since 2004 is engaged in promoting sustainable, ecological and profitable farming systems that helps to protect small and marginal farmers from the agrarian crises. Chetana Organics has organised its members into Self-Help Groups and Cooperatives and promoting certified organic production of Cotton through ‘Chetna Organic and Fair Trade Cotton Intervention Programme’. It operates under Chetna Organics Farmers Association (COFA) and Chetna Organics Agriculture Producing Company Ltd (COAPCL). COFA and COAPCL together represent the supply chain programme at the national level.

In this context of growing demand for Organic Agriculture, the present documentation of ‘Current Organic Agricultural Practices in Andhra Pradesh’ has been taken to promote sustained, viable Agriculture production which is also adaptable to Climate Change and enhance the sustained net income levels of the farmers through Organic Farming especially in the Rainfed regions of the Andhra Pradesh. The present documentation study is taken up during the year 2011, with the objectives; (i) to document organic Agriculture practices prevailing in Rainfed
regions of Andhra Pradesh and analyze such agricultural practices for their strengths and weaknesses in the context of Climate Change and adaptations; (ii) to identify technically sound and feasible options and assessing the potential to improve the performance of such practices through participatory research in farmers field; (iii) to assess for scope to extrapolate such technically sound and viable practices in similar Agroecological environments and socio-economic conditions. The qualitative research method was adopted for the study, which is exploratory and interpretive in nature. Current status of Organic Agriculture practices were documented from drought prone districts representing the Rainfed region of the state where the ‘Strategic Pilot on Adaptation to Climate Change (SPACC)’ Project is in operation, besides, collecting information on viable Organic Agriculture practices prevailing within and outside Andhra Pradesh by desk review.

Inspite of several economic, health and environmental benefits, Organic Agriculture practices have slowly moved out of Indian Agriculture system, especially among the Agriculturally advanced states including Andhra Pradesh. It is observed that very few farmers in SPACC project area are practicing Organic Agricultural practices and largely depending of chemical inputs, mostly for want of instant benefits from chemical inputs, easiness in handling and to some extent difficulty in accessing the organic inputs. Increasing labour cost is also preventing them to adopt labour intensive organic practices. Moreover, Agriculture policy of Indian government also favours chemical based Agriculture technology, biased towards irrigated farmers and is of limited use to dry land /Rainfed farmers. Chemical Agriculture no doubt helped India reaching self sufficiency in food grain production, but at the cost of environment. As Rainfed Agriculture is going to be effected badly due to Climate Change and Climate Variability, there is a need to design exclusive Agriculture policy tailor made to Rainfed regions, supporting labour incentives (it could be through MGNREGS) as well as organic matter addition.

It is observed that whatever, Organic Agriculture practices now prevailing in Andhra Pradesh are mostly the promoted under NPM–CMSA program. Irony is that, proper documentation of Indigenous Traditional Knowledge with respect to various Agricultural practices in Andhra Pradesh is lacking. Scientific organisations are now become alert in developing organic package of practices for important food crops. Most of the Organic Agricultural practices documented in this report have good scope to scale up in wider area in a project mode and few others still need technical validation. Following are the ways and strategies to promote and scale up Organic Agriculture, especially in Climate sensitive Rainfed region;
1. The potential Organic Agriculture practices documented with respect to seed treatment, crops cropping systems, soil management, pest & disease management, post harvest handling etc in this report need to be further refined and pilot tested to evolve crop specific and location specific organic package of practices.

2. There is a need to increase the knowledge and capacity of communities to adapt to climate variability. Further build the skills and tools for communities to integrate climate adaptation into sustainable land and water management (SLWM) practices and their decision making in Rainfed Region.

3. Diversification of crops and cropping systems is the best adaptation measure against Climate Change, especially for risk minimization. In dryland conditions crop diversification should be encouraged from irrigated crops (ex.Paddy, Sugar cane etc) to Irrigated dry crops (Pulses, Ground nut, Sunflower etc) to dry crops (Jowar, Coarse Cerials). Promoting ‘System of Rice Intensification (SRI)’ concept is more resilient in the context of scares water availability in Rainfed areas.

4. Integrating millets (Ragi, Jowar, Bajra, Little millet, Fox tail millets etc) occupy special place in the context of drought adaptations. Such production system is a good measure towards drought proofing as millets can withstand moderate drought, its production consumes less water, low cost of production because of less pest & disease problems. Affords may be placed to bring in the millets under the purview of the Public Distribution System (PDS) to increase the consumption demand in view of nation’s food security and the declining ground water scenario. Creating market incentives to the millets is prerequisite to encourage farmers.

5. Promoting Poly-cropping systems such as legume based intercropping system or millet based intercropping system that are highly resilient with variables climatic conditions and also minimize the risk of total crop loss as the risk is spread over several crops. Further, fodder cop based intercropping system also promote livestock component. Organic Agriculture to be successful, must integrate plant and livestock production to the extent possible to optimize nutrient use and recycling.
6. Organic Agriculture helps to counteract Climate Change by restoring soil organic matter content as well as reducing soil erosion and improving soil physical structure. Further, GHG emissions are reduced in organic systems by avoidance of mineral fertilizers and relies on only organic sources for soil fertility and crop nutrition management by using leguminous crops for Nitrogen source, incorporating crop residues, green manures/cover crops, compost, vermicompost, oil cakes, biofertilizers etc.

7. Botanical pesticides are best adaptive measure towards high climatic temperature as induced by Climate Change. Compared to synthetic pesticides, botanical products are generally safer to use and less persistent, most of them will break down quickly under influence of high temperature or sunshine. Therefore, they don't have a long lasting contaminating effect on the environment.

8. Success of Organic Agriculture involves careful use of water resources. Highly water use efficient micro irrigation systems (Sprinklers and Drip irrigation systems) should be promoted by providing financial incentives/subsidies.

9. Traditional Agriculture system which is organic in nature emphasizes more of small agriculture units and closed system. Hence, village may be considered as unit for development and planning for sharing of village level resources.

10. Sustainable development of degraded lands not only offers income opportunities for rural populations but also has a huge mitigation potential by increasing soil carbon sequestration.

11. The traditional form of Organic Agriculture is not necessarily sustainable, even if it has been adapted to local conditions. Population growth, declining prices, insecure land tenure and water-use rights, along with many other factors, have often led to overuse, loss of diversity, soil degradation and other environmental problems. In many instances, organic forms of agriculture can no longer produce enough income and a secure livelihood. Hence, there is an urgent need for more sustainable approaches such as
Low-External-Input Sustainable Agriculture (LEISA), Integrated Pest Management (IPM), Integrated Nutrient Management (INM), Conservation agriculture and minimum tillage, Certified Organic production etc.

12. It would be more effective to promote above mentioned systems by organizing the organic farmers and promoting as Commodity Interest Group (CIG) groups or Self Help Groups. These farmers/groups are trained in different techniques of Organic Farming under Farmer Field School concept. Facilitating the farmer groups in establishing forward and backward linkages.


14. Providing financial assistance to small and marginal farmers at individual basis or group basis for purchase and preparation of organic inputs, supporting the cost of certification for Organic Farms. Declaring compensation for declining yields for the first 2-3 years during the conversion period under Organic Production to gain the confidence of producers.

15. The exiting knowledge and data-base are inadequate and more extensive studies, data base and documentation are needed to develop climate resilient production system.

16. Public policies and research support is highly required to promote Organic Agriculture. For example, policies for MGNREGS support to prepare and incorporate compost and vermicompost in the soil. Example 2- Government support in the form of subsidies for organic inputs and labour cost in the manner supporting the chemical inputs. Government can take up the large scale production of inputs on Government land such as community composting will generate employment and ensure timely supply of input to Rainfed farmers.

17. There should be clear Exit policy with the Organic Farming promoting organization. Hand hold support may be provided to the organic farmers during the conversion period
atleast for initial 3-4 years. Organization support may be withdrawn when the Farmer
groups are self-reliant.

To conclude, Organic agriculture has great potential to reduce farmers’ risks. A single organically
grown crop might yield less than if it were grown conventionally, but the total value of all the
organic crops, in combination with drastically reduced input costs, many give farmers a similar or
(somewhat higher) profits. The organic farmer also is cushioned from price fluctuations of
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CHAPTER 1: INTRODUCTION

1.1. Context
Andhra Pradesh is the fifth largest state in the country both in area and population and one of the agriculturally important states in India. The state ranked eighth among the states in India both in terms of share of Agriculture GDP (24.7 %) and employment generation (58.55%) as per the 61st round of National Sample Survey 2007. The state has 23 districts classified under 3 regions, viz. Telangana (10 districts), Coastal (9 districts) and Rayalaseema (4 districts). The state has 1112 mandals with 26586 villages. The role of Agricultural Sector in the state economy is very significant. The contribution of primary sector including Agriculture, Horticulture and Animal Husbandry to the State Gross Domestic Product for the year 2009-10 is 22.18% (Agriculture Statistics at a Glance, Andhra Pradesh 2009-10). The proportion of area under agriculture in the state is 45.7%. The Gross Irrigated Area accounts to 45.9 % of Gross Area sown in the state, with a cropping intensity of 124 per cent. The sector employs 62% of the total work force (Agriculture Statistics at a Glance, Andhra Pradesh 2009-10). Small and marginal farmers account for 83% of land holdings and 46% of operated area. Rainfed Agriculture in Andhra Pradesh is to the extent of 6.4 million ha. The state receives an average rainfall of 940 mm.

Like in any other states of India, farmers of AP were also farming traditionally. However, food crisis and population pressure together during early sixties paved way to green revolution. As a result, production of food grains in India during 1949-50 to 1998-99 increased at the rate of 2.5% per annum leading to not only sufficiency but also surplus for export. The yields were increased because of new technology like introduction of HYV, extension of irrigation areas, and usage of high analysis NPK fertilizers, mechanization and increase in cropping intensity. Andhra Pradesh has been one of the front-runners in reaping the benefits of green revolution. However, the adverse impact of green revolution technology has been strongly felt only after Forty years of practicing. Green revolution no doubt increased the food grain production but at the cost of environment. The modern Agriculture practices and irrational use of chemical inputs over the last four decade resulted in development of vast stretch of degraded lands, loss of natural
habitat balance, loss of soil health and caused many hazards like soil erosion, decreased ground water table, soil salinity, pollution due to fertilizers & pesticides, genetic erosion, effect on environment, reduced food quality and increased cost of cultivation, making the Agriculture unviable and uneconomical. The heavy metals in the fertilizers and pesticides have entered in to the food chain as is the case with DDT contamination. Further, Green revolution technology is also one of the causes and accelerator of today’s Climate Change issue the major threat to the mankind and economy.

1.2. Climate Change and Agriculture
Climate Change is another emerging threat to the Agriculture sector since decade. Agriculture of the “Green Revolution” contributes a great deal to Climate Change. It is the main source of potent Green House Gases viz., Nitrous Oxide (N₂O) and Methane (CH₄); Agriculture is both affected by Climate Change but also contribute to it. Further, it is a source as well as sink for GHGs. In India, the Agriculture sector is contributing Green House Gas (GHG) accumulation upto 17% of the net CO₂ eq emissions (Indian Net Work for Climate Change Assessment (INCCA) Report for 2007). Further, the Agriculture sector alone emitted 334.41 million tons of CO₂ eq in 2007 arising from enteric fermentation in livestock (212.10 million tons of CO₂ eq or 10.1 million tons of CH₄), manure management (2.44 million tons of CO₂ eq), Paddy cultivation (69.87 million tons of CO₂ eq or 3.27 million tons of CH₄), from agricultural soils and field burning of crop residues (releases N₂O =CO₂ eq emitted from these two sources were 50.00 million tons) as reported by Indian Net Work for Climate Change Assessment (INCCA). The present level of GHG emissions are causing increased temperature, unpredictable rainfall pattern (Reduction in rainfall, Erratic onset of rainfall/ monsoons, Increased length of dry spells, Increased frequency of high-intensity rainfall events, Off-season rains), increased frequency of droughts, increased frequency of floods, altering groundwater status, extreme weather events etc adversely impact the most Climate Change sensitive sector like Agriculture.

Agriculture is extremely vulnerable to Climate Change. Climate Change impacts on Agriculture are more likely to arise from increased Climate Variability and increased frequency and intensity of extreme events, rather than from changes in mean climatic conditions (Padgham 2009). Higher temperatures resulted due to excess accumulation of GHGs eventually reduce yields of most crops while encouraging weed and pest occurrence, drying of soil demand more water and frequent irrigations, faster decomposition of organic matter due to high temperature which has cascading effect such as loss of fertility, loss of microbial biomass, soil become more susceptible
for erosion, increased transpiration in plants cause moisture stress with in plants, reduced growing period which again decreases dry matter accumulation and yield in plants. Although there will be gains in some crops in some regions, the overall impacts of Climate Change on Agriculture are expected to be negative, threatening global food security. The adverse impact of Climate Change in AP is already visible due to recurrent droughts in Andhra Pradesh, tank irrigation has declined during the last two decades, canal irrigation remained stagnant. Similarly, cultivation under dug wells and bore wells has increased significantly leading to depletion of water table below 600 feet in certain areas in Rayalaseema region of Andhra Pradesh. Further, with degraded lands and gradual withdrawal of subsidies to agricultural sector also increased cost of cultivation and Agriculture has become uneconomical. This has led to unrest among the farmers resulting suicide deaths in the state especially in Rainfed regions. As a sector, Agriculture must therefore both adapt to Climate Changes and offers options for mitigation ie., reducing green house gasses.

To name few specific potential impacts of Climate Change on Indian Agriculture would be, decline in productivity of most cereals due to increase in temperature and decrease in water availability especially in Indo-Gangetic plains (Venkateshwarlu 2008). The loss in crop production is projected at 10-40% by 2100, depending upon the modeling technique applied. Greater loss expected in rabi due to higher temperatures with longer duration. 1°C increase in temperature may reduce yields of major food crops by 3-7%. Length of growing period in Rainfed areas is likely to reduce, especially in peninsular regions. However, the positive side of the Climate Change impact for dry land farming is that the kharif rainfall is going to increase, further, one degree rise in temperature is not going to make a lot of difference to productivity of kharif crops (Venkateshwarlu 2008).

Rainfed Agriculture is more vulnerable to Climate Change impact. Rainfed Agriculture in Andhra Pradesh occupies >60 % of the cultivated area and is the main source of livelihood for a large number of poor and marginal farmers; who are also mostly wage labour. In general, the production in Rainfed areas is risky and constrained by inherently poor soils, low ground water resources, dry weather and lack of organic matter. Climate Change further accentuates these risks and may leave the Rainfed farmers much vulnerable and therefore, calls for an immediate action. These vulnerability aspects warrants to design special programs exclusively address the Rainfed issues.
1.3. Organic Agriculture Practices in the context of Climate Change

In the context of visible adverse impact of green revolution technology coupled with negative impact of Climate Change on Agriculture production, there is growing interest among the scientific community and also farmers, in finding alternative farming systems. One of the approaches would be to build upon age old traditional methods of crop production which are purely organic in nature, largely excludes chemical inputs. Fortunately, there is still a vast store of organic agriculture know-how in many of the farming households. Many traditional farmers in Andhra Pradesh are still practicing organic/ traditional farming methods that are in balance with the surrounding ecosystems, stable, sustainable and are highly efficient. Further, the new chemical Agriculture technology also has its own advantages, hence, blending of the Organic Agriculture practices with new technology will bring basketful of technological options that are socially acceptable, economically viable and environmentally safe. Organic agriculture was developed as a holistic, ecosystem-based approach, conceived as an alternative to what proponents see as the ecologically unsound practices of conventional agriculture (Smith 1993).

Organic Agriculture is gaining importance in all over the world as it offers a viable option to ill effects of modern Agriculture and adaptation and mitigation scope against Climate Change. Organic Agriculture is a form of Sustainable Agriculture system that aims for conservation of resources and protection of natural environment so that the needs of the people living today can be met without compromising the ability of future generation to meet their own needs. Modern Organic Agriculture is the form of Agriculture that relies on techniques such as multiple crops, crop rotation, green manure, compost and biological pest control to maintain soil productivity and control pests on a farm. Organic Farming does not mean going back to traditional methods. It takes the best of the traditional practices and combines them with modern scientific knowledge.

Organic produce is richer in minerals than conventional produce. One study in Chicago, USA, found that organic apples, potatoes, pears, wheat and sweet corn had 63% more calcium, 78% more chromium, 73% more iron, 118% more magnesium, 178% more molybdenum, 91% more phosphorus, 125% more potassium and 60% more zinc than comparable conventionally grown foods. The organic food also contained 29% less of the undesirable element mercury than the conventional produce (Smith 1993).
Agriculture specifically Organic Agriculture has the potential to make a cost effective contribution to mitigation of Climate Change, since, it realizes mitigation and sequestration of CO₂ in an effective way. The IPCC estimates that agricultural Green House Gas mitigation options are cost competitive with non-agricultural options in achieving long term climate objectives. Organic Agriculture systems are highly adapted to Climate Change due to the application of traditional skills and farmers’s knowledge, which is a key to adaptation to Climate Change. Organic Agriculture has considerable potential for reducing emissions of greenhouse gases. Organic Agriculture in general requires less fossil fuel per hectare and for kg of produce due to the avoidance of synthetic fertilizers (Smith et al., 2007). Organic Agriculture aims at improving soil fertility and Nitrogen supply by using leguminous crops, crop residues and cover crops. The enhanced soil fertility thus leads to stabilization of soil organic matter and in many cases to a sequestration of carbon dioxide into the soil. This in turn increases the soil’s water retention capacity, thus contributing to better adaptation of Organic Agriculture under unpredictable climatic conditions with higher temperatures and uncertain precipitation levels. Organically managed soils because of high organic matter content retain significantly more rain. The organic matter in the soil serves as sponge, absorb and retain more rain water. Organically managed soils are better adapted to weather extremes and are in good position to maintain productivity in the event of drought, irregular rainfall events even with floods and rising temperature. Organic soil fertility techniques have potential to enhance the productivity of degraded lands by enhancing the organic matter levels in the soil. Soil erosion, an important source of CO₂ losses, is effectively reduced by Organic Agriculture as it sequesters CO₂ in the soil and is expected to stop soil erosion (Bellamy et al., 2005) and converts carbon losses into gains. Consequently considerable amount of CO₂ may be removed from the atmosphere. Further, practicing

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**Box 1: Definition of Organic Agriculture**

‘Organic Agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of on-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using wherever possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system’ (FAO 1999).
conservation tillage improves soil conservation and reduces water and wind erosion considerably (Holland 2004). Organic Farming approach provided excellent soil fertility building and was superior to conventional no-tillage techniques, despite the use of a plough (Teasdale et al., 2007). The high level of diversity of organic farms enhances farm resilience. Positive influence of enhanced diversity on pest management is have been proved by many researches (Zehnder et al., 2007; Wyss et al., 2005). Diversified Agro-ecosystem has positive effect on diseases and better utilization of soil nutrients and water (Altieri et al., 2005). Leguminous crops grown as inter crops not only fixes atmospheric Nitrogen in the soil but also serve as soil cover and capture the soluble nutrients, building soil fertility and structure.

Organic Agriculture also has weaknesses, mainly related to productivity and yield losses in some crops such as Potatoes, Grapes, Horticulture crops, Vegetables etc. Pest and disease management relating to these crops have not yet been resolved satisfactorily. Such issues highlight the need for more research and investments followed by better technology transfer from research to practice. Further, techniques of improved manure management, manure application techniques, proper storage methods are lacking. Improved plant protection techniques are also a gap in Organic Agriculture. Breeding strategies for adaptability to management and environmental stress situations both in crops and livestock is required. In spite of these weaknesses, Organic Agriculture is so far the most promising approach for mitigation and adaptation to Climate Change. Organic Agriculture represents a positive example of how farmers can help mitigate Climate Change and adapt to its predictable and unpredictable impacts.

**Box 2: Concepts of Organic Agriculture**

- Avoiding usage of chemical inputs viz., fertilizers and pesticides there by not polluting the soil, environment and ground water with chemical residues.
- Increase/maintain biological diversity and heterogeneity among plants and animals.
- Utilization of available farm resources duly recycling them.
- Depends largely on environment and the local farming system for controlling pests & diseases.
- Organic Agriculture is low cost, low dependency on external inputs and places more reliance on natural and on-farm resources as inputs.

*Source: Andhra Pradesh State Policy on Organic Farming (Draft form)*
1.4. Government role in promoting Organic Agriculture in Andhra Pradesh

The farmers of Andhra Pradesh, especially in Rainfed regions have been practicing organic cultivation of crops since time immemorial. Government of AP is also promoting various Organic Agriculture practices in big way such as, compost preparation by pit method in convergence with MGNREGS of GoI program and Vermicompost units (ring methods) through RKVY program. In view of increasing demand for Certified Organic products in the national and International market and to benefit the farmers, the department of Agriculture had also taken up the Certified Organic Farming program under National Program for Organic Production (NPOP), only for Pulses and Paddy crops since 2006. Department is providing 100% cost of Certification, cost of NADEP compost unit, cost of various organic inputs such as Biofertilizers (Rhizobium, PSB, Azospirillum & Azatobacter), botanical pesticides (Neem oil), green manure seeds etc to all the Organic Farmers registered under the program. Total 4000 farmers have been organised in to 22 groups, one in each district. Farmers were trained on Organic Farming practices and preparation of botanical concoctions for use in crop production. Department is working as service provider in maintain the records and documents required for Organic Certification. Department has also authorized two private certification agencies viz., APof Organic Certification Agency and Vedic Organic Certification Agency, and is about to establish marketing linkage for organic produce with various Organic produce buyers for local markets and also for export. The Andhra Pradesh state’s policy on Organic Farming is yet to be finalized and the draft policy is developed in this regard and is being discussed at various levels.

Similarly, the Horticulture Department of AP is also implementing the Certified Organic Farming scheme under the State Horticulture Mission (SHM) from the financial year 2008-09. There are several Private Farms engaged in certified Organic Farming practiced in Grapes, Vegetables, Chillies and Cashew. State government is trying to encourage organic cultivation of fruits, Vegetables and spices by adopting relevant package of practices, assisting in setting up of Vermicompost units and certification of organic farms. Certified Organic Farming for Vegetables, Mango and Ginger crops is under taken since 2008-09. By 2011 a total of 2500 Ha have been certified organic. Separate outlets have also been opened for sale of organically produced material. Department of Horticulture is providing Assistance to the extent of Rs. 20,000 per farmer for three years to meet the cost of organic inputs as per the requirement of crop and local conditions, besides training and capacity building, cost of certification, cost of service providers, record maintenance etc. Department of Horticulture has authorized Vedic Organic Certification Agency as certification agency and is also engaged 9 NGOs in 7 districts.
1.5. Role of Agriculture Research Institutes in promoting Organic Agriculture in AP

Acharya NG Ranga Agricultural University (ANGRAU) has been conducting comparative research studies on Organic Farming since 2007 at all its research stations in the state. Each research station under the ANGRAU is conducting trials on the predominant crop grown in that particular area.

Central Research Institute on Dryland Agriculture (CRIDA), Hyderabad since 2005-06 is engaged in developing organic Agriculture practices for Redgram the important Rainfed crop.

1.6. Role of NGO’s in promoting organic Agriculture practices in AP

The Deccan Development Society (DDS) is an internationally well-known grassroots-level NGO working with dalit women groups, has developed a farm on the principles of Permaculture in Zaheerabad region of deccan area. It has a vision of consolidating Self Help Groups and community-based organizations into vibrant organs of primary local governance and federating them into strong pressure lobby for women, the poor and marginalized. DDS has organized 75 sanghams (voluntary village-level associations) for economic and social empowerment. These groups are organized around health, natural resources management, community seed banks, creches, media, and other social and economic themes. The DDS encourages sustainable agricultural practices in a big way and has been a pioneer in the country. More than 5000 women farmers in an area of more than 20,000 acres have adopted sustainable agricultural practices, which are environment friendly and are based on the traditional knowledge.

Similarly Centre for Sustainable Agriculture (CSA) a NGO based at Hyderabad during the year 2004-05 has experimented Non-Pesticidal Management of Pests (NPM) in few villages in the state, wherein the use of pesticides and chemical fertilizers is discouraged, while the use of local resources is encouraged. Learning from the experiences of villages like Punukula and Enabavi in AP, Society for Elimination of Rural Poverty (SERP) through Federation of Women Self Help

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**Box 3: Non Pesticidal Management (NPM)**

Non Pesticidal Management is an ‘ecological approach to pest management using knowledge and skill based practices to prevent insects from reaching damaging stage and damaging proportions by making best use of local resources, natural process and community action.

NPM promotes ‘Polycrop’ models, Organic soil management practices, soil and water conservation and In situ water harvesting practices

*Source: Ramanjaneyulu and Krishna Soujanya 2008.*
groups (Mandal Mahila Samakhyas) has initiated pilot scaling up of Non Pesticidal Management (NPM) in collaboration with a consortium of Civil Society Organisations in 2005-06 (Ramanjaneyulu et al., 2008; Vijay Kumar et al., 2009). Farmer Field School approach originally designed and promoted by FAO was suitably modified and establish to train farmers (both women and men) regularly on the NPM and other ecological farming practices. Centre for Sustainable Agriculture as the nodal agency for technical support and project management till 2007-08. In 2007-08 a state level Project Management Unit was setup to take over the roles of providing overall technical support and project management. As the scope of the intervention expanded it was named as ‘Community Managed Sustainable Agriculture’ (CMSA). CMSA represents a model of Agriculture which is largely based on farmers’ resources, knowledge and skills and the institutional systems for learning are managed by the Community. During 2009-10, the project covered about 18.15 lakh acres with 4.56 lakh farmers across 4114 villages in 21 districts of Andhra Pradesh. Currently the project is expanded to all 22 districts, with a plan to cover 25 lakhs acres. As on 2011, there are 124 pesticide free villages and 26 organic villages exists in AP. The program started in 2005-06 on a modest scale, has grown into a massive scale on the demand of women’s federations to 8033 villages in 503 mandals in all 22 rural districts covering 10 lakh farmers. ‘Custom Hiring Centres’ to improve the access of small and marginal farmers to such implements on a custom hiring basis, ‘NPM shops’ to make available the concoctions and other organic inputs and ‘Community Seed Bank’ to supply various types of seeds to the NPM practicing farmers were established by the women SHGs as an enterprise mode. So far 1944, NPM shops were established across the project implementation area in AP. During 2010, it was proposed to establish an independent organisation called as ‘AP Society for Sustainable Agriculture in Rainfed Areas (APSSARA)’ and have representatives of Agriculture and Horticulture Departments on board to implement Sustainable Agriculture initiatives through Community Based Organisations was mooted and is under process. The CMSA program is being regularly evaluated by Extension Education Institute of Acharya NG Ranga Agriculture University, Hyderabad and FAO - World Bank. The reports strongly indicated the savings in cost of cultivation and improvement in net profitability of the farmers who follow NPM practices. Most of the Organic Agriculture practices now prevailing in villages and documented in this technical report are the promotions of NPM –CMSA program.

Farmers who employ Non-Pesticidal Management use different practices to keep numbers below the level where they would reduce the yields significantly. They try to stop the pests reaching the stage where they can damage the crop maximum. They use natural and locally
available resources. Non-Pesticidal Management uses many different practices, some of them are mentioned below;

- Deep ploughing in the summer to expose the insect pupas so they dry in the sun.
- Using light trap and bonfires to trap the moths.
- Placing yellow and white sticky boards in the field to attract sucking insects.
- Hand-removing leaves on which many insect eggs have been laid.
- Setting pheromone traps (which use substances that attract insects) to check on the number of pests in the field.
- Using biological pesticides such as Neem seed-kernel extracts and Chilli–garlic extracts to control bollworms and sucking insects. There are also other locally available plants to make biological pesticides.
- Using an extract made from cow dung and urine to control aphids and leafhoppers (this extract also acts as a fertilizer!).
- Planting trap crops such as Castor and marigold. Insects are likely to lay their eggs on these plants, where they can be picked off easily.

Table 1: Topics covered and subjects for Long term experiments under Farmer Field School under NPM program.

<table>
<thead>
<tr>
<th>Topics covered under Farmer Field School</th>
<th>Long term experiments under Farmer Field School</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Water holding capacity</td>
<td>• Varietal trail</td>
</tr>
<tr>
<td>• WHC in different soils</td>
<td>• Seed treated vs non treated</td>
</tr>
<tr>
<td>• WHC in different composts</td>
<td>• Ghanjeevarutham applied vs non applied</td>
</tr>
<tr>
<td>• Crop cutting experiments</td>
<td>• Yield difference in conservation furrows vs non conservation furrows filled</td>
</tr>
<tr>
<td>• Seed germination test</td>
<td>• Yield difference in panchagavaya sprayed vs non sprayed panchagavaya fields.</td>
</tr>
<tr>
<td>• Seed treatment</td>
<td>• SRI Paddy vs Normal Paddy</td>
</tr>
<tr>
<td>• Azolla supplies Urea</td>
<td>• Weed control, transpiration losses by</td>
</tr>
<tr>
<td>• Preparation of insect life cycles</td>
<td></td>
</tr>
<tr>
<td>• 1000 grain weight</td>
<td></td>
</tr>
<tr>
<td>• Adoption of non negotiable</td>
<td></td>
</tr>
<tr>
<td>• Yellow and white sticky plates</td>
<td></td>
</tr>
<tr>
<td>• Pheromone traps</td>
<td></td>
</tr>
<tr>
<td>Topics covered under Farmer Field School</td>
<td>Long term experiments under Farmer Field School</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>• Azolla establishment</td>
<td>using mulching vs non mulching</td>
</tr>
<tr>
<td>• Soil testing</td>
<td>• Difference between NPM vs Non NPM in cost of cultivation and yield</td>
</tr>
<tr>
<td>• Beneficial insects eat harmful insects</td>
<td>• Fertilizer and yield difference in Azolla application vs non Azolla application</td>
</tr>
<tr>
<td></td>
<td>• Construction of NADEP and application</td>
</tr>
</tbody>
</table>

Source: Information from CMSA project, IKP-SERP.

Timbaktu Collective ([www.timbaktu.org](http://www.timbaktu.org)) is a voluntary organization which has been promoting Organic Farming practices since long time in 140 villages of Chennekothapalli, Roddam and Ramagiri Mandals of highly drought prone Ananthapur district of AP. The organization has promoted ‘Dharani Farming and Marketing Mutually Aided Cooperative Society Ltd.’, which is now promoting, procuring, processing and marketing the organic produce of its farmer members, if possible at a premium price. The Dharani cooperative Promote diversification of the Groundnut mono-cropping pattern through millets and pulses with eco-friendly Organic Farming methods that build on the traditional knowledge base of the farmers and utilize locally available resources such as biomass, livestock and labour. Besides, provide cultivation loans through the cooperative to the farmers and organize marketing support for the farmer's organic produce in both rural and urban markets. Organic certification is organised through the Participatory Guarantee System (PGS- www.pgsorganic.in) promoted by the PGS Organic India Council, Organic Farming Association of India (OFAI) – Goa and the Food and Agriculture Organisation United Nations, New Delhi (FAO-UN). A Dharani processing unit is also established to handle and process 15 agro-commodities at this processing unit. As on 2011, 850 farmers had been certified organic. During 2010-11, achieved recorded sale is Rs. 38.5 lakhs with net profit of approximately Rs 1 lakh. The success of this venture will ensure better income for the marginalized dry land smallholder farmers of Anantapur district and in the long term will improve their livelihood security through sustainable Agriculture methods.

Chetana Organics, a NGO in AP since 2004 is also promoting certified organic production of Cotton through ‘Chetna Organic and Fair Trade Cotton Intervention Programme’. Assist farmers in growing organic and fair trade Cotton. It systemizes the agricultural supply chain to create a niche market for outputs. It aims to promote sustainable, ecological and profitable farming that
helps to protect farmers with small and marginal land holdings in India from the agrarian crises.

Chetna has organised its members into Self-Help Groups and Cooperatives. It operates under Chetna Organics Farmers Association (COFA) and Chetna Organics Agriculture Producing Company Ltd (COAPCL). COFA and COAPCL together represent the supply chain programme at the national level. COFA, as a non-profit, engages in the provision of socio-technical extension, certification and other support services for these farmers. COAPCL, a farmer-owned trading company, focuses on marketing and trading of cotton, pulses and other crops for the farmers (members) and in developing market linkages in India and abroad. Presently, COFA works with more than 10,000 small and marginal Cotton farmers from the regions of Andhra Pradesh, Maharashtra and Odisha. Its strong ethical supply chain represents partners such as i) ethical ginning factories in Maharashtra and Odisha ii) a integrated garmenting unit in Kolkata dedicated to making only organic and fair trade Cotton garments and iii) brands who insist on buying garments made of COFA Cotton.

Organic Agriculture is gaining momentum in AP. It has much to offer in both mitigation of Climate Change through it’s emphasis on closed nutrient cycles and is a particularly resilient productive system for adaptation strategy. In this context, the present documentation of ‘Current Organic Agricultural Practices in Andhra Pradesh’ has been taken to promote sustained, viable Agriculture production which is also adaptable to Climate Change and enhance the income levels of the farmers through modern Organic Farming especially in the Rainfed regions of the Andhra Pradesh.

1.7. Objectives and Methodology of the Documentation Study
The present documentation study is taken up during the year 2011, with the following objectives; This Technical Report is the outcome of the documentation study.

- To document organic Agriculture practices prevailing in Rainfed regions of Andhra Pradesh and analyze such agricultural practices for their strengths and weaknesses in the context of Climate Change and adaptations.

- To identify technically sound and feasible options and assessing the potential to improve the performance of such practices through participatory research in farmers field.
To assess for scope to extrapolate such technically sound and viable practices in similar Agroecological environments and socio-economic conditions.

Methodology
The qualitative research method was adopted for the study, which is exploratory and interpretive in nature. Organic Agriculture practices were documented from drought prone districts representing the Rainfed region of the state where the ‘Strategic Pilot on Adaptation to Climate Change (SPACC)’ Project is in operation, besides, collecting information on current Organic Agriculture practices prevailing in Andhra Pradesh collected through literature search through Internet, interacting with scientists at various Agriculture Research stations/ Agriculture University (ANGRAU)/ICAR Institutes/ other Research Institutes etc. In the SPACC project villages within the selected project districts, group meetings were organized with farmers. The Organic Agricultural practices were gathered through group discussion and personal interview with farmers and keynotes were prepared to facilitate paper documentation. Information with respect to prevailing Organic Agriculture practices were gathered through a structured survey Performa. Partner NGOs (PNGOs) working under SPACC project at the respective project districts have facilitated in collecting the information as per the survey proforma. Organic Agriculture practices were documented only with respect to major crops viz., Cotton, Paddy, Redgram, Maize, Groundnut, Horticultural crops like Sweet Orange, Mango, Tomato, Brinjal, Chilli, and others grown commonly in that particular area. Collected information is compiled under each practice ranging from sowing to post harvest management and presented in the form of Technical Report. The present report is a compilation of current Organic Agriculture practices prevailing in the SPACC project villages as well as in Andhra Pradesh.

Data Sources
Besides interviewing the farmers and scouting for Organic Agriculture practices prevailing in the project districts by using semi-structured questioners, information on Organic Agriculture practices prevailing in the area and other relevant information required for assessment of the practices were collected from the following sources;

- Desk review of literature on Organic Agriculture Practices in the Andhra Pradesh
- Literature review of technical reports, evaluation studies, independent assessments
- Information collected from State department of Agricultural, department of Horticulture, Acharya NG Ranga Agriculture University (ANGRAU), Research stations of ANGRAU, ICAR Institutes.

- Consultations with the scientists and technical officials of research organizations, officials of relevant government departments and discussing with the field functionaries of Partner NGOs.

- Interaction with Community Based Organisations and women Groups.

- Limited personal field visits (aided with study instrument i.e. checklist for focussed group discussions) to validate the findings from secondary sources of information.

**Box 4: About SPACC project**

The project “Reversing Environmental Degradation and Rural Poverty through Adaptation to Climate Change in Drought Stricken Areas in Southern India: A Hydrological Unit Pilot Project Approach”, also referred to as Strategic Pilot on Adaptation to Climate Change (SPACC) Project is implemented in 9 Hydrological Units, spread over 143 habitations of the extent of about 134,442 ha, covering a population of 204,567. The Project is financed by the Global Environment Facility (GEF), under its Focal Area – Climate Change; Operational Program – Strategic Pilot on Adaptation; and GEF Strategic Program 8 – to support pilot demonstration projects for adaptation to Climate Change. The project is co-financed by the Food and Agriculture Organization (FAO) of the United Nations (UN). The project duration is 3 years, starting on December 6, 2010. Bharathi Integrated Rural Development Society (BIRDS) is the Executing Partner of the SPACC project. While the Project Management Office (PMO) of BIRDS provides technical and managerial support, its Nodal Desk at the registered office (Nandyal town in Kurnool district) takes care of financial and fiduciary management. BIRDS sub-contracted eight partner Non Governmental Organizations (PNGOs).details are mentioned in Table 2.

The development objective of the proposed project is to increase the knowledge and capacity of communities to adapt to climate variability and change in seven drought-prone districts of Andhra Pradesh. The project will help build the skills and tools for communities to integrate climate adaptation into sustainable land and water management (SLWM) practices and their decision making.
The list of Organic Agriculture practices gathered were classified into various categories as mentioned below and the practices were analyzed for their scientific basis from literature and also in consultation with the scientists of the concerned departments. Further, these practices were assessed for their potential to adapt to Climate Change and scope for pilot study in the SPACC project.

i. Organic Seed Treatment Methods

ii. Crops and Cropping Systems

iii. Soil Fertility & Crop Nutrition Management

iv. Pest & Disease Management

v. Post Harvest Management Techniques & Storage Methods

**Table 2: Details of the SPACC project area where the Organic Agriculture practices were documented.**

<table>
<thead>
<tr>
<th>S. No</th>
<th>District</th>
<th>No. of Project (Pilot) Villages</th>
<th>NGO Partner</th>
<th>Field Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chittoor</td>
<td>13</td>
<td>Gram Vikas Samstha (GVS)</td>
<td>Madanapalle</td>
</tr>
<tr>
<td>2</td>
<td>Kadapa</td>
<td>13</td>
<td>People’s Activity and Rural Technology Nurturing Ecological Rejuvenation (PARTNER)</td>
<td>Porumamilla</td>
</tr>
<tr>
<td>3</td>
<td>Anantapur</td>
<td>16</td>
<td>Star Youth Association (SYA)</td>
<td>Guthi</td>
</tr>
<tr>
<td>4</td>
<td>Mahbubnagar</td>
<td>17</td>
<td>Center for Applied Research and Extension (CARE)</td>
<td>Achampet</td>
</tr>
<tr>
<td>5</td>
<td>Nalgoda</td>
<td>11</td>
<td>Social Awareness for Integrated Development (SAID)</td>
<td>Miryalaguda</td>
</tr>
<tr>
<td>6</td>
<td>Prakasam</td>
<td>16</td>
<td>Development Initiatives and People’s Action (DIPA)</td>
<td>Giddalur</td>
</tr>
<tr>
<td>7</td>
<td>Prakasam</td>
<td>16</td>
<td>Collective Activity for Rejuvenation of Village Arts and Environment (CARVE)</td>
<td>Markapur</td>
</tr>
<tr>
<td>8</td>
<td>Prakasam</td>
<td>19</td>
<td>Society for Sustainable Agriculture And Forest Ecology (SAFE)</td>
<td>Cumbhum</td>
</tr>
<tr>
<td>9</td>
<td>Anantpur</td>
<td>18</td>
<td>Bharathi Integrated Rural Development Society (BIRDS)</td>
<td>Nandyal</td>
</tr>
</tbody>
</table>
CHAPTER 2

OVER VIEW ON ORGANIC AGRICULTURAL PRACTICES IN ANDHRA PRADESH

In the name of green revolution, the age old traditional agricultural practices that were gained by the farming community through the informal experiments and intimate understanding of local conditions to maintain the soil health, organic matter and biodiversity were largely ignored. This situation is making the Agriculture sector more vulnerable to Climate Change/ Variability. In general, the Traditional Agricultural practices are organic in nature, cost effective, less dependent of external inputs, moreover, climate resilient and have high potential to counteract the adverse impact of Climate Change. However, at the present population level and estimated demand for food grain requirements, the Organic Agricultural practices alone may not meet the demand of food grain production. As the chemical technology also has its own advantages, blending of the old techniques with that of new ones will bring a basketful of technological options that are socially acceptable, economically viable and environmentally safe. Such blend of practices will be readily acceptable to small and marginal farmers. Integrated Nutrient Management (INM), Integrated Pest Management (IPM) and Integrated Farming Systems Approach (IFSA) are some of the viable options in the present context. Even Certified Organic Farming may also be promoted to capture the ever increasing national and international market for Organic Products.

As part of the present study, the various Organic Agricultural practices prevailing in Andhra Pradesh and specifically in SPACC project districts are documented and their potential in the context of Climate Change is well discussed in this chapter. Most of the practices presented here have scope to scale up in larger areas and few others need technical validation. Such immense wealth of Traditional knowledge on Organic Agriculture practices can be best used in developing package of practices for important crops under organic production. The Organic Agriculture practices are discussed under the following five sub-headings;

   i. Organic Seed Treatment Methods
   ii. Crops and Cropping Systems
   iii. Soil Fertility & Crop Nutrition Management
   iv. Pest & Disease Management
   v. Post Harvest Management Techniques & Storage Methods
2.1. Organic Seed Treatment Methods
Seed carries disease causing fungi, bacteria, and viruses on the seed coat or within the seed and can damage seed in storage or after planting. Soil also contains organisms that attack seed and seedlings. Hence, sowing a healthy seed is a prerequisite to get healthy crop stand. Seed treatment or seed dressing is typically coating the seed with antimicrobial chemical pesticides or process designed to reduce, control, or repel disease organisms, insects, or other pests that attack seed or seedlings (Gary Munkvold and Wendy Wintersteen 2006).

Seed treatment in whatever form improve crop stand, increase yields, and increase return on investment. In general in the present context, seed is chemically treated in anticipation of economic damage. However, chemical seed treatment poses certain risks while handling pesticides, contamination of food chain and contamination to the environment. At present, mostly the chemically treated seeds are readily available in the market, sold by private seed industries. In case farmers if using their own seed are also treating them with chemical pesticides readily available in the market. It is observed that, not only in SPACC project areas in entire state, farmers are rarely practicing traditional seed treatment methods. Only the old aged farmers could able to recollect the organic seed treatment practices once upon a time were in practice. However, few farmers are still practicing organic seed treatment techniques as discussed in this chapter.

There are several alternatives or supplements to avoid chemical seed treatment such as sowing Certified Seeds (Certified seed is checked for the presence of certain seed borne diseases. Therefore, treatments for seed borne pathogens may be unnecessary with certified seed); Seed treatments may be less necessary where crop rotation is practiced; Following proper soil fertility management, as lack of micronutrients (especially Chloride) and an excess of Nitrogen, can favor certain diseases (Gary Munkvold and Wendy Wintersteen 2006). Maintaining appropriate soil fertility can reduce disease pressure; Adjusting planting date affects the severity of some root rots, certain insects, and some insect-borne viruses, for Ex. all root rots of wheat, Pythium root rot, and barley yellow dwarf are the diseases that can be affected by planting date; Some scientists believe that, seed treatments may be unnecessary when high varietal resistance (Gary Munkvold and Wendy Wintersteen 2006).

Traditionally also different seed treatment methods were used by our ancestors and they are having their own science behind them. Such method avoids the use of pesticides and best use of
local material for seed treatment. However, very few farmers are practicing alternatives to chemical seed treatment.

Review on organic seed treatment practices/materials is mentioned below

- Treating the seeds with wood ash reduces the incidence of most of the fungal diseases as wood ash has both fungicidal and insecticidal properties (Messiah 1992; Famisa 2004). Ash absorbs the moisture thus preventing the germination and growth of most of the fungal spores. Further, ash sticks to the cut surface and acts as physical barrier for the insects to invade. (Das and Karim 1968). There is no risk of microbial contamination from ash as it is a burnt product and don’t contain microorganisms. Moreover, ash contains nutrients and also holds moisture that helps in proper germination and early establishment and also gives strength to the seedlings.

- Seed coating with fine Neem (*Azadirachta indica* L.) kernel powder or dried Neem leaf powder protect the seeds at the time of germination. Neem powder and extracts are used as insect repellants and also as biological insecticide (Odeyemi 1984). The efficacy and economics of Neem derivatives as seed protectant against Bruchids *Callosobruchus chinensis* L. were successfully evaluated using it as seed treatment and by sack impregnation (Castillo et al., 1994). Results of the study showed that mungbean seeds could be protected from Bruchids infestation by treating the seeds with Neem derivatives. Neem seed powder (2% seed treatment) was the most effective followed by Neem oil (3 ml/kg of seeds), Neem seed kernel extract (5% sack impregnation), Neem cake powder, (5% seed treatment and Neem oil (3% sack impregnation), respectively (Castillo et al., 1994).

- Treating Paddy seeds with salt, cow urine and asafetida (local name-hing/inguva) at different proportions will also reduce major seed born fungal diseases. This practice eliminates the chemical pesticide usage hence, reduces the environmental hazards. This is a common practice documented in Assam state (Vanaja 2007).

- Treating the seed with cow-milk reduces the incidence of majority of viral diseases in food crops; Milk has been described as natural inhibitor for managing plant viruses and fungal diseases with better sticking and spreading qualities. Cow and Goat milk have amino acids containing potassium phosphate, which boosts the immune system of
plants through induced resistance. Experiments undertaken in Central Arid Zone Research Institute, Jodhpur have shown positive results regarding the bio-efficacy of raw cow milk to manage the leaf curl disease of Chilli and Downy Mildew of Pearl millet (*Pennisetum glaucum* (L.)) with seed and soil application of fungal bio-protectants (Arun kumar 2007). Arun Kumar and Mali 2011, reported lowering the incidence of Downy Mildew disease in Pearl millet by Seed and soil treatments with raw cow milk *together with Gliocladium virens*. It is assumed that the combination is capable of stimulating different systemic responses in host plant. *G. virens* was mixed with FYM and incorporated in to the soil. While the Pearl millet seeds were treated with raw cow milk for 18 h in 1:1 ratio (i.e., raw cow milk diluted to 50% by adding water) at the room temperature and dried under the shade. The seeds treated so were further treated with *G. virens* @ 6 g kg-1 seed and *G. virens* @10 g m2 is also mixed in FYM and applied to the soils of treated plants.

- Treating the seed with dry cow dung powder also serve as seed treatment practice. Salakinkop *et al.*, (1996) at Mugad (Karnataka) noticed that the seed treatment with cow dung extract increased the plant height, dry matter production and yield of Paddy under rainfed condition as compared to untreated seeds.

- Soak the seeds in cow's urine for one to two hours, depending on the size and nature of the seed. Larger seeds like beans need 2 hours; for smaller seeds like lettuce, 1 hour is sufficient. Make sure that seeds mix well with the urine and none are floating on top. Drain the seeds and mixed with enough cow dung to coat them thoroughly. The dung and seed mixture can then be spread until semi-dry. The mixture can then be crumbled easily and sown. Ash is also mixed with cow dung for better results (http://homafarming.com/content/treating-seeds).

- It is always better to sow the seed only in the top layer of the soil to prevent the seed borne diseases as very deep sowing may favor certain rot diseases.

Seed treatment with cow urine recorded significantly higher grain yield (1767 kg/ha) than seed treatment with water (1594 kg/ha) and without seed treatment (1479 kg/ha). However, the seed treatment with cow urine was at par with that seed treatment with calcium chloride (Shivamurthy 2005).

Soaking the Paddy seeds in diluted cow's urine before sowing, considerably reduces the incidence of leaf spot and Rice blast (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

Kamalam Joseph and Rajappan Nair (1989) reported that Paddy seed treatment with 5% per cent cow urine, 10 % cow urine, 10 % cow dung extract with water recorded higher germination, shoot length and root length than that of control (unsoaked seeds).

Presoaking of Paddy seeds in cow milk increases its resistance against 'tungro' virus and 'stunt' virus (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

For control of red leaf spot disease in Paddy, the seeds are soaked in 'Pudina' leaf extract (Mentha sativa) for 24 hours (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

Sweet Orange seeds are mixed with ash to avoid ant’s attack. Rohini Reddy

**Organic Seed treatment techniques documented in SPACC project area**

Altering the date of sowing could avoid pest and disease incidences in many crops. Ex. Rice blast in Paddy appears mostly in November month; if the date of planting is changed can prevent attack from this disease or atleast reduce the severity of the disease.

For preservation of Paddy for seed purpose dried Neem leaves were mixed with seed and stored in bamboo container. On an average, only 7% of the farmers are following this practice in documented villages (documented in Modin puram village and Bollupalli village in Arhdriveedu Mandal in Prakasam district).
Dung is coated as seed coat to the Desi Cotton seeds. However, this is in practice among 5% of the farmers in the project villages (documented in Racherla, Paluguntipalli Racherla (Md) villages in Prakasam district).

Chilli seed is thoroughly mixed with fine powder of dry FYM as seed coat to protect seed from seed borne diseases. Farmers believe that, such seeds also grow healthy. Only 10% of the farmers in the village are using this practice (documented in Chinna Nalla Kaluva village in Prakasam district).

Finely grinded dry Neem leaf powder is mixed with Bajra seeds. Only 4% of the farmers are using this practice in documented villages (documented in Madapalli village in Prakasam district).

Groundnut seeds were treated with Rhyzobium biofertilizer before sowing. Practiced in all the SPACC project districts.

For treating the Groundnut seed, water is boiled in a container and Lantana camera leaves are soaked in hot water over night by covering with lid. Next day morning the solution is filtered add 100 gm of jaggery. Sprinkle the solution on Groundnut seeds and mix it thoroughly. It prevents attack by ants, seed rot and dying of young plants. This technique is in practiced in Anantpur district. As informed during telephonic discussion with officials of department of Agriculture, Kadiri mandal, Anantpur district).

Chilli seeds are treated with Trichoderma viridi @ 5gms per kg seed and shade dried before sowing (documented in MV Palli, Yacharam villages in Prakasam and also in Kadapa districts). However, in Dharampuram and Vannedoddi villages of Gooty mandals of Anantpur districts, the dose is @ 8.0gm/kg Chilli seed.

Redgram seeds were treated with Trichoderma viridi @ 5gms per kg seed as seed coating. (Documented in MV Palli, Yacharam villages in Prakasam and also in Kadapa districts).
Sweet Orange seeds are treated with mixture of Copper, gum and lime before sowing in nursery (documented in Moddulapalli village in Prakasam and also in Nalgonda districts).

**Other Agronomic practices followed in Organic Agriculture system**

- In entire state of AP, including SPACC project area, the Paddy seeds are soaked in water. Healthy seeds reach the bottom of the water. Those, which float on the water are considered as unhealthy and rejected for sowing.

- In entire AP including SPACC project districts, sowing is done by Gorru for crops like Maize, Cotton, Pulses, Groundnut, Castor, Sunflower etc.

- To reduce the flower drop in Tomato, 500 gm wood ash and 500 gm of cow dung is dissolved in 10 litre of water and sprayed on the plants to reduce flower dropping in Tomato. (documented in SPACC districts viz., Chittoor, Kurnool and Kudappa districts).

- Chilly seeds are immersed in biogas slurry for half an hour to promote vigorous growth and to impart disease resistance to seedlings (Rohini Reddy)

- To induce more flowering and to reduce flower dropping in vegetable crops, asafoetida @ 1 kg/ac is powdered, tied in a cloth and placed in the irrigation channel (http://agritech.tnau.ac.in/success_stories/success%20stories_organic%20farming.html).

- Ploughing the main field of Paddy crop, four to six times and transplanted along the wind direction gives good establishment and higher yields (http://agritech.tnau.ac.in/success_stories/success%20stories_organic%20farming.html).

- To the Paddy field apply the Neem seeds @ 40 kg / ac as basal to get more yield as compared to the equal quantity of Neem cake. (http://agritech.tnau.ac.in/success_stories/success%20stories_organic%20farming.html).

- About 30kg of Tamarind seeds are applied for an acre of Paddy field one day after transplanting to boost up the crop growth and yield. (http://agritech.tnau.ac.in/success_stories/success%20stories_organic%20farming.html).
➢ Irrigate the Paddy fields, allow the weed seeds to germinate and then plough the fields to incorporate the weeds into the soil before sowing or transplanting of Rice crop to control weed growth (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

➢ Grinding and applying the Neem seeds @40kg./ac. on 35th day after transplanting gives higher yield (http://agritech.tnau.ac.in/success_stories/sucess%20storiesorganic%20farming.html).

➢ Whenever local Onion variety is grown, sowing is done directly by broadcasting method, while Hybrid Onions are raised in nursery and transplanted at 25-30 days later in the main field (Information provided by Agriculture Officer, Mahabubnagar).

➢ Application of 100 kg of Groundnut cake per acre reduces the flower dropping in vegetable crops (Rohini Reddy).

➢ Groundnut cake is applied to reduce the flower dropping and increase the yields (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

➢ Grinding and applying the neem seeds @40kg /ac. on 35th day after transplanting gives higher yield in Brinjal (Rohini Reddy and also available at http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

➢ Sunflower is cultivated in between the Mango trees to attract honeybees, which increases pollination and fruit production (Rohini Reddy).

➢ To bring the non-bearing trees to bearing, the bark on the trunk is removed at a height of 3-4 feet from the ground level during solar or lunar eclipse day (Rohini Reddy).

➢ Prune young trees to build up a strong frame work for better bearing. (Rohini Reddy).

It is observed that very few farmers in respective SPACC project locations are following Organic Agriculture methods. As far as seed treatment is concerned, farmers are getting treated seeds
either from seed dealers/shops or from government supplied subsidized seeds which are treated with chemicals before packing.

2.2. Traditional Crops and Cropping Systems

Monoculture system and Agri-based industrialization promoted under Modern Agriculture era lead to low biodiversity, un-uniform nutrient use and pests build up, necessitating the greater use of pesticides and fertilizers. In contrast, crop diversification by growing different crops in time and space seeks to enhance the Agro-ecosystem resilience to external shocks such as extreme weather events or price variation, such risks are likely to increase as the Climate Changes. The diversification of cropping systems also make more efficient use of available soil nutrients, with improved productivity and economic performance, which is of high importance in times of limited nutrients and financial constraints. Growing a number of different crops rather than relying on one crop is also very important to make the system resilient to Climate Change. This helps to protect against pests and diseases and acts as insurance against crop failure in unusual weather such as drought or flood. Farmers in Rainfed region of Andhra Pradesh by tradition do not only rely on only cash crops but also grow food crops for household consumption. Polyculture systems viz., Mixed/multiple cropping, in which several crops are grown sequentially in one year, and intercropping, when several crops are grown at the same time are the other kinds of annual cropping systems that are in resilience with Climate Variability. For vegetables, a 3 to 4 year rotation is usually recommended as a minimum (www.hdra.org.uk). Mixed cropping does not allow the microbes to propagate and the incidence of the diseases would be low. The spread of the pathogen from one plant to other would be restricted, as the pathogens attacking one species may not infect the other species and the spread of the disease could be restricted. Crop rotation also helps a variety of natural predators to survive on the farm by providing diverse habitats and sources of food for them (www.hdra.org.uk). Agroforestry system has also been recommended as a mitigation strategy by the IPCC and is encouraged by different standards for Organic Agriculture.

In general the traditional crops grown by farmers contain greater genetic diversity than modern bred crops as the modern breeding methods tend to be very similar and if one plant is prone to disease, all the other plants are as well. Although some modern varieties may be very resistant to specific pests and diseases are often less suited to local conditions than traditional varieties. It can therefore be dangerous to rely too much on any one of them. It is also important to select
when choosing which crops to grow. Each crop and crop variety has its own specific needs. In some places it will grow well and others it will not.

Crops, in general are affected by soil type, rainfall, altitude, temperature, the type and amount of nutrients required, the amount of water needed. These factors affect how a crop grows and yields. If a crop is grown in a climate to which it is not suited, it is likely to produce low yields and be more susceptible to pest and diseases. This then creates the need to use agrochemicals to fertilize the crop and control pest and diseases. Hence, traditionally the Organic Agriculture system stresses the need to grow the crops and varieties which are suited to the local conditions. In this context, millet crops occupy special place in the context of drought adaptations. Integrating millets in the production system is a good measure towards drought proofing as millets can withstand moderate drought and fit as intercrop in any crop.

### Box 5: Principles of crop selection under Organic Farming

- Grow a mixture of crops in the same field (mixed cropping, intercropping, strip cropping etc.).
- Grow different varieties of the same crop.
- Use as many local crop varieties as possible.
- Use own seed of local and improved crop rather than relying on buying seed from outside.
- Exchange of seed with other farmers to increase diversity.
- Encourage traditional crops such as millets, highly resilient to change in climate.
- Growing Rice in ‘System of Rice Intensification (SRI)’ where soils are kept un-flooded most of the growing period and hence methane emissions are significantly reduced.


### Few promising multiple cropping systems in SPACC project area

- Farmers in Chinamandyam mandal in Kadapa district are practicing multiple cropping systems with Chrysanthemum as main crop with Maize and Red gram as border crops, Marigold as trap crop and Vegetables (Chillies, Drum Stick, Onion, Bendi and Brinjal) grown as inter crops. The main crop turned out healthy and good but in the flowering
stage, due to rain, the returns were less from main crop Chrysanthemum. However, this loss was compensated with returns from other crops. Such cropping system would also minimize the pest attack. Further, use of botanical pesticides would minimize the cost of pest management. Economics of multiple cropping system practiced by Yashodamma, a farmer from Chinamandyam mandal, Kadapa district is presented in Table 3. This cropping system has been promoted under NPM program, details available at www.serp.ap.gov.in/CMSA/SuccessStories/CMSAsuccessstoriesEnglish.pdf).

**Table 3: Economics of multiple cropping system practiced by Yashodamma.**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of the crop</th>
<th>Name of the crop</th>
<th>Amount (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main crop</td>
<td>Chrysanthemum</td>
<td>32850.00</td>
</tr>
<tr>
<td>2</td>
<td>Border crop</td>
<td>Maize</td>
<td>800</td>
</tr>
<tr>
<td>3</td>
<td>Border crop</td>
<td>Red gram</td>
<td>1650</td>
</tr>
<tr>
<td>4</td>
<td>Trap crop</td>
<td>Marry gold</td>
<td>330</td>
</tr>
<tr>
<td>5</td>
<td>Inter crops</td>
<td>Chillies</td>
<td>10400</td>
</tr>
<tr>
<td>6</td>
<td>Inter crops</td>
<td>Drum stick</td>
<td>2158</td>
</tr>
<tr>
<td>7</td>
<td>Inter crops</td>
<td>Onion</td>
<td>730</td>
</tr>
<tr>
<td>8</td>
<td>Inter crops</td>
<td>Beans</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>Inter crops</td>
<td>Bhendi</td>
<td>285</td>
</tr>
<tr>
<td>10</td>
<td>Inter crops</td>
<td>Brinjal</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td><strong>Total Returns</strong></td>
<td></td>
<td><strong>Rs.49288</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total Investment</strong></td>
<td></td>
<td><strong>Rs.5400</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Net Income</strong></td>
<td></td>
<td><strong>Rs.43888</strong></td>
</tr>
</tbody>
</table>

*Source: [http://www.serp.ap.gov.in/CMSA/SuccessStories/CMSA](http://www.serp.ap.gov.in/CMSA/SuccessStories/CMSA)*

- Sesamum & Redgram; Castor & Redgram; Redgram & Cowpea are the popular mixed cropping systems in Redgram crop grown in Rainfed areas of AP particularly in Mahabubnagar, Nalgonda and Prakasam districts including the SPACC project areas.

- The popular Redgram based intercropping systems in Rainfed areas are, Greengram & Redgram (4:1); Groundnut & Red gram (3:1); Redgram & Cotton (1:4 ); Redgram &
Sesamum (1:4); Redgram & Blackgram (1:4). These are the crops and cropping systems followed in SPACC project districts.

- Redgram is also grown as an intercrop in sorghum and groundnut in SPACC project districts Anantpur, Mahabubnagar, Kadapa and Nalgonda districts.

- In three year old Sweet Orange garden, Tomato, Chilli, Greengram & Blackgram Crops are grown as intercrop. These are the crops and cropping systems followed in SPACC project villages in Racherla, Cumbum, and Giddalur mandal in Prakasam districts.

- A farmer in Chinnakoppula village of Koniejerla mandal in Chittoor district, in one acres land he has grown multiple crops. Cotton and Chilli each grown as main crop in each 0.5 acres of land, besides, planted with Vegetables like Bottle Gourd, Ridged Gourd, Lady’s Finger, Cluster Beans, Brinjal, Tomato etc as intercrops in both Cotton and Chilli. The net profit from Chilli and Cotton together is Rs. 85250 besides, income of Rs. 500 per month additionally from the Vegetables from just one acre of land (http://www.serp.ap.gov.in/CMSA/SuccessStories/CMSAsuccessstoriesEnglish.pdf).

- In the main crop of Chilli, intercrops of Vegetables like Onion, Bitter Gourd, Ridged Guard, Cluster Beans etc were grown apart from the trap crops like Marigold, Chrysanthemum and Castor. From 2 acres of land, 60 quintals of Chilli were harvested fetching income of Rs.6000 per quintal of Chilli. Income from Vegetables is at least Rs.1000 per week. Overall from 2 acres of multiple cropping system, net profit of Rs.2.5 lakh were received by the farmer. (http://www.serp.ap.gov.in/CMSA/SuccessStories/CMSAsuccessstoriesEnglish.pdf)

2.3. Soil Fertility & Crop Nutrition Management
The soil is a living system and habitat for millions of soil microorganisms that are very important for release of nutrients from native soil as well as from applied nutrient sources and made available for plants. Organically managed soils excludes high analysis fertilizers, hence, reduces N₂O emissions from soils. Artificial fertilizers provide only short term nutrient supply to crops and encourage plants to grow quickly but with soft growth which is less able to withstand drought, pests and diseases. These provide nutrients for plants but do not improve soil structure. They usually only improve yields in the season in which they are applied. Further,
artificial fertilizers do not feed beneficial soil micro organisms and do not add organic matter to the soil. Fertilizers do not help to build good soil structure, improve the soils water holding capacity or drainage. In contrast, feeding the soil with organic nutrient sources serve as food for the microorganisms and aid in proliferation of the same. Besides, adds nutrients and organic matter to the soil which has a positive effect on the water holding capacity of the soil. A higher water holding capacity strengthens the resilience to droughts and reduces the risk of runoff and erosion, both are more likely to increase with Climate Change. For soils with high organic matter, the need for irrigation is lowered, which has an additional adaptation and mitigation effect. Furthermore, soil organic matter enhances the nutrient buffer capacity and the microbial activity, both strengthen soil fertility. Soil cultivation at right time and in right way is also very important to provide the best living conditions for the soil life and plant roots (http://www.infonet-biovision.org/res/res/files/488.OrgFarm.pdf).

To keep and build good soil structure and fertility various organic practices such as incorporation of recycled and composted crop wastes and animal manures, vermicompost, the right soil cultivation at the right time, following suitable crop rotation, incorporation of green manures and legumes, applying soil mulch on the soil surface, intercropping with legumes etc proved beneficial in restoring the soil fertility including in degraded soils (http://www.infonet-biovision.org/res/res/files/488.OrgFarm.pdf). Degraded land not only offers income opportunities for rural populations but also has a huge mitigation potential by increasing soil carbon sequestration (Nadia El-Hage Scialabba and Maria Mu’ller-Lindenlauf 2010).

<table>
<thead>
<tr>
<th>Source</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Organic matter</th>
<th>Moisture content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N)</td>
<td>(P₂O₅)</td>
<td>(K₂O)</td>
<td>(Ca)</td>
<td>(Mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRESH MANURE</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Cattle</td>
<td>0.5</td>
<td>0.3</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
<td>16.7</td>
<td>81.3</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.9</td>
<td>0.5</td>
<td>0.8</td>
<td>0.2</td>
<td>0.3</td>
<td>30.7</td>
<td>64.8</td>
</tr>
<tr>
<td>Poultry</td>
<td>0.9</td>
<td>0.5</td>
<td>0.8</td>
<td>0.4</td>
<td>0.2</td>
<td>30.7</td>
<td>64.8</td>
</tr>
<tr>
<td>Horse</td>
<td>0.5</td>
<td>0.3</td>
<td>0.6</td>
<td>0.3</td>
<td>0.12</td>
<td>7.0</td>
<td>68.8</td>
</tr>
</tbody>
</table>

Table 4: Nutrient sources of various manures of animal source
<table>
<thead>
<tr>
<th>Source</th>
<th>Nitrogen (N)</th>
<th>Phosphorus (P₂O₅)</th>
<th>Potassium (K₂O)</th>
<th>Calcium (Ca)</th>
<th>Magnesium (Mg)</th>
<th>Organic matter %</th>
<th>Moisture content %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
<td>0.2</td>
<td>0.03</td>
<td>15.5</td>
<td>77.6</td>
</tr>
<tr>
<td>TREATED DRIED MANURE</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Cattle</td>
<td>2.0</td>
<td>1.5</td>
<td>2.2</td>
<td>2.9</td>
<td>0.7</td>
<td>69.9</td>
<td>7.9</td>
</tr>
<tr>
<td>Sheep</td>
<td>1.9</td>
<td>1.4</td>
<td>2.9</td>
<td>3.3</td>
<td>0.8</td>
<td>53.9</td>
<td>11.4</td>
</tr>
<tr>
<td>Poultry</td>
<td>4.5</td>
<td>2.7</td>
<td>1.4</td>
<td>2.9</td>
<td>0.6</td>
<td>58.6</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Source: http://www.ecochem.com/t_manure_fert.html

Review of different kinds of organic soil fertility & crop nutrition management practices

*a. Green manuring/Green leaf manuring*

Green manuring is a traditional way to improve soil fertility and supply part of the crop’s nutrient needs. It is an age old practice of growing plants on the soil and ploughed back into the soil after 45-50 days and allowing it to decay and release nutrients for the next crop. Generally, Green manure plants are sown as part of crop rotation and are incorporated into the soil at 50% flowering stage, when the plants are succulent to facilitate easy decomposition. When fresh plant material decomposes in the soil, its Carbon to Nitrogen ratio becomes low, allowing the nitrogen to be easily released into the soil by the bacteria [http://cmg.colostate.edu/gardennotes/244.pdf](http://cmg.colostate.edu/gardennotes/244.pdf). In general, a 40–50 day-old green manure can supply up to 80–100 kg of N/ha (Vandana Shiva). Some plant species are selected as green manures because of it’s efficiency to decay at faster rate, deep root systems that bring nutrients up to the soil surface and also have high Nitrogen content in them, others because they are hardy or more tolerant of nutrient, moisture or environmental stresses. The most important green manures are leguminous plants that together with ‘Rhizobium’ the nitrogen fixing bacteria growing in nodules on the legume roots are able to capture and fix atmospheric nitrogen and make it available to plants. Intern the plants provide carbon for survival of bacteria (John Biernbaum). Potential green manures include Sesbania (*Sesbania aculeata, dhaincha, dhunchi*),
Sunhemp (*Crotalaria juncea*), Cowpea (*Vigna unguiculata*), Mungbean (*Vigna radiata*), Cluster bean (*Cyamopsis tetragonoloba*, guar), Berseem clover (*Trifolium alexandrinum*), etc.

**Box 6: Benefits of Green Manures**

- Increase and recycle plant nutrients
- Increase organic matter content in the soil
- Improve soil fertility
- Improve soil structure
- Improve Water Holding Capacity of soil
- Control soil erosion
- Prevent weed growth
- Stop nutrients being washed out of the soil


**Table 5: Nutrient composition of important green manure crops**

<table>
<thead>
<tr>
<th>Green manure crop</th>
<th>Botanical Name</th>
<th>Biomass produced (t/ha)</th>
<th>Nutrient content (%)</th>
<th>Nutrient content (%)</th>
<th>Nutrient content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nitrogen (N%)</td>
<td>Phosphorous (P2O5%)</td>
<td>Potassium (K2O%)</td>
</tr>
<tr>
<td><strong>Green Manure Crops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunhemp</td>
<td><em>Crotalaria juncea</em></td>
<td>42</td>
<td>2.30</td>
<td>0.50</td>
<td>1.80</td>
</tr>
<tr>
<td>Dhaicha</td>
<td><em>Sesbania aculeata</em></td>
<td>36</td>
<td>3.50</td>
<td>0.60</td>
<td>1.20</td>
</tr>
<tr>
<td>Sesbania</td>
<td><em>Sesbania A.uleata</em></td>
<td>-</td>
<td>2.71</td>
<td>0.53</td>
<td>2.21</td>
</tr>
<tr>
<td><strong>Green Leaf Manure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pongamia leaf</td>
<td><em>Pongamia glabra</em></td>
<td>-</td>
<td>3.31</td>
<td>0.44</td>
<td>2.39</td>
</tr>
<tr>
<td>Forest tree leaf</td>
<td></td>
<td>-</td>
<td>1.20</td>
<td>0.60</td>
<td>0.40</td>
</tr>
<tr>
<td>Green weeds</td>
<td></td>
<td>-</td>
<td>0.80</td>
<td>0.30</td>
<td>0.20</td>
</tr>
<tr>
<td>Subabul</td>
<td><em>Leucaena</em></td>
<td>-</td>
<td>3.15</td>
<td>0.2</td>
<td>-</td>
</tr>
</tbody>
</table>

*Source:* Table 5 indicates the nutrient composition of important green manure crops, including their botanical names, biomass produced, and nutrient content in air dry basis.
### b. Intercropping with legumes

Intercropping is a practice of growing of two or more crops in proximity in the same field during a growing season to promote interaction between them. Available growth resources, such as light, water and nutrients are more completely absorbed and converted into crop biomass by the intercrop as a result of differences in competitive ability for growth factors between intercrop components (http://en.wikipedia.org/wiki/Organic_farming). The more efficient utilization of growth resources leads to yield advantages and increased stability compared to sole cropping. Intercropping through legume crop will have additional advantage of fixing Nitrogen from the atmosphere through the process of symbiosis with *Rhizobium* bacteria growing in the root nodules and this Nitrogen is made available to the crop. Intercropping practice is sometimes used for insect and disease control, can also keep soil nutrient balance. However, the competition between the legume and the crop sometimes can be problematic hence, wider spacing between crop rows is required. Intercrop may also contribute to the prevention of Nitrogen leaching risks sometimes observed from sole crops (http://en.wikipedia.org/wiki/Organic_farming).

### c. Crop rotation
It is the practice of growing different types of crops in the same area in sequential seasons. A traditional element of crop rotation is the replenishment of Nitrogen through the use of leguminous crop in a sequence with cereals and other crops. Crop rotation also mitigates the build-up of pathogens and pests that often occurs when only single species is continuously cropped, and can also maintain the nutrient balance in the soil by alternating deep-rooted and shallow-rooted plants. Ex. Cereals followed by pulses.


d. Incorporating ash into the soil

In general, in most parts of Andhra Pradesh, farmers generally burn the leftover crop residues in the field after the harvesting of the crop and resultant ash is incorporate into the soil. However, crop residue burning is not an acceptable practice though ash is a good soil amendment and has many advantages like, improve the soil fertility, check the soil born pests and diseases, conserves moisture, prevents evaporation loss besides enriching the soil with potassium. Methane (CH₄) and Nitrous Oxide (N₂O) released from biomass burning account for 12% of the agricultural GHG emissions in India. Additionally, the carbon sequestered in the burned biomass as well as the nutrients in the plant parts are lost to the atmosphere (http://en.wikipedia.org/wiki/Organic_farming). Instead of burning of crop residue, it would be more advantageous to make it compost or incorporate in to the soil as such. Sometimes kitchen ash and compost together are incorporated in the soil just before sowing to increase the soil fertility (Vanaja 2007). Dissolve 500 gm wood ash and 500 gm cow dung in 10 litre of water and spray it to reduce flower dropping in Tomato besides supplying nutrients (Rohini Reddy).
e. Compost application

Compost is a key ingredient in Organic Farming. Compost is a form of organic matter (plant and animal residues) which has been rotted down by the action of bacteria and other organisms, over a period of time. Any organic materials such as leaves, twigs, fruit skins and animal manures can be used to make compost. Compost is cheap, easy to make and is a very effective material that can be added to the soil, to improve soil health and crop quality. Incorporation of compost enriches the soil and also improves the soil physical environment. Apart from nutrients, it also adds organic matter in to the soil. Incorporation of ash also controls certain pests.

<table>
<thead>
<tr>
<th>Box 7: Benefits of Compost</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Compost improves the structure of the soil. This allows more air into the soil, improves drainage and reduces erosion.</td>
</tr>
<tr>
<td>➢ Compost improves soil fertility by adding nutrients and by making it easier for plants to take up the nutrients already in the soil. This produces better yields.</td>
</tr>
<tr>
<td>➢ Compost improves the soil’s ability to hold water. This stops the soil from drying out in times of drought.</td>
</tr>
<tr>
<td>➢ Compost can reduce pests and diseases in the soil and on the crop.</td>
</tr>
<tr>
<td>➢ Compost feeds soil life and improves soil structure; the beneficial effects are long lasting.</td>
</tr>
</tbody>
</table>

f. Vermicompost application:
Vermicompost is the end-product of the breakdown of organic matter by some species of earthworms. Vermicompost is a nutrient-rich, natural fertilizer and soil conditioner. Vermicompost (compost made by earthworms) is very rich in nutrients, can act as the single source of all nutrients the crop needs. It contains approx. 1.5% Nitrogen, 0.5% Phosphorus and 0.8% Potassium, as well as other micronutrients besides, containing 10% organic carbon (http://www.worms.com/worm-pdfs/whats%20vermicomposting.pdf). It also contains millions of microbes which help break down nutrients already present in the soil into plant-available forms. Unlike other compost, worm castings also contain worm mucus which keeps nutrients from washing away with the first watering and holds moisture better than plain soil. It also add
plant hormones such as Auxins and Gibberellic acid. Vermicompost is usually too rich and gummy for use alone as a seed starter, and is used as a top dressing or mixed with soil in a ratio of one to four. Most fruit and seed pits are reported to germinate in vermicompost easily (http://www.vanashree.in/vermicompost.htm). Continuous application significantly increases organic matter content in soil (http://www.sustainet.org/download/sustainet_publication_india_part1.pdf). Earthworms can convert about 1,000 tons of moist organic waste into 300 tons of rich, dry vermicompost (http://www.sustainet.org/download/sustainet_publication_india_part1.pdf). Earthworms consume almost any type of organic matter, including bones and eggshells, and they consume their own weight of residue every day, converting it into nutrient-rich worm casts. In 45–60 days, one kg of earthworms (1000–1250 worms) can produce 10 kg of casts (Rangasamy and Jayanthi 2001).

g. Farm Yard Manure
Incorporation of Farm Yard Manure is an age old soil management practice not only in entire Andhra Pradesh, also in entire India. Farmers either apply FYM every year or once in 2-3 years to all types of crops, depending on the availability. Farm yard Manure is prepared basically using cow dung, cow urine, waste straw and other dairy wastes. Well-rotted farmyard manure, for example, contains 0.5% nitrogen (N), 0.2% phosphorus (P2O5) and 0.5% potassium (K2O) (http://www.sustainet.org). FYM when incorporated into the soil, a small portion of N is directly available to the plants while a larger portion is made available as and when the FYM decomposes. The cut ends of plant cuttings are pasted with cow dung ball –Better sprouting and rooting and reduces desiccation and acts as growth promoter (Rohini Reddy).
h. Mulching

Mulching is a means covering the soil surface with a layer of plant derived organic material such as stalks of cereals, Paddy straw, dry grass, compost, manure, leaves or any crop residues etc. Generally dried material is used for mulching as green vegetation can take long time to decompose and can attract pests and fungal diseases (http://www.infonet-biovision.org/res/res/files/488.OrgFarm.pdf).

Mulches should always be applied to a warm, wet soil. Mulch applied to a dry soil will keep the soil dry. Care should be taken as to the thickness of the mulch applied. Too much mulch will prevent air flow and encourage pests. To allow the germination of planted seeds through the mulch, a layer of less than 10cm should be used. To clear an area of land of persistent weeds a layer of 10cm or more can be used Mulching (http://www.infonet-biovision.org/res/res/files/488.OrgFarm.pdf).
i. **Crop residues**

Leftover plant material after harvest of the crop can be ploughed back into the soil. Different plants leave different amounts of nutrients up on decomposition and build organic matter.

j. **Neem cake/Neem leaves**

The dual activity of Neem cake as fertilizer and pest repellent has made it a favored input. When Neem cake is ploughed into the soil it also protects plant roots from nematodes and white ants. Neem leaves have also been used to enrich the soil. Together, they are widely used in India to fertilize cash crops. Farmers in Andhra Pradesh and other southern states puddle Neem leaves into flooded Rice fields before the Rice seedlings are transplanted. Neem cake contains Nitrogen 3.56%, Phosphorous 0.83%, Potassium 1.67%, Calcium 0.77%, Magnesium 0.75% ([http://www.Neemfoundation.org/Neem-articles/Neem-in-organic-farming/organic-farming-a-Neem/69-fertilizer-uses.html](http://www.Neemfoundation.org/Neem-articles/Neem-in-organic-farming/organic-farming-a-Neem/69-fertilizer-uses.html)). Application of 250 kg of Neem cake per acre results in higher yield (Rohini Reddy). Apart from Neem cake, other oil seed cakes such as Castor cake, Groundnut cake, Cotton seed cake, Mustard oilcake etc are also used as source of organic soil nutrients. Mustard oil cake is a concentrated organic manure and contain approx. 4.5 %, 1.5%, 1.0% of nitrogen, phosphorous and potassium, respectively. Because of its low C: N ratio (3-5) releases nitrogen quickly (Biswas and Mukherjee 1993). Fishmeal incorporation is an age-old practice. Fish is rich in minerals and organic contents. Fish contains 7.0 % nitrogen, 6.0 % of phosphorous and 1.0% potassium with a C: N ratio of 4-5 (Biswas and Mukherjee1993).

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**Box 8: Benefits of Mulching**

- Help to improve plant growth:
- Decreasing water loss due to evaporation
- Reducing weed growth by reducing the amount of light reaching the soil
- Preventing soil erosion
- Increasing the number of micro-organisms in the top soil
- Adding nutrients to the soil and improving soil structure
- Adding organic matter to the soil

K. Tank silt application:
Tank silt application to soil not only adds major and micro nutrients but also improve soil physical and physic-chemical properties due to excess addition of finer particles mostly the clay and silt particles. Clay and silt particles improves the improves the Cation Exchange Capacity of soil that leads to holding of more of soil nutrients and the same made available to the plants. Mohammed et al., (2009), in a research study on tanks reported the available Nitrogen content of tank silt ranged from 328 mg kg-1 to 748 mg kg-1, available Phosphorous 5 to 35 mg kg-1 and available Potassium 271 to 522 mg kg-1 silt. Similarly, available Sulfur ranged from 12 mg kg-1 to 30 mg kg-1 Zinc from 1.2 mg kg-1 to 5.6 mg kg-1 and Boron 0.4 to 0.8 mg kg-1 silt. Textural analysis indicated 70 to 80% clay, while the silt ranged from 15 to 25%. Further, addition of tank silt at 50, 100, 150 and 375 tractor loads per hectare improved the available water content by 0.002, 0.007, 0.012 and 0.032 g g-1 of soil, respectively in the plough layer and enhanced the tolerance of rain-fed crops to moisture stress by three to five days. Application of tank silt @ 25 t/ ha to irrigated Tomato saves cost on plant protection and supplies micronutrients that build resistance to pests (Rohini Reddy)

I. Biofertilizers
Biofertilizers are the organisms that fix nitrogen from the air and make it available for plants. They are applied to the seed before planting, or directly to the soil. Bio-fertilizers such as Rhizobium, BGA, Azotobacter, Azospirillum when inoculated to the soil/seed, fixes atmospheric Nitrogen in to the soil. Hence, minimizes the need to add synthetic fertilizers, there by contributing to climate change mitigation. Biofertilizers are highly crop specific. Research shows that these biofertilizers can save around 20 kg of nitrogen per hectare, depending on the application rates and local conditions (NIRI-KVIC, www.niri-kvic.org). Some biofertilizers sources are mentioned below;

Rhizobium is the bacteria that live in the root nodules of legume plants and fix Nitrogen from the air and make it available for crop. Many legume seeds have to be inoculated with the right type of Rhizobium before they can fix Nitrogen. Using efficient strains of Rhizobia can save of the Nitrogen requirement significantly (Vandana Shiva). Recommended for pulse legumes such as Bengal gram, Red gram, Lentil, Blackgram, Greengram and Cowpea; Oilseed legumes like Soybean and Groundnut; Fodder legumes like Berseem and Lucerne and Tree legumes like Acacia, Leucaena and Gliricidia.
Blue Green Algae also fix Nitrogen. They can be cultured in the shallow ponds, harvested and inoculated in the Rice fields.

*Azolla* (a water fern) is grown in nearby water ponds is harvested during the rainy season and incorporated in the last puddling. After the crop season, the *Azolla* get dried and add lot of organic matter to the soil.

Other Nitrogen fixing bacteria include *Azotobacter* and *Azospirillum* (two types of bacteria). **Phosphate Solubilizing Bacteria (PSB)** is also inoculated to the soil to enrich the soil with Phosphorous. PSB can be used for all crops including Paddy, millets, oilseeds, pulses and vegetables. Applied as seed treatment, seedling dipping, and soil application.

Table 6: Recommended liquid Bio-fertilizers and its application method, quantity to be used for different crops.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Recommended Bio-fertilizer</th>
<th>Application method</th>
<th>Quantity to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field crops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulses</td>
<td><em>Rhizobium</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Chickpea, pea, Groundnut, soybean, beans, Lentil, lucern, Berseem, Green gram, Black gram, Cowpea and pigeon pea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cereals</td>
<td><em>Azotobacter/Azospirillum</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Wheat, oat, barley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td><em>Azospirillum</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Oil seeds</td>
<td><em>Azotobacter</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Mustard, seasum, Linseeds, Sunflower, Castor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millets</td>
<td><em>Azotobacter</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Pearl millets, Finger millets, kodo millet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize and Sorghum</td>
<td><em>Azospirillum</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Forage crops and Grasses</td>
<td><em>Azotobacter</em></td>
<td>Seed treatment</td>
<td>200ml/acre</td>
</tr>
<tr>
<td>Bermuda grass, Sudan grass, Napier Grass, ParaGrass, StarGrass etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>Recommended Bio-fertilizer</td>
<td>Application method</td>
<td>Quantity to be used</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------------------------</td>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Other Misc. Plantation Crops</td>
<td>Azotobacter</td>
<td>Seedling treatment</td>
<td>500ml/acre</td>
</tr>
<tr>
<td>Tobacco</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea, Coffee</td>
<td>Azotobacter</td>
<td>Soil treatment</td>
<td>400ml/acre</td>
</tr>
<tr>
<td>Rubber, Coconuts</td>
<td>Azotobacter</td>
<td>Soil treatment</td>
<td>2-3 ml/plant</td>
</tr>
<tr>
<td>Agro-Forestry/Fruit Plants</td>
<td>Azotobacter</td>
<td>Soil treatment</td>
<td>2-3 ml/plant at nursery</td>
</tr>
<tr>
<td>All fruit/agro-forestry (herb, shrubs, annuals and perennial) plants for fuel wood fodder, fruits, gum, spice, leaves, flowers, nuts and seeds purpose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leguminous plants/ trees</td>
<td>Rhizobium</td>
<td>Soil treatment</td>
<td>1-2 ml/plant</td>
</tr>
</tbody>
</table>

**Note:** Doses recommended when count of inoculum is $1 \times 10^8$ cells/ml then doses will be ten times more besides above said Nitrogen fixers, Phosphate solubilizers and potash mobilizers at the rate of 200 ml/acre could be applied for all crops.

*Source:* [http://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html](http://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html)

**m. Panchagavya**

Panchagavya, an organic liquid product has the potential to play the role of promoting growth and providing immunity in plant system. Panchagavya consists of nine products viz. cow dung, cow urine, milk, curd, jaggery, ghee, banana, tender coconut and water. When suitably mixed and used, these have miraculous effects. Panchagavya revealed that they possess almost all the major nutrients, micro nutrients and growth harmones (IAA & GA) required for crop growth. Generally panchagavya is recommended for all the crops as foliar spray at 30 % level (3 litre panchagavya in 100 litres of water). For details visit [http://agritech.tnau.ac.in/org_farm/orgfarm_panchakavya.html](http://agritech.tnau.ac.in/org_farm/orgfarm_panchakavya.html).
Organic soil fertility & crop nutrition management practices in Paddy observed in SPACC project area

- Green manuring is practiced for Paddy crop once in two years to increase the soil fertility. *Daincha (Sesbania aculeata)* or *Sunnhemp (Crotalaria juncea)* a legume green manure crop is incorporated at 50% flowering in the last puddle. (Practiced in all the SPACC project districts and also in entire Andhra Pradesh).

- Greenleaf manuring with *Pongamia pinnata* (Kanuga)/ *Glyricidia* leaves were also incorporated in last puddle in Paddy crop in Anumulapalli in Prakasam district, all the pilot villages in Mahabubnagar and Kadapa districts.

- Inoculating Paddy fields with *Azolla* to enrich the soil with Nitrogen (documented in Nariganipalli, Mittapalli villages in Nalgonda district and also in all the pilot villages in Mahabubnagar district).

- As part of soil management for Tomato crop farmers are applying FYM, Vermicompost, tank silt and Paddy crop is applied with Green leaf manuring, Poultry manure, Crop residues depending on the source and quantity available. (documented in Nariganipalli, Mittapalli villages in Nalgonda district).
Applying tank silt to soil irrespective of crops grown. Tank silt is applied to the soil before the onset of rains. Tank silt is applied as part of land development program under MGNREGS of department of Rural Development. (Practiced in all the SPACC project districts and also in entire Andhra Pradesh).

Vermicompost @3q/acre is applied to Chilli crop in Gowtavaram, Anumulaveedu, Gangampalli, Bodepadu, Moddulapalli, MV Palli villages in Prakasam district and also in Chittoor district. This practice is followed by only 5% of farmers in the project villages.

Vermicompost @ 3 q/acre is being applied regularly in Sweet Orange orchards in Racherla, Bodapadu, Gangampalli villages in Prakasam district. Observed among in 4% of farmers in the project villages.

Dried fallen leaves from forest area are collected and applied as mulch in Sweet orange orchards to conserve soil moisture and to maintain uniform soil temperature during both summer and winter seasons. This practice is observed in SPACC project area in Prakasam district and Kadapa and Mahabubnagar district.

Pruning is in practice in young Sweet Orange trees to impart strengthen and vigour and for better bearing in Nalgonda and Prakasam district.

FYM and Tank silt whatever quantity available is being incorporated before the sowing of Groundnut crop (documented in Nariganipalli, Mittapalli villages in Chittoor district and also in Gooty in Anantpur).

Farmers in Prakasam, Nalgonda, Kadapa, Chittoor, Anantpur, Mahabubnagar districts are incorporating FYM@ 1-2 Tractor (Approx. 10-20 tonnes/-acres) before sowing of Chilli, Cotton, Paddy and Redgram crops. FYM application whatever quantity available is practiced in entire AP.

Farmers of P. Yachavaram village in Prakasam district are spraying Vermiwash @3% to Sweet Orange to rectify the Nitrogen deficiency and also to control pests of Sweet Orange.
➢ To increase the fertility of the soil, dry cowdung is incorporated @ (4-5 cartloads /acre) in to the soil during the last ploughing. Practiced once in 2-3 season to all the crops. Farmers believe that dry cowdung incorporation also control pests besides adding nutrients and organic matter. (Practiced in all the SPACC project districts and also in entire Andhra Pradesh).

➢ In entire Andhra Pradesh including SPACC project area, 90% of the farmers burn the previous season crop residues and the resulting ash is incorporated in to the soil either solely or incorporated along with FYM or compost. Incorporated in to the soil just before sowing to increase the soil fertility. Farmers believe that, burning process kills the pests and disease causing organisms and incorporation of ash also control pests and diseases. However, burning of crop residues results in loss of nutrients, hence, not recommended by the scientific community.

➢ Groundnut oil cake is incorporated in irrigated Groundnut crop. Upon decomposition, add nutrients to the soil, besides adding organic matter. Oil cakes also control pests and diseases. The Groundnut oil cake contains 7-8% of N, 1.5% of P₂O₅ and 1.2% of K₂O. (documented in SPACC project areas in Anantpur and Chittoor districts).

➢ Groundnut shell is used for mulching purpose around the fruit trees and also in the groundnut field. Growing groundnut itself enriches soil nitrogen, being legume fixes atmospheric nitrogen in to the soil. (documented in SPACC project areas in Anantpur district).

➢ Groundnut shell is mulched around the Mango trees and also other fruit trees. (very common practice in Anantpur district)

➢ Cow dung and poultry manure mixed in 1:1 ratio and applied to Brinjal crop during land preparation for higher yields. (Practiced in Nalgonda and Chittoor districts).

➢ Grinding 40 kg of Neem seeds and incorporated to one acre land helps in obtaining higher yields. Documented in SPACC areas in Prakasam, Nalgonda, Kadapa, Chittoor, Anantpur, Mahabubnagar districts.
Application of tank silt @ 25 t/ha to irrigated Tomato saves cost on plant protection and supplies micronutrients that build resistance to pests. Documented in SPACC areas in Kadapa, Chittoor districts.

Application of 250 kg of Neem cake per acre results in higher yield in Chilli. Castor cake is also incorporated in vegetable crop fields before sowing. (documented in Warangal, Kurnool, Kadapa, Chittoor districts).

Pruning vegetative branches in Chilli enhances growth and yield and induces fruiting branches. Common practice in Chilli growing areas of Andhra Pradesh.

Application of 100 kg of Groundnut cake per acre reduces the flower dropping in Chilli. Commonly practiced in Chilli growing districts of Andhra Pradesh.

Poultry manure (from cages or broiler system) is incorporated @ 2-5 q/acre to the Paddy field in last puddle. Incorporation is done 7-10 days before transplanting. Immediately after incorporation the field need to be irrigated. If irrigation is not given, it generates lots of heat and cause damage to seedlings. Hence, farmers don’t incorporate Poultry manure to uplands and to Rainfed crops. However, if irrigation is assured, Poultry manure can be applied to upland crops also. Poultry manure because of high nutrient content (approx. 1.5 - 3.0% of Nitrogen, 1.02 – 2.63% of Phosphorous and 1.5-3.0 % of Potash) and narrow C: N ratio (approx. 17), the nutrient release is very fast (Rajput and Goyal 1991). Moreover, the Nitrogen is present in uricacid form, which decomposes rapidly, and nitrogen is made available to the crop immediately. Poultry manure because of these characters increases the yields tremendously and thereby lots of carbon is sequestered. (documented in Nalgonda and also in many other districts in Andhra Pradesh).

Sheep penning is practiced for better yields in entire Andhra Pradesh including SPACC project areas. Sheep/goat are allowed to stay in the field for whole night till morning hours, where they discharge urine and dung. This is done before the onset of monsoon. Generally 250-300 numbers of goats/sheeps in a flock are penned in an acre of land. The dung is spread uniformly in the field and incorporated in the soil. Incorporation of dung is done with the anticipation of monsoon rains or a light irrigation is given to the soil to
facilitate decomposition and also to percolate the nutrients up to the root zone depth. To maintain a thin layer of water in the field to facilitate decomposition and leaching of nutrients, small furrows are made and water is allowed to retain in the furrows for some time. During the decomposition lot of heat is generated hence, sufficient quantity of water is required to harvest good results.

Sheep manure contains good amounts of nutrients approx. 3 % N, 1 % P2O5 and 2 % K2O (Shankernarayan). The heat that is generated during the decomposition of the dung activates enzymes in the soil. It is one of the best practices to improve the soil fertility and enhance the yields. This practice sequesters lots of Carbon and has good mitigation effect. However, research is required to check the net balance of Carbon sequestration and Methane emission from Goats by enteric fermentation during digestion process. Sheep penning is practiced for getting higher yields in Chilli.

2.4. Pest & Disease Management
Warmer climate due to global warming will increase pest populations, including weeds, insects and insect-borne diseases, which will likely lead to large increases in the use of pesticides. Warmer summers may in particular favor certain Thermophilic fungi and increase the activity of weak bacteria (Bhakta and Palikhe). An increased incidence of summer drought would probably favor diseases caused by fungi whose activity is dependent on host stress, particularly root pathogens. Heavy precipitation events cause runoff and erosion there by leaching of pesticides, fertilizers and other chemicals into surface and groundwater. Adaptation options in the context of Climate Change would be to reduce grower input cost with concomitant increase in yield and quality with reduced environmental impact.

Organic Agriculture system believes that, the pests and diseases are part of nature and in the ideal system there is a natural balance between predators and pests. If the system is imbalanced then one population can become dominant because it is not being preyed upon by another. The aim of natural control is to restore a natural balance between pest and predator and to keep pests and diseases down to an acceptable level. The aim is not to eradicate them altogether. Further, in the Organic Agriculture production, every insect pest need not be seen as pest, every plant out of place as a weed and the only solution to every problem is chemical pesticide spray. The aim is not to eradicate all pests and weeds, but to keep them down to an acceptable level.
and make the most of the benefits that they may provide. However, during the past few decades
the indiscriminate use of pesticides causing number of problems such as insect pest developing
resistance, resurgence and residue problems along with elimination of beneficial insects and also
causing health hazards.

Hence, it has become necessary to manage pests through safe and cost effective pest
management tactics. Traditional pest management tactics with indigenous technical knowledge
of the farmers themselves and renewable natural resources are reported to be effective in
managing the pests and diseases to a large extent. These strategies include the cultural
practices, mechanical methods, biological methods, host plant resistance and use of
biopesticides to suppress the pests. The basic principle of Organic Agriculture with respect to
pest including insects, disease and weeds are careful planning and crop choice, use of resistant
crops, good cultivation practice, crop rotation, encouraging useful predators that eat pests,
increasing genetic diversity and using natural pesticides derived from plants and animal
for a farmer to learn to recognize insects and other animals that eat and control pests. Through
careful planning and using all the other techniques available it should be possible to avoid the
need for any crop spraying. If pests are still a problem natural products can be used to manage
pests, including sprays made from plant sources. Locally available materials of various kinds are
highly effective in controlling the pests and diseases.
Box 9: Climate Resilient Traditional Pest Management Strategies

- Maintaining healthy crop stand that suffer less damage from pests & diseases.
- Choosing crops with a natural resistance to specific pests and diseases.
- Local varieties are better at resisting local pest and diseases than introduced varieties.
- Timely planting of crops to avoid the period when a pest does most damage.
- Companion planting with other crops that pest will avoid.
- Trapping or picking pests from the crop.
- Correctly diagnosis of pest and diseases.
- Keeping the knowledge on life cycles, breeding habits, preferred host plants and predators of pests.
- Using crop rotations to help break pest cycles and prevent a carryover of pests to the next season.
- Providing natural habitats to encourage natural predators that control pests.
- Inspite of using all the other techniques available, if pests are still a problem natural products can be used to manage pests, including sprays made from Chillies, onions, garlic, Neem products etc

Under Organic Agriculture system irrespective of locations traditionally farmers used to pay more emphasis on simple preventive measures, inspite of that, if pest appears in population more than threshold level, botanical sprays were sprayed. Some of the preventive measures are maintaining flowering shrubs and trees throughout the garden will attract many beneficial insects, including parasitic wasps which require pollen and nectar for their growth and maturity. Plants belonging to Umbelliferae family are particularly effective in attracting natural enemies of pests. Providing alternate hosts for pests to ensure availability of food for the beneficial organisms, growing alternate host plants along fence lines and in between cultivated crops. The natural enemy populations on these alternate host plants will control pests attacking the cultivated crop. Further, creating nesting sites for frogs, reptiles and birds by providing logs of dead trees, irregularly shaped rocks with crevices and cavities and plenty of mulch can be a good nesting sites for snakes, lizards, frogs, rove beetles and carabid beetles, which feed on insects.
Increasing humidity by providing water holes is much needed for the survival of natural enemies. It serves as a source of drinking water for reptiles, birds and frogs. Many predatory insects live in, on and near water. Intercropping with aromatic herbs such as Onion, Garlic, Marigold, Basil (Ocimum spe.) etc can be grown together with the main crop to repel insects because of pungent odor from plants. Growing of indigenous varieties/Traditional varieties which are hardier and relatively more resistant to pests. They can withstand harsh environmental conditions better than modern hybrids (Rohini Reddy).

<table>
<thead>
<tr>
<th>Box 10: Preventive Measures for Pest Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Good seed selection (no disease contamination, etc.)</td>
</tr>
<tr>
<td>2. Planting at appropriate time</td>
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There are several organic methods of pest management that need to be revived. It has been observed that, such practices are generally practiced by small and marginal farmers. Following are some of the organic pest management techniques, organic formulations in use within and outside SPACC project villages.
Review of promising Organic Agriculture practices for pest & disease management

- **Sprinkling of Ash** acts as physical barrier for insects. It acts as antifeedant and repellent. When sprinkled on the leaves, ash makes the leaf unpalatable. This technique is very effective for the control of chewing and sucking pests like beetles, leaf defoliators, leaf minor, thrips and aphids. Moreover, ash contains considerable amounts of potassium for plant growth that impart disease resistance in plant (Senthil Vinaygam et. al. 2006). Ash also add organic matter to the soil that helps in improving the soil structure and moisture holding capacity. Generally ash is sprinkled on the crop early in the morning when moisture in the form of dew is present. This technique is highly acceptable because of low cost, easy availability and without any adverse effects on the environment. It is very popular among the small and marginal farmers of North East states and many Northern states of India. Dusting ash on Tomato crop in the morning hours to control aphids, thrips etc.

Soybean growers in Madhya Pradesh also practice this Indigenous pest control measure to control beetles (Senthil Vinaygam et. al. 2006). Farmers of Shimla in Himachal Pradesh spray a mixture of ash + cow urine to protect cabbage plant from insects and also improve compactness of the ball and the marketable yield (Chamanlal and Verma 2006). In several districts of Assam, kitchen ash approx @ 2-3 kg/bigha is sprinkled at least for 1-2 times for the control of pests of vegetables such as Chilli, Beans, Brinjal, Tomato, Onion, Cucumber, Potato etc. In some areas ash is also incorporated during the last ploughing to control the pests. In Morigaon district of Assam, farmers are applying a mixture of cowdung, ash, urea (approx. 20 kg) and single super phosphate (approx.15 kg) to the soil as a preventive measure for the control of pests of Tomato. In some areas cow dung ash is preferred over wood ash (Vanaja 2007). To control most of the pests in Tomato, 1½kg ash is spread in one acre of land (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

Rohini Reddy has documented pest control practices with wood ash controlling root maggots in Radish, Onions, Cabbage and other Brassicas can be controlled by spreading fresh (not hot) wood ash around the plant roots. Ashes are then covered lightly with soil. Snails, slugs and cutworms can be controlled by encircling plants with 3-4 inch– wide trench 1-2 inches deep. Fill this trench with fresh wood ash. Pests will avoid crossing this
trench. Flea beetles on Tomatoes can be controlled by spraying a mixture of wood ash and water. Cucumber beetles can likewise be controlled by spraying a mixture of equal quantities of wood ash and powered lime mixed with soapy water (Rohini Reddy).

Application of Neem products: Neem tree (Azadirachta indica) and its derivatives have great relevance in organic farming. This remarkable tree has been identified as a renewable resource for home grown agro-chemicals and nutrients which are biodegradable, non-toxic and effective. Unlike chemical insecticides, Neem compounds work on the insect’s hormonal system, not on the digestive or nervous system and therefore do not lead to development of resistance in future generations. Neem seeds and leaves have pesticidal properties, work as insecticidal, repellent, antifeedant, acaricidal, growth inhibiting, nematocidal, fungicidal and anti-viral (http://www.Neemfoundation.org/Neem-articles/Neem-in-organic-farming.html).

Azadirachtin an alkaloid in Neem impart bitter taste and is considered as main agent for controlling insects due to it’s antifeedent property that repels and disrupt the growth and reproduction in insects (Narayana Swamy 2006). Presence of other active compounds like Nimbicidin, Nimbin, Salamin, Meliantrol imparts oviposition different, Insect Growth Regulator & Insecticidal activities (Narayana Swamy 2006). It is advisable to takeup Neem spraying in the morning or late in the evening for effective results. During hot conditions the frequency of spraying should be increased. In winter season spraying once in 10 days and in rainy season, every day spraying is recommended. Generally, most insects lay eggs on the underside of the leaves. Hence it is important to spray on the underside of the leaves as well. (http://www.Neemfoundation.org/Neem-articles/Neem-in-organic-farming/organic-farming-a-Neem/68-pest-management.html).

Several studies have been carried out on Neem products as pesticide. Neem compounds act mainly as stomach poison and systemic in nature. Neem has found effective against 200 agriculturally important pests that includes, American boll-worms, stemborers, ants, desert locusts, leaf hoppers, gross hoppers, hairy caterpillars, leaf miners, mites, mealy bugs scales, termites, thrips, beetles, fruit flies, white fly, nematodes (in Tomato, Chilli, Brinjal and cauliflower) and various pests of stored grains (Pramod and Kshama 2007). A general recipe for Neem pesticide common for any pests is prepared from 1 kg of Neem leaves dipped in 2 litres of water and left overnight. Boil it 15-20 minutes until 1/4 is left. Dilute with 10-15ml of water before spraying
Placing green twigs and leaves of Neem in the field control plant hoppers and whorl maggots in Rice and Maize crop (Ley Steven 1994). De-oiled Neem cake (the residual remainings after the oil has been pressed out of the seeds) and Neem oil are quite effective against Rice pests. Five applications of 25% oil emulsion sprayed can protect Rice crops against brown plant hoppers. Neem products greatly reduce the tungro virus transmission efficiency of green leaf hopper in Rice (http://www.Neemfoundation.org/Neem-articles/Neem-in-organic-farming/organic-farming-a-Neem/68-pest-management.html).

### Box 11: Promising Neem derivatives for pest management

**Neem Kernel Extract:**
50g of Neem kernel is required for use in 1 litre of water. The Neem kernel is pounded gently. It should be pounded in such a way that no oil comes out. The outer coat is removed before pounding, this is used as a manure. The seeds that are used for preparation of Neem kernel extract should be at least 3 months old and should not be used after 8-10 months. Before 3 months or after 8 months, the azadirachtin quantity is quite low in the seed and hence, it cannot efficiently be used for pest control. The pounded Neem kernel powder is collected in a muslin pouch and this is soaked overnight in the water. The pouch is squeezed and the extract is filtered. To the filtrate, an emulsifier like teepol, sandovit, soap oil or soap cake powder is added. One ml of emulsifier is added to one litre of water. The emulsifier helps the extract to stick well to the leaf surface.

**Neem Leaf Extract:**
For 5 litres of water, 1 kg of green Neem leaf is required. Since the quantity of leaves required for preparation of this extract is quite high (nearly 80 kg are required for 1 hectare) this can be used for nursery and kitchen gardens. The leaves are soaked overnight in water. The next day the leaves are grounds and the extract is filtered. The extract is beneficial against leaf eating caterpillars, grubs, locusts and grasshoppers. To the extract, emulsifier is added as mentioned in kernel extract.

**Neem Cake Extract:**
100 gms of Neem cake is required for 1 litre of water. The Neem cake is put in a muslin pouch and soaked in water. It is soaked overnight before use in the morning. It is then filtered and emulsifier is added -1-ml for 1-litre of water. It can then be used for spraying.

**Neem Oil Spray:**
30 ml Neem oil is added to 1 litre of water and stirred well. To this emulsifier is added (1ml/1litre). It is very essential to add the emulsifier and mix properly. This should be used immediately before the oil droplets start floating. A knapsack sprayer is better for Neem oil spraying in preference to a hand sprayer.

**Tobacco extract:** Both leaves and stalk of Tobacco have pesticidal properties. It forms one of the three major groups of organic insecticides after Rotanoids and Pyrethroides (Sethil Vinaygam 2006). In Tobacco (*Nicotana tabacum*), the alkaloids namely Nicotine which is a very toxic organic contact poison and also act as stomach poison and repellent. Leaves and stems of the Tobacco plant are used to prepare extracts which can be applied to control certain insects like aphids, caterpillars, thrips, leaf miners and mites. Sometimes Tobacco powder can be prepared by grinding dried leaves and stems and used against certain insects such as thrips. Mix 250 gram of Tobacco (can be collected from cigarettes) with 4 liters of water and add 30 gram soap. Boil this mixture softly for 30 minutes, then filtered and diluted with 16 liters of water to control many insects very effectively (http://thailand.ipm-info.org/components/tobacco_extract.htm).

Boil 4 litres of water, add ½ kg of tobacco leaves and 1 table spoon of lime. Dilute it with 10-15 litres of water, sprayed to control sucking pests (http://www.farmingsolutions.org/successstories/stories.asp?id=163). Boil the midribs and stem in water for a few minutes or soak for 3-4 days. Let it cool. This is an effective spray against numerous insect pests (Rohini Reddy).

- **Turmeric** is well known for its antifungal and antibacterial properties that also work as repellent and insecticidal agents. Turmeric rhizome is generally used for pest control. Curcumin is the main active ingredient responsible for turmeric's antimicrobial properties. (http://www.livestrong.com/article/141168-antimicrobial-activity-tumeric/#ixzz1kaNpM3i4). Turmeric has been found effective in controlling certain agricultural and animal pests due to the presence of a variety of bioactive constituents that interfere with insect behavior and growth (Christos 2011). Target pests include aphids, caterpillars, mites and Rice leaf hoppers (http://www.farmingsolutions.org/successstories/stories.asp?id=163). Turmeric powder (@20 g/kg) in combinations with mustard oil (@4 ml/kg) has been reported to protect stored Rice against *Sitophilus oryzae* by completely suppressing the progeny emergence of *S. Oryzae* (Chander et al., 1991). Fly ash (fine particles of ash produced during combustion) plus turmeric dust 10% indicated promising activity against some pests of Rice (*Cnaphalocrosis medinalis, Oxya nitidula*), some pests of Brinjal (namely *Epilachna vigintioctopunctata, Aphis gossypii, Urentius hystricellus, Coccidohystrix insolitus*), and against several pests of okra (namely *Amrasca devastans, Tetranychus neocaledonicus, Dysdercus cingulatus, Oxycarenus hyalinipennis, Anomis flava, Spodoptera litura, and...*
Earias vittella) inflicting up to 80% mortality depending on species (Sankari and Narayanasamy 2007). Likewise, dust from rhizomes was shown to be effective against store-grain pests such as lesser grain borer (Rhizopertha dominica) (Chander et al., 2003). Also, there was complete mortality of adult insects on milled Rice treated with 6 ml oil plus 1-4 g of turmeric powder (Chander et al., 2003), whereas mustard oil in various combinations with turmeric powder suppressed the progeny by more than 92%. Rhizome extracts were highly effective even at the lowest concentrations of 2.5 and 3.12 mg/cm² on jute fabric. The concentrations exhibited repellency even after three months of their ageing at room temperature. Red flour beetle adults fed on wheat flour, which had been treated with turmeric oil at 200 ppm produced fewer and underweight larvae, pupae, and adults compared with those fed on untreated flour (Jilani et al., 1988). Generally, 500g of turmeric rhizomes chopped and soaked overnight, dilute into 2 litres of water and again dilute into another 10-15ml of water.

Asafoetida (Ferula asafoetida Regel.), locally known as hing has tannins, which act as enzyme inhibitor and check the growth of the fungus. To control the wilt disease in Solanaceous vegetables, farmers of Cachar and Morigaan districts in Assam add 100gm of dry turmeric powder and 10gm of powdered hing and dissolved in one liter of water. Further 3 lts of water is added to this solution just before spraying. This solution is to be prepared freshly. One or two sprays of this solution effectively control the seedling rot disease especially in Tomato (Vanaja 2007)

Garlic spray is generally an effective insecticidal, repellent, antifeedent, fungicidal, nematocidal and is highly effective against ticks and kills soft-bodied insects viz., aphids, house flies, mites, white fly, bacteria, cucumber and scab. Garlic acts on a wide spectrum of organisms in unrelated crop plants singly or in combination with Neem products, Chilli, Asafoetida etc. Besides, Garlic is effective against bacteria, fungi and nematodes. (Lakshmanan, 2001). Normally 3 bulbs of garlic are ground finely added some kerosene, kept for 2 days. One table-spoon of soap powder is added, stir and filter and add 15-20 litres of water for spray on any crop to control sucking pests.
➢ **Ginger** has germicidal properties. Control diseases very effectively. The mode of action is as repellent, insecticidal, nematicidal and fungicidal. Specially targeting American boll worms, aphid, thrips, white fly, and mango anthracnose etc. A common Ginger pesticide preparation consists of 500g of crushed garlic add 10ml of kerosene oil kept overnight. Next day remove outer skin of ginger and make ginger paste. In another vessel add 100g green Chillies, mixed with 50ml of water and add 30g of liquid soap as emulsifier. Solution is stirred and filtered and 10-15 ml of water added before spraying on crops (http://www.farmingsolutions.org/successtories/stories.asp?id=163).

➢ **Chilli** spray act as stomach poison and has insecticidal, repellent, antifeedent, fumigant-viroid properties. Effective against ants, aphid, caterpillars and slugs. Normally 500g of Chillies, dip into 3 litres of water for 10-15 minutes. Add 30g of soap as sticker. Add 3 more litres of water, filter and then spray the plants. One can add tobacco, garlic, onion, citrus, alcohol, Neem and lime (http://www.farmingsolutions.org/successtories/stories.asp?id=163).

➢ **Cow urine** application is a very old practice. Cow urine acts as insecticide and the odour from cow urine repels the insects and also imparts resistance in plants against pests and disease.

➢ Soap solution acts as deterrent against Aphid infestation. Also work as emulsifier in many botanical pesticides.

➢ Planting of trap crop, boarder crop, intercrop to protect the main cash crop from several pests is a very common practice to check the pest population. Maize grown as boarder crop in Vegetable gardens act as physical barrier for insects, that also act as vector in spread of diseases.

**Organic Pest & Disease Management practices documented in SPACC project area**

In general farmers in SPACC project area practice less of organic pest management practices, rather rely more on synthetic pesticides. However, organic pest management
practices in SPACC project area are observed in villages where the NPM program of SERP is being implemented effectively.

**Organic Pest Management in Tomato (documented in SPACC project area)**

- Neem oil -5.0 ml/lit is sprayed to all types of vegetable crops for the control of sucking pests and leaf eating caterpillars (documented in Dharampuram and Vannedodi villages of Gooty mandals of Anantpur districts)

- In the main crop of Tomato, Maize is grown as border crop, while Marigold is grown as intercrop at 1:10 ratio, or sometimes beans were also grown as intercrop. This combination will control fruit borer and leaf miner attack (documented in all the SPACC pilot villages in Kadappa and Chittoor districts).

- To control the sucking pests in Tomato, Marigold, Maize and Jowar is grown as trap crop. 85% farmers in these villages are practicing this method (documented in all the SPACC pilot villages in Kadappa and Chittoor districts).

- An age old practice followed by burning of Agriculture and weed waste materials near the fields along the wind direction, immediately after sunset, to control many pests in any crops (Noticed in Anantpur, Kadapa, Mahabubnagar districts of AP).

- Dusting wood ash on the crop in the morning hours to control Aphids, Thrips etc. Ash acts as physical barrier for insects. It also acts as antifeedant and repellent. When sprinkled on the leaves, ash makes the leaf unpalatable. Documented in Prakasam district.

- In general, about 25 - 30 days old Tomato seedlings are preferred for planting to avoid pest incidence at early stage. This is a common practice in entire AP. (Informed by Scients at ANGRAU)
Organic pest management practices in Tomato listed from literature.

- Five ml of Neem oil in one litre of water, with one drop of soap liquid (which acts as emulsifier) are mixed thoroughly and sprayed on the plants to control sucking pests (Aphids), fruit borer (*Helicoverpa armigera*) attack and also control flower droppings in Tomato (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

- Six releases of *T. chilonis* @ 50,000/ha per week coinciding with flowering time (http://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect-veg_Tomato.html).

- Release *Chrysoperla carnea* at weekly interval at 50,000 eggs or grubs / ha from 30 DAS (http://agritech.tnau.ac.in/crop_protection/crop_prot_crop_insect-veg_Tomato.html).

- One kg of *Asafoetida* tied in a cloth is kept in irrigation channel to control fruit borer in Tomato. The quantity is sufficient for one acre (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html and also by Rohini Reddy).

- Dissolving Chula ash and cow dung in water and spraying it to reduce flower dropping in Tomato (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

- Mixing Neem cake with sheep droppings and dusting on the field to control thrips (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

- Two kg of Neem kernels are powdered and soaked in five litres of water for 10 days after which it is filtered, mixed with 50 litres of water and sprayed for one acre of Tomato crop to control fruit borer, leaf miner and thrips (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html; and also by Rohini Reddy).

- Raising garlic or onion as border crop in Tomato fields to prevent fruit borer attack (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).
To control most of the pests in Tomato, 1½ kg. of Kanuga (*Pongamia pinnata*) leaves, 1½ kg of *Vitex negundo* leaves and one kg of Neem leaves are cooked in a container for two hours from which decoction is prepared and dissolved in 20 litres of water and sprayed during evening hours for three or four times at monthly intervals (Rohini Reddy).

250 gms of dried Tobacco leaves are boiled in 4 litres of water for 30 minutes, allowed to cool, and filtered. The filtrate is diluted with an equal part of water and 30 gms of bar soap is added and sprayed. It works against fruit borer in Tomato (Rohini Reddy).

In Solanacious Vegetable crops such as Tomato, Brinjal etc. to control the wilt disease, 100gm of dry turmeric (*Curcuma aromatics*) and 10gm of hing (*Ferula asafoetida Regel*) are ground separately and dissolved in one liter of water. Further 3 lts of water is added to this solution just before spraying. This solution is to be prepared freshly. One or two sprays of this solution effectively control the seedling rot disease especially in Tomato (Rohini Reddy).

Spreading of dried Neem leaves powder over the Vegetable seedling nursery, helps to control termite damage (Rohini Reddy).

Grow marigold as border crop in Tomato field to prevent fruit borer and leaf miner attack (Rohini Reddy).

Tomato flea beetles can be controlled by spraying a mixture of wood ash and water (Vanaja 2007).

**Organic Pest Management in Chilli (documented in SPACC project area)**

Farmers are spraying Neem oil to control powdery mildew in Chilli crop. Neem products contain Terpenoids that impart bitter taste and act as antifeedant. Neem leaves also contains Azadirachtin an alkaloid, which is toxic to insects. (documented in Chimelatipally, Ankabupalem, verabadhra puram, villages in Prakasam district).
Neem oil is being sprayed to control pests in Chilli, Cotton, Paddy, Ground Nut, Tomato crops in Racherla, Gangampalli villages in Prakasam districts and also documented in SPACC project area in Anantpur and Mahabubnagar districts.

Growing Castor as a border crop acts as a trap for tobacco cut worms. (Documented in SPACC project area in Anantpur and Mahabubnagar districts).

Organic pest management practices in Chilli listed from literature

- Farmers of Nagulapadu in Guntur district In the 1 acre of land, Chilli crop was planted along with Vegetable as intercrops and obtained highest premium of Rs. 1600 per quintal Chilli cultivated following NPM methods. The pods were rated as excellent quality and was also exported to European countries. Apart from the intercrops, trap crops viz., Chrysanthemum, Marigold and Castor were planted. White and Yellow plates were placed across the field to control Trips in the field (http://www.serp.ap.gov.in/CMSA/SuccessStories/CMSA)

- Spray the leaf extract of *Prosopis juliflora* (5kg in 50 litres of water), two months after planting to control leaf spot, powdery mildew and fruit rot in Chillies (Rohini Reddy).

- Four Kg of Neem seeds powdered, placed in muslin cloth and tied are soaked in 10 litres of water for 24 hours; the content is filtered and 50 gm of soap powder is added to the filtered extract and diluted with 90 litres of water; and sprayed in the evening times to control many pests of Chillies (Rohini Reddy).

- Leaf extract of “Bilwapatra” (*Aegle marmelos*) is sprayed to control fruit rot in Chilli (Rohini Reddy).

- Growing Castor as a border crop acts as a trap for tobacco cut worms (Rohini Reddy and also (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).
Asafoetida @ 1kg/ac powdered, tied in a cloth and placed in the irrigation channel will act as a pest repellant (Rohini Reddy).

Chilli seeds are immersed in biogas slurry one and half hour for vigorous growth and disease resistance (Rohini Reddy).

Two rows of maize or sorghum are grown for every five rows of Chilli to control mosaic disease (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

Spraying the leaf extract of *Prosopis juliflora*, two months after planting to control leaf spot, powdery mildew and fruit rot in Chilli. (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

To control leaf curl and to encourage good growth in Chillies, the leaves of Neem, *Vitex negund*, *Morinda tinctoria*, thulasi (*Ocimum canum*), *Leucas asaper* and *Calotropis gigantea* are pounded, and the solution is sprayed to control white flies (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

Leaf extract of *Aegle marmelos* is sprayed to control fruit rot in Chilli (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

Organic Pest Management in Brinjal (documented in SPACC project area):

To control the pests in Brinjal crop, Marigold and Onion are grown as intercrops. 45% farmers in the village are following this practice (documented in all the few SPACC pilot villages in Chittoor district).

For Brinjal crop, pest attacked fruits and top
side branches were removed manually to stop the further spread. (documented in all the SPACC districts viz., Chittoor, Anantpur, Kadapa, Mahabubnagar, Prakasam and Nalgonda districts).

- Take ½ kg Neem cake and soaked overnight in enough water to submerge them. (This quantity is sufficient for an area of 50 sq. meters). The soaked cake should be broadcasted and mixed well with the soil in early morning. It gives good yield and reduces the population of all major Brinjal pests like root aphids, fruit and shoot borer, Epilachna beetle and other major pests (Practiced in Guntoor, Prakasam and Ranga Reddy districts in AP).

**Organic pest management practices in Brinjal listed from literature.**

- Growing Castor in Brinjal fields as border crop acts as a trap crop for Tobacco cut worm (Rohini Reddy).

- Growing Onion/Garlic as intercrop in Brinjal helps to control many pests including fruit borers (Rohini Reddy).

- Neem cake 4 kgs (Powdered), and *Aloe vera* 4 Kgs (chopped and crushed finely) are soaked in 100 liters of water and the above mixture is stored in a container closed with lid. After 10 days, the contents are filtered and sprayed to control Thrips in one acre of Brinjal crop (Rohini Reddy).

- Ash and turmeric powder are mixed in 1:1 ratio and sprinkled to control aphids in the morning hours, when the dew is there on the leaves (Rohini Reddy).

- Sprinkling of lime powder helps to control Mealy bugs (Rohini Reddy).

- Cow urine, Neem oil and tobacco decoction are mixed in 1:1:1 ratio in one litre of water and sprayed to control all sucking pests (Rohini Reddy).

- Placing one spoon of Neem cake at the root zone helps to control Brinjal shoot borer and stem rot (Rohini Reddy).
> Two-three Kgs of *Trichoderma viridi* is released in the field before transplanting the Brinjal seedlings in the main field (http://takingroots.in/ipm_Chilli).

> Spray Neem cake extract to control mites and the spotted beetle (*Epilachna octopunctata*) in Brinjal (http://takingroots.in/ipm_Chilli).

> 1 Kg of fresh Custard Apple leaves and 1 kg of Neem cake soaked in 2.5 litre of cow urine overnight, then filtered. The filtered solution is diluted with water in a ratio of 1:3 and sprayed on foliage. It gives the effect in controlling the pests of Brown hairy caterpillar (Rohini Reddy).

> Take 1 kg of fresh Custard Apple leaves and ½ kg of Neem cake are soaked in 3 lts of cow urine overnight. The filtrate is diluted with 8 lts of water and sprayed. It effects against *Epilachna* beetle, and controls Grub and adult (Rohini Reddy).

> In order to prevent fruit rotting in Brinjal plants, a solution is made of 1 lit. of water and eight crushed leaves of Aloe vera and sprayed on the crops (http://agritech.tnau.ac.in/success_stories/sucess%20stories Organic%20farming.html).

> *Chrysanthemum coronaries* is grown as a border crop in Brinjal to control fruit borers (http://agritech.tnau.ac.in/success_stories/sucess%20stories Organic%20farming.html).

> Mixing and grinding well Neem cake with *Aloe vera* and soaking in water for 10 days, after which spraying the filtrate to control thrips. (http://agritech.tnau.ac.in/success_stories/sucess%20stories organic%20farming.html).

> Ash and turmeric powder are mixed in equal proportion and sprinkled to control aphids (http://agritech.tnau.ac.in/success_stories/sucess%20stories organic%20farming.html).

> Sprinkling of lime powder to control mealy bugs (http://agritech.tnau.ac.in/success_stories/sucess%20stories organic%20farming.html).
- Cow urine, Neem oil and tobacco decoction are mixed and sprayed to control all sucking pests
  (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

- Spraying Neem cake extract to control mites and the spotted beetle (*Epilachna octopunctata*) in Brinjal
  (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

**General pest control methods and tips for Vegetables crops**

- During nights, burning heaps of straw in several places near the fields along with a bucket full of water or Castor cake dissolved in water near the fire helps to attract and kill the insects (Rohini Reddy).

- Planting of garlic, onion, mint, marigold and other aromatic plants in between the rows of Vegetable gardens will act as a natural pest repellent (Rohini Reddy).

- Spray a solution made out of 1 kg crushed garlic which is soaked in 200ml of kerosene, mixed with 2 kg green Chilli paste & dissolved in 200 liters of water. This will help in controlling hairy caterpillar and *Heliothis* pest. It also acts as contact insecticide and a repellent
  (http://agritech.tnau.ac.in/success_stories/sucess%20stories_organic%20farming.html).

- Sprinkling with Neem leaves, cow urine mixed with water (1:10 ratio) helps to control many pests and diseases (Rohini Reddy).

- Four kg of Neem seed kernel extract in 100 litres of water is mixed with 50 gm of detergent powder. Spraying the extract will destroy the eggs (ovicidal properties) of the insects and also it controls many pests in different Vegetables (www.takingroots.org)

- Take five kg of Tobacco powder soak in five litre of water and add one litre of cow urine, keep for five days. Filter and dilute with 50 litres of water and spray to control the sucking pests (Rohini Reddy).
➢ Take two kg each of custard apple leaves, Neem leaves and lantana leaves, crush them finely and boil with five litres of water. Filter this mixture, add one litre of cow urine and five gm of detergent soap. Dilute with 10 litre of water, and spray to control many pests in Vegetables (Rohini Reddy).

➢ Take 1 kg each of the plant stems and leaves of Ipomea fistula, Agave americana, Datura spe, Pongamia pinnata, Argemone mexicana, Annona- squamos, shred and soak in a large pot with 10 litre of cows urine, and allow to stand for at least 10 days and then filter. The filtrate is diluted in a ratio of 1:6 with water, and sprayed on the affected Vegetable crops. This is effective on all major Vegetable pests like fruit borers, leaf eaters and root damagers (Rohini Reddy).

➢ Take 100 gms of garlic cloves, crush and soak in kerosene, and live overnight. 100 gms of green Chillies are ground, soaked in ½ litre of water, and left overnight. Both solutions are filtered and mixed. 30 gm of soap powder is added and thoroughly mixed. The solution is diluted with water in a ratio of 1:5 and sprayed. It is effective on the pests like, Diamond back moth, Fruit borer and Leaf roller (Rohini Reddy).

➢ Wood ash broadcasted early in the morning (before sunrise) for the control of pests of Vegetables such as Chilli, beans, Brinjal, Tomato, onion, cucumber, potato etc. Whatever quantity available is sprinkleed at least for 1-2 times. This technique is very effective for the control of chewing and sucking pests like beetles, leaf defoliators, leaf minor, thrips and aphids. Sometimes, ash is mixed with cowdung and sprinkled (Vanaja 2007).

**Organic Pest Management in Paddy (documented in SPACC project area)**

➢ To control Leaf folder in Paddy crop, farmers are spraying solution prepared with Chilli paste, Vinegar and surf powder to the crop. This practice is followed by only 7% of the farmers in the villages (documented in Chimelatipally, Ankabupalem, verabadhra puram, Donakonda villages in Prakasam district).

➢ In the Paddy fields, deep ploughing is practiced to expose the insects/pupae to scorching sun so that they are killed (documented in all the SPACC pilot villages in Chittoor).
- Excess water is drained out in Paddy fields to control fungal diseases. (documented in all the 13 pilot villages in Chittoor district).

- To control leaf roller in Rice, a long thread is dipped in kerosene oil and spread over the twigs. With the help of two persons the rope is dragged on the canopy. In this process the leaves were unrolled (folds opened) and larvae were exposed. This technique is practiced to control case worm also (As per telephonic discussion with scientists at Regional Agriculture Research Station-ANGRAU, Nandyal, Kurnool district).

- Dragging the branches of country ber on the affected field to control the leaf roller. Documented in all the SPACC project districts).

- T' shaped bamboo stands are placed in many places in the Paddy fields so that birds can sit on them and feed on the larvae and adults of Rice pests (Documented in all the SPACC project districts).

**Organic pest management practices in Paddy listed from literature**

- Application of Calotropis gigantean as green leaf manure will prevent thrips attack in the nursery ([www.takingroots.org](http://www.takingroots.org)).

- Neem (*Azadirachta indica*) oil cake extract is sprayed to control thrips in Rice ([www.takingroots.org](http://www.takingroots.org)).

- Neem oil is mixed with water @ 30ml./lit. and sprayed to control stem borer in Rice (As per telephonic discussion with scientists at Regional Agriculture Research Station-ANGRAU, Nandyal, Kurnool district).

- Dusting Kitchen (chulah) ash in the early morning to control stem borer and ear head bug (As per telephonic discussion with scientists at Regional Agriculture Research Station-ANGRAU, Nandyal, Kurnool district).
- To control the ear head bugs, 10 kg. of cow dung ash is mixed with 2 kg. of lime powder and 1 kg. of powdered tobacco waste and dusted on the Rice crop during morning hours.

- Hundred ml. of leaf extract of "Karuvel" (Acacia nilotica) and 10 kg of cow dung are dissolved in 10 lit. of water and sprayed on the Rice crop to control ear head bug.

- Growing or planting Calotropis at 12 feet interval on all sides of Paddy fields to control the hoppers (Documented in SPACC project area in Anantpur).

- Applying neem cake before last plough to control root rot and nematode problem (Documented in SPACC project area in Anantpur).

- A mixture of 5 kg. of common salt and 15 kg. of sand is applied for 1 acre to control brown spot disease

- Soaking the Paddy seeds in 20% mint leaves solution before sowing will control the brown leaf spot

- Spraying the leaf extract of *Adaathoda vasica* to control Rice tungro

**Organic Pest Management in Groundnut (documented in SPACC project area)**

- In Groundnut main crop, Jowar is grown as boarder crop and Redgram, Fieldbean, Cowpea were grown as inter crops at 1:10. 70% farmers in the village are following this practice (documented in all the 13 SPACC pilot villages in Chittoor district all the project villages in Anantpur).
Summer ploughing is practiced to expose and destroy the pupae of pests of Groundnut. This is an age-old practice irrespective of crop observed in entire Andhra Pradesh state. Including all the SPACC project districts.

After sowing, tying colour tapes (reflectors) in criss-cross manner in the Groundnut field helps to avoid bird damage. (Documented in SPACC area in Anantpur, Kurnool districts)

Mix Neem oil with irrigation water at second or third irrigation to prevent root rot in Groundnut (Rohini Reddy). This practice is observed in Anantpur and Kurnool districts of Andhra Pradesh.

Spray lime solution to control leaf roller, and spraying water also brings down the leaf roller attack. Lime also improves pod filling. Documented in Anantpur, Mahabubnagar districts of Andhra Pradesh (As per the discussion with scientists of ARS Anantpur and RARS PalemMahabubnagar).

During nights, burning heaps of straw in several places near the fields along with a bucket full of water or Castor cake dissolved in water near the fire helps to attract and kill the insects. Practiced in many districts of Andhra Pradesh, including SPACC project districts.

### Organic pest management practices in Groundnut listed from literature

- Grinding well and dissolving 10 kg of the leaves of *Aloe vera* in water and spraying for an acre to control Red Hairy Caterpillar (RHC) in Groundnut (Rohini Reddy).

- Cowpea is grown as border crop to attract Red Hairy caterpillar (RHC) in Groundnut crop in Mahabubnagar and Anantpur districts. Crop rotation can also be practiced to control Red Hairy Catterpillar (RHC) pest. (Rohini Reddy).

- Farmers in Anantpur, Mahabubnagar district grow Castor as a border crop (trap crop) to reduce the attack of tobacco cut worms (Rohini Reddy).
Neem oil solution 4% or Neem kernel extract 6% is sprayed to control rust and root rot disease in Groundnut, as recommended under NPM program of SERP throughout the Groundnut growing areas of Andhra Pradesh. Neem oil spray @ 6 lit/ac controls root rot (Rohini Reddy; www.takingroots.org).

To control Groundnut ring mosaic, dried sorghum or coconut leaves are powdered and boiled in water to 600 for one hour, filtered, diluted and sprayed two times at 10 days interval (Rohini Reddy).

**Organic Pest Management in Cotton (documented in SPACC project area)**

- Aphids in Cotton, Maize, Redgram, Tomato crops is controlled by spraying Neem oil. (documented in Chimelatipally, Ankabupalem, verabadhra puram, Donakonda villages in Prakasam district).

- To control the Red Hairy Caterpillars in Cotton crops very few farmers are still using the bonfire to trap the moths. Hand picking of caterpillars is also in use in SPACC project villages in Nalgonda and Kadapa, districts.

- Cotton farmers in Warangal district are growing Green gram as intercrop in Cotton, Such combination not only reduces the pest incidence also enrich the soil nitrogen status because of Nitrogen fixation by Green gram. (documented in Ganturpally village of Hasanparthy Mandal).

- For the management of *Helicoverpa armigera* in Cotton crop farmers have their own innovation. A bed sheet is spread in between two opposite rows of Redgram and holding the two bunches of plants on either side, are shaken vigorously. The caterpillars along with damaged bunds, flowers and young pods are collected on the mat. Later the collected mass is burnt. The process to be repeated 2 to 3 times in the season (documented in Karimnagar, Nalgonda, Guntoor, Prakasam, Adilabad, Warangal districts of AP).
- Castor plants are grown on the field boundaries of Cotton and Chilli main crop. Castor plants hosted both egg masses of *Spodoptera* and neonate gregarious larvae (documented in Adilabad, Kurnool Nalgonda districts of AP).

- Number of organic pest control practices that are available for the control of Cotton pests as identified through the extensive literature survey is presented in Table 7. These practices are being promoted under NPM program of Government of Andhra Pradesh through SERP.

**Table 7: List of Organic Agriculture practices for Cotton pest management promoted under NPM program in AP.**

<table>
<thead>
<tr>
<th>S. No</th>
<th>NPM Technological options</th>
<th>Target pests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deep ploughing with tractors</td>
<td>Helicoverpa pupae</td>
</tr>
<tr>
<td>2</td>
<td>Summer harrowing</td>
<td>Holotrichia grubs</td>
</tr>
<tr>
<td>3</td>
<td>Pest tolerant variety</td>
<td>Specific for pests</td>
</tr>
<tr>
<td>4</td>
<td>Seed Treatment</td>
<td>Trichodermaviridae</td>
</tr>
<tr>
<td>5</td>
<td>Inter Crop</td>
<td>Cotton with Redgram</td>
</tr>
<tr>
<td>6</td>
<td>Random sowing of sorghum/Maize/Marigold</td>
<td>Helicoverpaarmigera</td>
</tr>
<tr>
<td>7</td>
<td>Organic manures</td>
<td>Maintaining soil health and soil fertility</td>
</tr>
<tr>
<td>8</td>
<td>Soil testing</td>
<td>To know the nutrient levels in soil, for the management of soil fertility</td>
</tr>
<tr>
<td>9</td>
<td>Light traps</td>
<td>Helicoverpa/Spodoptera/Scirpophagia moths</td>
</tr>
<tr>
<td>10</td>
<td>Bon fire</td>
<td>Helicoverpa/Spodoptera/Scirpophagia moths</td>
</tr>
<tr>
<td>11</td>
<td>Pheromone traps</td>
<td>Helicoverpa/Scirpophaga/Spodoptera moths</td>
</tr>
<tr>
<td>12</td>
<td>Neem seed extract (spray)</td>
<td>Helicoverpaarmigera</td>
</tr>
<tr>
<td>13</td>
<td>Tobacco leaf decoction (spray)</td>
<td>Helicoverpa/Spodoptera</td>
</tr>
<tr>
<td>14</td>
<td>Chili garlic extract (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>15</td>
<td>Tobacco leaf decoction – Jatropha (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>16</td>
<td>Jaggery solution (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>17</td>
<td>Cattle urine – dung extract (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>18</td>
<td>Hand picking of eggs</td>
<td>Helicoverpaarmigera</td>
</tr>
<tr>
<td>19</td>
<td>Neem oil (spray)</td>
<td>Aphids</td>
</tr>
<tr>
<td>20</td>
<td>Neemark (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>21</td>
<td>Other neem based products (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>22</td>
<td>Neemax (spray)</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>23</td>
<td>Nuclear Polyhydrosis Virus (NPV) spray</td>
<td>Helicoverpaarmigera</td>
</tr>
<tr>
<td>24</td>
<td>Aphidin (spray)</td>
<td>Aphids</td>
</tr>
<tr>
<td>25</td>
<td><em>Bacillus thuringensis</em> Bt. spray</td>
<td>Helicoverpa pupae</td>
</tr>
<tr>
<td>26</td>
<td>Custard apple seed extract spray</td>
<td>Aphids/Jassids/Thrips/whitefly</td>
</tr>
<tr>
<td>27</td>
<td>Bird perches</td>
<td>Helicoverpa larvae</td>
</tr>
<tr>
<td>S. No</td>
<td>NPM Technological options</td>
<td>Target pests</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>28</td>
<td>Release of Trichogramma</td>
<td>Helicoverpa eggs</td>
</tr>
<tr>
<td>29</td>
<td>Release of Chrysopa</td>
<td>Helicoverpa eggs</td>
</tr>
<tr>
<td>30</td>
<td>Pest Monitoring</td>
<td>Helicoverpa armigera</td>
</tr>
<tr>
<td>31</td>
<td>Entomopathogens</td>
<td>Nomoriaanisoplae</td>
</tr>
</tbody>
</table>

Source: Qayum et al., 1998.

- Long bamboo sticks as bird perches are kept @5/ha randomly in different places in the field would help predation and conserve natural enemy population. The idea is to attract the birds to sit on the bamboo sticks to feed the pests in their vicinity. Very effective for the control of stem borer and Helicoverpa, swarming caterpillars, bollworms etc. Practiced in entire Andhra Pradesh including all the SPACC project districts (As per the personal discussion with scientists of Regional Agriculture Research Station/ Agriculture Research Station under ANGRAU in SPACC project districts).

- Planting Marigold or Cowpea around Cotton crop ensures reduced incidence of bollworm populations. Flowering of the border crops should synchronize with initiation of square formation in Cotton (As per the personal discussion with Officials of department of Agriculture, Govt. of Andhra Pradesh).

- Trap crop with Okra (1:10), Castor Marigold, have offered protection to the crop. Insects feeding on the trap crops should be periodically removed. (As per the personal discussion with Officials of department of Agriculture, Govt. of Andhra Pradesh).

**Organic pest management practices in Cotton listed from literature**

- Intercropping with Mung bean, Soybean, Groundnut, Setaria, Maize, Cow pea and Onion, two rows for every ten rows of Cotton reduced infestation of bollworms and helped to colonize the bio-control fauna. Being leguminous crops having nodules in their roots, they fix the atmospheric nitrogen through symbiotic activity of the bacteria in their root nodules. Therefore, growing of pulses invariably enhances soil fertility.

- On-farm trail at KVK of Mahabubnagar on NPM in Cotton and Redgram during 1996-97 and 1997-98 through participatory approaches revealed that, Tobacco leaf power extract, Neem seed kernel extract and custard apple leaf extract @ 10 ml/l was found...
significant in control of pod borer and leaf hoppers at flowering and 10-20 days after flowering in Cotton (Rajendra Kumar and Narsimha Reddy 1998).

- Spraying of Cow urine + Cow dung (2kg) mixture @10ml/l at flowering shown good growth of Cotton crop and acted as a repellent to the sucking pests especially to the hoppers (Qayum et al., 1998).

**Organic Pest Management in Redgram (documented in SPACC project area)**

Not a single Organic Agriculture practice is observed in SPACC project area. Interaction with Officials of department of Agriculture revealed that, farmers are either spraying chemical pesticides or not sprayings anything at all. Chemical pesticides are sprayed in case of heavy pest incidence or disease infestation only. Some farmers have expressed that it is not economical to invest high on Rainfed crops. Farmers have expressed that Red gram intercropping with Jowar will minimise the pest attack. Farmers believe that, maintaining very high population within the row by sowing Redgram seeds continuously without maintaining any gap between the plants within the row control the pod borer building its’ population, pod borer will attack only few plants. This is the advantage of maintaining high population within the row.

**Organic pest management practices in Redgram listed from literature.**

- Five kg of Tobacco waste is dissolved in 10 litres of water and diluted with 50 litres of water to control sucking pests and *Helicoverpa sp.* caterpillars in Red gram (Rohini Reddy).

- One spray of Chilli and Garlic extract @10ml/l at flowering followed by one spray of Neem seed kernel extract @10ml/l, 15 days after flowering shown significant control of pod borer larvae of Pigeonpea (Rohini Reddy).

- One spray of tobacco leaf powder extract @10 ml/l, 30 days after flowering found effective against pod borer and Pod fly (Rohini Reddy).
Organic Pest Management in Sweet Orange (documented in SPACC project area)

- Neem oil is sprayed as preventive measure for various pests in Sweet oranges. (documented in SPACC project villages in Nalgonda district).

Organic pest management practices in Sweet Orange listed from literature

- Orange trees attacked by stem borer are given lime wash; holes are cleaned and plugged with lime soaked Cotton or wrapped with lemon grass. (Rohini Reddy).

- Greenish Aloe Vera plants are cut into small pieces and spread to a radius of 2 feet around the tree during flowering to control powdery mildew. (Rohini Reddy).

- Roughing or Pruning for removal of diseased plants or plant parts in Sweet Orange garden prevents the spread of microorganisms to uninfected areas (Rohini Reddy).

Organic Pest Management in Mango (documented in SPACC project area)

- Not a single organic pest management practice is noticed in SPACC project area. Farmers are relying only on chemical pest management.

Organic pest management practices in Mango listed from literature

- For planting mango grafts, pits of 3x3x3 feet are dug 25 feet apart on either side and allowed to dry for three months so as to kill the weeds, insect & diseases. (As informed by Scientists at ANGRAU).

- Dried leaves and twigs are burnt and fumigated under the tree during early morning before sunrise or late evening after sunset which will help the plants to induce flowering and drive away the hoppers. (As informed by Officials of department of Agriculture, AP).
Non bearing trees are brought to bearing by digging ½ foot deep trench like basin around the tree at 5 feet from the tree base in which green leaf manures are applied and covered with soil (As informed by Scientists at ANGRAU).

To induce good bearing in Mango, excess and useless roots are removed and one kg of bone meal and 50 kg of farm yard manure are applied for 10 year old tree. Incisions are made on the tree trunk above 1 meter from the ground level and the bark removed in circular manner to a width of 2 inches to prevent food materials from going to tree base and make it bleed (Rohini Reddy).

Filling mustard oil to a shallow depression on the upper surface of the thickest Mango branch, prevents fruits drop and ascetic layer formation (Rohini Reddy).

Planting cashew in Mango orchards, reduces Mango hopper incidence. Cashew acts as an alternate host for the hopper (Rohini Reddy).

Dissolve 400 ml of Neem oil in 100 litres of water and mix 50 gm of detergent soap. Mix thoroughly and spray. It helps to control the hoppers (Rohini Reddy).

Dissolve one kg of cow dung in 10 litres of water, add 5 gm of detergent soap, and spray on Mango plants which ensures effective control of Sooty mould. Cow dung is a known disinfectant and physically removes the pathogen by washing off (Rohini Reddy).

Weed Control under Organic Agriculture

In olden days under traditional farming system, the aim was not necessarily the elimination of weeds but their control means reducing the effects of weeds on crop growth and yield. It was believed that weeds do have some useful purposes. They can provide protection from erosion, food for animals and beneficial insects and food for human too. No herbicides were in use. Weeds were controlled using a number of methods such as crop rotation, hoeing, mulches (which cover the soil and stop weed seeds from germinating), hand-weeding or the use of mechanical weeders, planting crops close together within each bed inorder to prevent space for weeds to emerge, green manures or cover crops were also grown to outcompete weeds, soil
cultivation carried out at repeated intervals and at the appropriate time when the soil is moist (http://www.infonet-biovision.org/res/res/files/488.OrgFarm.pdf).

2.5. Post Harvest Management Techniques & Storage Methods
A safe storage place must be provided for the grain produced until it is needed for consumption and multiplication purposes. Since grain production is seasonal, and consumption is continuous, safe storage must maintain grain quality and quantity. Grains have to be protected from weather, molds and other microorganisms, moisture, high temperature, insects, rodents, birds, objectionable odours and contamination, and from unauthorized distribution. The Cereals, pulses, oilseeds etc. are very important products for storage. However, small and marginal farmers in need of immediate cash sell their produce immediately after harvesting at whatever price prevailing. Hence, they don’t go for special practices for storage. Most farmers store the produce in gunny bags for short period and also ease in transport of grains to market.

Organic practices for post harvest handling of produce in SPACC project districts

- Farmers in many places in Andhra Pradesh do not purchasing the seeds for next year sowing. They generally save the Vegetable seeds from the produce they got in the current season. For the seed purpose, the Vegetables such as Beans, Brinjal, Chilli, Lady’s finger, Cucurbits etc. are allowed to fully ripe on the plants. Later shade dried and stored in the wooden, earthen pots, bamboo made or metallic containers without separating the seeds from the fruits. Few farmers expressed that seeds stored in metallic containers have less germination percentage. Sometimes seeds are separated from the fruit and further dried and stored in containers. In some places dried seeds or fruits are tied in a cloth bags and hang from the roof in the kitchen room. Hanging of fruits get exposed to smoke. Smoke repels the stored grain insects, ants etc. Cooking operations keep the kitchen room warm and keep the seeds dry at required moisture content. Also observed in all the SPACC project districts.

- Food grains are stored in gunny bags made of jute. Jute is loosely knitted to enable free air circulation. The bags after filling with grains are stored on raised platforms to protect the grains from moisture from the floor and also to protect from rats. Practiced in entire Andhra Pradesh including SPACC project area.
Brinjal fruits are harvested for market before their stalks change from green to brown in colour. All the farmers in AP follow this practice to decide the time of harvest.

To store the maize seeds for next year sowing, four or five good quality cobs were selected and hung to the roof above the stove (chulah) in the kitchen room. The cobs were exposed to the smoke that emitted from the cooking fire. Exposure of the cobs to smoke protects them from insect and fungus attack. Hanging facilitates air circulation to the cobs and keeps the cobs free from fungus infestation.

Red earth treatment to Chili – Retention of red color – Acts as insulator against temperature and sunlight (Rohini Reddy)

Coating with fine Red earth to Chilli pods helps in retention of Red colour and also acts as insulator against temperature and sunlight (Documented in Anantpur and Chittoor districts).

Groundnut seeds are sundried for 4 days before storage in gunny bags. Common practice in entire SPACC project districts.

Grains of Paddy, Groundnut, Millets, Red gram are stored in gunny bags, the low cost storage structures. Good aeration and ventilation keeps the produce dry and pest free. Common practice in entire SPACC project districts.

Seeds of Paddy, Ground Nut, Millets, Red gram are stored in Bamboo baskets in Racherla, Goutavaram, Narsireddypalli villages in Prakasam district.

To get uniform ripening of mango fruits in a week, fruits are spread on Paddy straw on the floor and covered with straw and the room is kept closed. Common practice in entire AP including SPACC project areas.

Groundnut kernels are stored with their shells intact to have long storage life, even for one year. Seed kennels are stored viable up to three months only.
Sun drying the Groundnut seeds for longer period will reduce its viability. Hence, farmers are very cautious for sun drying the Groundnut kernels for seed purpose.

In almost entire Andhra Pradesh, for Rice fields, irrigation is stopped 20 days before harvesting. The time of harvest is decided when 80% of the panicles have about 80% of ripened spikelets.

To get uniform ripening of Mango fruits within a week, fruits are spread on the Paddy straw on the floor and covered with Paddy straw and the room is kept closed (Practiced in entire Andhra Pradesh).

Neem (Azadirachta indica) leaf power (quantity not specific) is mixed with the seeds of cereals, pulses or any other grains to control storage pests. Grains are thoroughly mixed with Neem leaf powder and stored in gunny bag. Gunny bags were kept in dry place above a wooden platform or cement floor. (documented in Dharampuram and Vannedoddi villages of Gooty mandals of Anantpur districts)

Organic practices for post harvest handling as listed from literature

Seeds of most food grain crops ie., cereals, millets, pulses etc are coated with Ash approx. @ 500gm/kg seeds. At the time of mixing, ash may be wet or slight water may be sprinkled so that the ash will form a coating on the grains. Then the grains are dried in the shade before storing in the storage structure. It is believed that this practice ensures good germination and healthy disease free crop stand. Ash sticks to the seed surface and act as barrier for pest to invade. As ash is a burnt product it don’t contain microorganisms. When the ash coated seeds are sown in the field, coating of the ash on the grains acts as physical barrier for the insects. Moreover, ash contains nutrients and also holds moisture that helps in proper germination and early establishment and also gives strength to the seedlings.

Food grains are mixed with mustard oil @ 500 ml per quintal grains. This technique is practiced for cereals, pulses and millets. Mustard oil has insecticidal properties. It also repels the insects. Smearing oil acts as barrier for microbial attack.
For seed extraction in Brinjal, medium sized fully ripened fruits which are bright yellow in colour are harvested. Then they are cut into 4-6 pieces and softened by soaking in water overnight. Next day, the seeds are removed and washed well with water. After washing little quantity of wood ash is sprinkled on the seeds. Dried in the shade and preserved in a cloth / mud pot (Rohini Reddy).

Well matured and ripen Brinjal fruits are cut with some portion of the stem. Each Brinjal is cut in to four parts and tied together with a thread and hang it (8 to 10 feet) above the Kitchen exhaust outlet (chimney). Smoke from the chullah will help the seeds to dry naturally. Moisture content is maintained naturally. Extracted seeds are mixed with wood ash and shade dried for 2-3 days and stored up to six months (Rohini Reddy).

Ripen Bitter guard seeds kept inside the cowdung ball and the cowdung is posted on the wall like chapathi. It will dry under sun and later used for sowing. This practice makes the seed to germinate quickly and give rise to healthy seedling (Rohini Reddy).

Coconut oil or any other Vegetable oil is smeared for Vegetable seeds, especially for bean seeds. For one kilogram of bean seed 2 teaspoons of Vegetable oil is added and stored in clean container. It helps the seeds to prevent from the pest (Rohini Reddy).

Vegetable seeds of bitter gourd, pumpkin, snake gourd and ridge gourd are stored by mixing them with ash. It is widespread practice to plant these seeds after mixing them with ash that leads to better growth (Rohini Reddy).

Neem (Azadirachta indica) leaf power (approx. 3-5 kg/ q) is mixed with the seeds of cereals, pulses or any other grains to control storage pests. Grains are thoroughly mixed with Neem leaf powder and stored in gunny bag. Gunny bags were kept in dry place above a wooden platform or cement floor. Neem has insect repellent properties. Because of bitter taste act as antifeedent. The grains in this method can be stored for upto 2 years. Neem leaves, oil or extracts acts as repellant against several insects such as weevils, flour beetles, bean-seed beetles and potato moths. Treatment of jute sack by Neem oil or azadirachtin-rich-products prevents the penetration of pest like weevils and flour beetles http://www.Neemfoundation.org/Neem-articles/Neem-in-organic-farming/organic-farming-a-Neem/68-pest-management.html).
Chilli pods are de-stemmed before marketing. This practice is fetching them an additional premium of Rs.7 per kg (practiced in Nagulapadu village in Guntur district).

Chilli is one of the main cash crops in Guntur districts. Cold storage facilities are also well developed in and around Guntur. Farmers are storing the Red Chilli in cold storage for few months and selling when the prices are high.

Coating red earth to overnight soaked Red gram and drying in shade – Reduces insect damage and facilitates milling – Wetting and drying (thawing) process loosens husk from kernel and red earth acts as Physical barrier to the storage insect (Rohini Reddy).

Redgram seeds are smeared with Neem oil / Pogonacia oil / Castor oil to reduce the incidence of store pests. Cost effective control method. Oil removes glued eggs and acts as physical barrier to pests (Rohini Reddy).

Drying the Redgram seeds well and storing them in gunny bags after placing dried leaves of Ocimum canum inside them helps to prevent pod borer attack (Rohini Reddy).

Redgram seeds are mixed with ant hill soil with little moisture, dried and stored to avoid storage pests (Rohini Reddy).

Castor seeds are dried, powdered and mixed with Redgram seeds to reduce pest attack during storage (Rohini Reddy).

Storing the Redgram seeds after mixing them with one kg of ‘sweet flag’ (Acorus calamus) powder, will be sufficient to treat 50 kg of seeds to preserve them for one year. (Rohini Reddy).

One kg of Neem or Vitex leaves is powdered, made as a paste with water and mixed with 100kg of Redgram seeds. (Rohini Reddy).

Putting the pods of dried Chillies in the Redgram containers helps to control Bruchids (beetle) attack (http://www.angoc.org/)
Mixing the Paddy grains with the leaves of Pongamea (P.pinnata) or Vitex. *negundo* or Neem (Azadirachta indica) before storage to avoid storage pest attack (Rohini Reddy).

During the storage of Rice grains, leaves of Neem and *Vitex negundo* are mixed thoroughly with the Rice seeds. These seeds are stored in gunny bags or bamboo made storage structures. This technique protect the seeds from storage pests as Neem leaves have insecticidal properties, act as repellent. The bitter taste of Neem keeps the pests away. The pungent smell of *Vitex* prevents the invasion of storage pests. ([http://www.angoc.org/](http://www.angoc.org/)).

Putting the leaves of *Vitex negundo* and pungam (*Pongampinnata*) inside the Kulumai to ward off storage pests (Rohini Reddy).

Lime also has insect repelling properties. For every kilogram of seed, 50 gm of lime powder can be mixed. The mixing can be done in the same container in which the seeds are to be stored.
3.1. Concluding Remarks
Inspite of prevailing issues with Agricultural sector in Andhra Pradesh, the sector is still contributes to more than one-third of Gross State Domestic Product. It supports more than two thirds of the rural population. The development of Agriculture is an essential pre-requisite to the state. The dominant macro trends in Agriculture towards mono-cropping in large areas, high cost and intensive use of inorganic inputs, degradation of soils, degradation of biomass, overuse of groundwater resources, livestock becoming relatively independent of Agriculture increases vulnerability of the farming systems. Further, changing environmental conditions such as rising temperatures, changing precipitation patterns and an increase of extreme weather events are going to be seriously affecting Agricultural productivity and even farming viability.

Climate Change triggered by the chemical Agriculture is a global phenomenon, however, the impact is localized. The type and intensity of impact is widely varied with locations and sectors indicates the need to develop location specific adaptations with a wider applicability. Andhra Pradesh is going to be effected by chronic water scarcity and drought conditions in future due to Climate Change, as indicated by one of the World Bank studies entitle “Drought in Andhra Pradesh Long-Term Impacts and Adaptation Strategies (2005)”. Further, the responses to drought require intensified efforts at the micro scale i.e., at the level of villages. Hence, there is an urgent need to redesign the existing Agriculture production system and strengthen the livelihoods resilience to Climate Variability.

Organic Agriculture is one best option that enables ecosystems to better adjust to the effects of Climate Change and has major potential for reducing agricultural Green House Gas emissions. Organic Agriculture has a strong potential for building resilience in the face of climate variability. Organic Agriculture systems have an inherent potential to both reduce GHG emissions and to enhance carbon sequestration in the soil. GHG emissions are reduced in organic systems by avoidance of mineral fertilizers. The highest mitigation potential of Organic Agriculture lies in carbon sequestration in soils and enhancing crop biodiversity, restoring natural ecosystem. The omission of mineral fertilizer production and application is estimated to reduce the agricultural
GHG emissions by about 20% — 10% caused by reduced N₂O emissions and about 10% by lower energy demand (Nadia El-Hage Scialabba and Maria Mu¨ller-Lindenlauf 2010). The carbon sequestration is increased by practicing poly-cropping techniques such as intercropping, mixed cropping, strip cropping, Agroforestry, promoting tree based farming systems etc. The main organic strategies are diversification and an increase of soil organic matter, both could enhance resilience against extreme weather events and are recommended by the IPCC. These strategies have, in particular, a high potential to enhance the productivity of degraded soils, especially in marginal areas, while enhancing soil carbon sequestration. The adaptive approach inherent to Organic Agriculture offers simultaneous climate mitigation benefits. Finally, certified organic products cater for higher income options for producers and hence a market-based incentive for environmental stewardship. The scaling-up of Organic Agriculture would promote and support climate friendly farming practices worldwide. However, investments in research and development of Organic Agriculture are needed to better unlock its potential and application on a large scale.

Organic Agriculture helps to counteract Climate Change by restoring soil organic matter content as well as reducing soil erosion and improving soil physical structure. Organic soils also have better water-holding capacity, which explains why organic production is much more resistant to climate extremes such as droughts and floods. Diversified farming in Organic Agriculture is the antidote to global warming. Use of climate-ready crops such as millets, integrate livestock and non-farm income generating activities, adjust the seasonal calendar, employ climate-resilient post-harvest storage and post-harvest processing, and include climate risks through Insurance products in agricultural planning were some of the suggestions to adapt production system to Climate Change. Organic Agriculture promotes better water infiltration, retention, and delivery to plants, and these actions sustain crop yield during drought. There is an urgent need to change the cropping pattern in drought prone areas to prevent further downslide of underground water table. This could be possible by promoting millet based cropping system either as main crop or intercrop or in rotation provides high resilience in Climate variability. It is important to remember, however, that using too much animal manure or nutrient rich organic matter, or using it at the wrong time, could be as harmful as using man-made, artificial fertilizers (http://www.infonet-biovision.org/res/res/files/488.OrgFarm.pdf).

Global demand for organically grown foods is increasing and Organic Agriculture is growing fast in recent years. However, in the beginning the yields might decline, but stabilizes slowly year
after year due to built in soil fertility over a period of time. Organic system of Rice production needs more than two years period to stabilize Rice productivity and bring about perceptible improvement in soil quality, sustainability indices and economic returns under intensive, irrigated Rice-Rice system in Vertisols of tropical climate (Surekha et al). In Andhra Pradesh, the 60% of cultivated area is Rainfed, which provide great opportunity to promote Organic Farming as under drought condition Organic Agriculture system produces significantly and sustainably higher yields than comparable conventional Agriculture crops. Hence, Rainfed drought prone areas are the priority areas for conversion to Organic Agriculture.

Further, to be successful, Organic Agriculture must integrate plant and livestock production to the extent possible to optimize nutrient use and recycling. From the point of view of integrating ecology and sustainable resource use, the combination of organic cropping with livestock production is undoubtedly a strong point for highly climate sensitive Rainfed areas of Andhra Pradesh. Hence, using easily available local natural resources, Organic Farming can be practiced with a view to protect/preserve/safe guard our own natural resources and environment for a fertile soil, healthy crop and quality food and let our future generations enjoy the benefits of non-chemical Agriculture. Given the same profitability, Organic Farming is more advantageous than conventional farming considering its contribution to health, environment, and sustainability. Summary of Organic Agriculture practices and their adaptive action in the context of Climate Change is presented in Table 8.

Table 8: Summary of Organic Agriculture practices and their adaptive action in the context of Climate Change.

<table>
<thead>
<tr>
<th>Climate Change impact</th>
<th>Relevant Organic Agriculture Practice</th>
<th>Adaptive Action</th>
</tr>
</thead>
</table>
| Increased droughts and floods | ➢ Mulching  
➢ Conservative/dead furrow  
➢ Crop diversity/poly cropping  
➢ Compost/vermicompost, crop residue incorporation | ➢ Mulching conserve soil moisture, maintain soil temperature, increases organic matter content.  
➢ Dead furrow Increases water holding capacity of soil and facilitate infiltration  
➢ Organic matter increases water holding capacity apart from |
<table>
<thead>
<tr>
<th>Climate Change Impact</th>
<th>Relevant Organic Agriculture Practice</th>
<th>Adaptive Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>➢ Healthy, robust plants</td>
<td>improving soil fertility and reducing erosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ GHG emissions are reduced in organic systems by avoidance of mineral fertilizers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Crop diversification to control pests, maintain biodiversity and minimises risks against total loss of income</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Polycropping Increases carbon sequestration</td>
</tr>
<tr>
<td>Extreme temperatures and diurnal variations</td>
<td>➢ Multi-storied cropping based on photo candle light requirement and leaf mulch on soil.</td>
<td>Increased carbon sequestration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Efficient utilization of sun shine, solar energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Increased conversion of energy in to food, more yields</td>
</tr>
<tr>
<td>Increased incidence of pests and diseases</td>
<td>➢ Building of improved pest ecology with proliferation of beneficial insects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ Managing pests by understanding life cycles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ Crop diversity with millets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ Crop rotation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ Lower application of Urea etc makes plants less prone to pests and diseases</td>
<td>Multiple cropping systems are resilient to climate variability, increases biodiversity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Control pest population</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Risk of total loss is spread on number of crops to get income from one or the other crop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Millet crops follow C4 pathway hence, yields more under increased CO2 levels, less water requirement, less pest attack millets, withstand harsh climate.</td>
</tr>
<tr>
<td>Decline in water resources</td>
<td>➢ Rain water harvesting – Farm ponds</td>
<td>Efficient utilization of rain water in case of sudden and heavy down pouring.</td>
</tr>
<tr>
<td></td>
<td>➢ Selection of low water</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Climate Change impact</th>
<th>Relevant Agriculture Practice</th>
<th>Adaptive Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased risk</td>
<td></td>
<td>- Millets are low water requirement crops. Efficient utilization of ground water.</td>
</tr>
<tr>
<td></td>
<td>- Bund plantation – Acts as wind breaks develops micro climate and reduces evaporation</td>
<td>- Bund planting sequesters carbon and also act as wind breaks apart from providing biomass for compost preparation</td>
</tr>
<tr>
<td></td>
<td>- In situ moisture conservation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- SRI in Paddy</td>
<td></td>
</tr>
<tr>
<td>Soil nutrient depletion due to high temperatures</td>
<td></td>
<td>- Probability of getting income under Multiple cropping system is high</td>
</tr>
<tr>
<td></td>
<td>- Crop diversity – Spreading risk</td>
<td>- Under Agroforestry system trees withstand dry and harsh climate and extreme weather events compare to annuals. Besides provide sustained income, sequesters carbon.</td>
</tr>
<tr>
<td></td>
<td>- Increased yield frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Agro forestry</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Monocot (Cereals) and Dicot (pulses) combination maintains nutrient balance in the soil and breaks the pest lifecycle and reduces pest population</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Earthworms take out the nutrients in deeper layers and deposit on the surface.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Azolla fixes Atmospheric Nitrogen besides adding dry matter when the crop dries. Thus increases organic matter content in the soil.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- An organic nutrient source increases the organic matter in the soil. GHG emissions are reduced in organic systems by avoidance of mineral</td>
</tr>
<tr>
<td>Climate Change impact</td>
<td>Relevant Organic Agriculture Practice</td>
<td>Adaptive Action</td>
</tr>
<tr>
<td>-----------------------</td>
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</tr>
<tr>
<td></td>
<td>➢ Green leaf manuring</td>
<td>fertilizers and sequestration of carbon dioxide into the soil. This in turn increases the soil’s water retention capacity, thus contributing to better adaptation under climatic variability.</td>
</tr>
<tr>
<td>Increased weed problems</td>
<td>➢ Weed as source of mulching</td>
<td>➢ Intern increases the organic matter content.</td>
</tr>
<tr>
<td>GHS emissions</td>
<td>➢ SRI in Paddy&lt;br&gt;➢ Using biomass for composting rather than burning&lt;br&gt;➢ Eliminating chemical fertilizer usage&lt;br&gt;➢ Bund plantations</td>
<td>➢ SRI believed to minimise Methane emissions. Usage of more of organic inputs minimises environmental pollution.&lt;br&gt;➢ Biomass burning releases Carbon-dioxide, which can be stopped by composting it&lt;br&gt;➢ Elimination of fertilizers reduces Nitrous oxide release&lt;br&gt;➢ Bund plantations sequester CO2 efficiently.</td>
</tr>
<tr>
<td>Energy use</td>
<td>➢ Animal power or human power&lt;br&gt;➢ Limited use of machinery&lt;br&gt;➢ Zero tillage</td>
<td>➢ Avoidance of machinery leads to avoidance of fissile fuel, which otherwise would have contributed to GHGs&lt;br&gt;Zero tillage saves labour cost of use of fossil fuel to till the soil using tractors.</td>
</tr>
</tbody>
</table>

Inspite of several economic, health and environmental benefits, Organic Agriculture practices have slowly moved out of Indian Agriculture system, especially among the agriculturally advanced states including Andhra Pradesh. It is observed that very few farmers in SPACC project area are practicing Organic Agricultural practices and largely depending of chemical inputs,
mostly for want of instant benefits from chemical inputs, easiness in handling and to some extent difficulty in accessing the organic inputs. Increasing labour cost is also preventing them to adopt labour intensive organic practices. Moreover, Agriculture policy of Indian government also favours chemical based Agriculture technology, biased towards irrigated farmers and is of limited use to dry land/Rainfed farmers. Chemical Agriculture no doubt helped India reaching self sufficiency in food grain production, but at the cost of environment. **As Rainfed Agriculture is going to be effected badly due to Climate Change and Climate Variability, there is a need to design exclusive Agriculture policy tailor made to Rainfed regions, supporting labour incentives (it could be through MGNREGS) as well as organic matter addition.**

Whatever, Organic Agriculture practices now prevailing in Andhra Pradesh are mostly the promoted under NPM–CMSA program. Irony is that, proper documentation of Indigenous Traditional Knowledge with respect to various Agricultural practices in Andhra Pradesh is lacking. Scientific organisations are now become alert in developing organic package of practices for important food crops. Most of the Organic Agricultural practices documented in this report have good scope to scale up in wider area in a project mode and few others still need technical validation. Following are the ways and strategies to promote and scale up Organic Agriculture, especially in Climate sensitive Rainfed region;

### 3.2. Recommendations

Keeping in view the cost of Climate Change on Agriculture sectors the levels of GHG accumulations in the atmosphere warrants to take up appropriate Adaptations in short run and develop appropriate mitigation strategy in the long run. Organic Agriculture systems that rely on eco-friendly organic sources and less dependency on external inputs offer better resilience for Climate Change/Climate Variability needs to be revived and brought in to practice. Following are the ways and strategies to promote and scale up Organic Agriculture, especially in Climate sensitive Rainfed region;

1. The potential Organic Agriculture practices documented with respect to seed treatment, crops cropping systems, soil management, pest & disease management, post harvest handling etc in this report need to be further refined and pilot tested to evolve crop specific and location specific organic package of practices. A brain storming exercise with PNGOs may be carried out to select the practices that are appropriate to their
project areas need to be identified for pilot testing in participatory Technology Development (PTD) mode involving farmers as one of the partners. Farmers may also be involved in the selection process.

2. There is a need to increase the knowledge and capacity of communities to adapt to climate variability. Further build the skills and tools for communities to integrate climate adaptation into sustainable land and water management (SLWM) practices and their decision making in Rainfed Region. Government and Non-Government Organizations (NGOs) need to create increased awareness on global warming, Climate Change in the context of agricultural and environment among the farming community.

3. Several alternatives or supplements to avoid use of chemical inputs right from the seed treatment to grain storage are available in documented form. There is a need to popularize such organic practices among the farming community to minimize the cost of production in small holdings and to make their small farms adapt to Climate Change and contribute to mitigation of GHGs. The organic practices mentioned in this report with respect to seed treatment, soil fertility and crop nutrition management, pest & disease management using botanicals and biological sources, storage pest management etc are technically validated, simple and easy to adapt can be promoted among the small and marginal farmers either individually or promoted in farmer group concept. Organic production is a holistic approach, integrating all the techniques of crop productions should go as a single package.

4. Diversified farming in Organic Agriculture is the antidote to global warming. Diversification of crops and cropping systems is the best adaptation measure against Climate Change, especially for risk minimization. In dryland conditions crop diversification should be encouraged from irrigated crops (ex.Paddy, Sugar cane etc) to Irrigated dry crops (Pulses, Ground nut, Sunflower etc) to dry crops (Jowar, Coarse Cereals). As far as possible wetland Rice cultivation should be discouraged in dryland areas, under unavoidable situations promoting ‘System of Rice Intensification (SRI)’ concept is more resilient in the context of scares water availability in Rainfed areas.
5. Promotion of millets (Ragi, Jowar, Bajra, Little millet, Fox tail millets etc) occupy special place in the context of drought adaptations. Integrating millets in to the production system is a good measure towards drought proofing as millets can withstand moderate drought, its production consumes less water, low cost of production because of less pest & disease problems. Millets can be easily integrated in to the cropping system as intercrop and meet the house hold food as well as nutritional security. Moreover, the byproducts/residues may also be used as fodder/feed for livestock. Millets are highly nutritious, contains high amounts of fiber, vitamins and in minerals. Affords may be placed to bring in the millets under the purview of the Public Distribution System (PDS) to increase the consumption demand in view of nation’s food security and the declining ground water scenario. Once the millets are made available for consumption to the public may trigger the production of the same. Promotion of millets provides great support to the Rainfed farmers provided the market issues are resolved. Creating market support to the millets is prerequisite to encourage farmers. This could be achieved by providing financial incentives for marketing millets. Processing of millets is also likely to generate rural employment to women.

6. Promoting Poly-cropping systems such as legume based intercropping system or millet based intercropping system that are highly resilient with variables climatic conditions and also minimize the risk of total crop loss as the risk is spread over several crops. Mixed cropping system increase predator population and aid in natural pest control, thus minimize the use of chemical pesticides. Further, fodder cop based intercropping system also promote livestock component. Organic Agriculture to be successful, must integrate plant and livestock production to the extent possible to optimize nutrient use and recycling. Community managed seed banks may be promoted in cluster of villages to ensure the various intercrop seed available within close vicinity and for timely availability.

7. Organic Agriculture helps to counteract Climate Change by restoring soil organic matter content as well as reducing soil erosion and improving soil physical structure. Further, GHG emissions are reduced in organic systems by avoidance of mineral fertilizers and rely on only organic sources for soil fertility and crop nutrition management by using leguminous crops for Nitrogen source, incorporating crop residues, green
manures/cover crops, compost, vermicompost, oil cakes, biofertilizers etc. Easy access of such organic nutrient sources should be ensured. High organic matter content in soil contributes to better adaptation of Agriculture system under unpredictable climatic conditions coupled with uncertain precipitations. Composting by pit method, vermicomposting, biofertilizers etc should be promoted on massive scale. Encouraging bund plantations with Multi Purpose Trees not only sequesters Carbon-di-oxide also provide biomass for composting and fodder for animals besides income from timber species. Community compost may also be promoted where ever communities are highly supportive. This can also be done in convergence with MGNREGS’s labour support. Vermicomposting should be popularized in areas where water availability is ensured.

8. Botanical pesticides are best adaptive measure towards high climatic temperature as induced by Climate Change. Compared to synthetic pesticides, botanical products are generally safer to use and less persistent, most of them will break down quickly under influence of high temperature or sunshine. Therefore, they don't have a long lasting contaminating effect on the environment. However, care should be taken as some plants contain very toxic substances. For example, the Nicotine in tobacco, Alkaloids in Datura (*Calatropis spe*) are highly toxic chemical. Further, botanical pesticides are cheap and affordable for small-scale farmers. Making available the Biofertilizers, Bioagents, Biopesticides and other organic inputs available to small-scale farmers in sufficient quantities and reasonable price. To ensure this, financial assistance in the form of loan or subsidy may be given to establish local selling centres on enterprise mode (in the lines of NPM shops promoted under NPM program of SERP in AP).

9. Success of Organic Agriculture involves careful use of water resources. Highly water use efficient micro irrigation systems (Sprinklers and Drip irrigation systems) should be promoted by providing financial incentives/subsidies. Chittoor district of Andhra Pradesh is a success case of improving the Agriculture economy of district due to massive promotion of micro irrigation systems in the district.

10. Traditional Agriculture system which is organic in nature emphasizes more of small agriculture units and closed system. Hence, village may be considered as unit for development and planning for sharing of village level resources such as both surface &
ground water, common lands for biomass production and pasture development, promoting village level community organizations/groups for equitable sharing of village level resources for the benefit of community and environment.

11. Sustainable development of degraded lands not only offers income opportunities for rural populations but also has a huge mitigation potential by increasing soil carbon sequestration. Hence, village wise an inventory of degraded land may be prepared and development plans may drawn to develop the degraded lands on participatory mode involving community including women right from the planning stage. Biomass from degraded lands can also used for soil management.

12. The traditional form of Organic Agriculture is not necessarily sustainable, even if it has been adapted to local conditions. Population growth, declining prices, insecure land tenure and water-use rights, along with many other factors, have often led to overuse, loss of diversity, soil degradation and other environmental problems. In many instances, organic forms of agriculture can no longer produce enough income and a secure livelihood. Hence, there is an urgent need for more sustainable approaches. Some of such organic practices can be best utilized under other improved versions of sustainable production systems as mentioned below;

- **Low-External-Input Sustainable Agriculture (LEISA)**- This also aims to practice sustainable agriculture with minimal use of external inputs, but does not completely exclude the use of pesticides or synthetic fertilizers.
- **Integrated Pest Management (IPM)**-This approach reduces the use of synthetic pesticides by integrating a range of ways to control pests and disease pathogens, from crop rotations to determining damage thresholds before applying plant protection products.
- **Integrated Nutrient Management (INM)**-This approach makes a special effort to minimize fertilizer inputs.
- **Conservation agriculture and minimum tillage**- This aims to conserve the soil structure and improve the water storage capacity of the soil. Introduced on a large farm level it is often combined with weed management through pesticides. Because it eliminates ploughing, conservation agriculture needs less labour, so is a viable option for areas with labour shortages.
Certified Organic production- is a niche market which offers premium prices to producers. For small-scale farmers to tap this potential, they must be connected to the potential organic food markets. This will require improved organization (e.g., organizing as cooperatives or farmer associations), training, quality control, market information and facilitation for certification and storage provision.

13. Selecting and empowering innovative farmers towards Certified Organic Farming or any other above mentioned production systems. It would be more effective to promote above mentioned systems by organizing the organic farmers and promoting as Commodity Interest Group (CIG) groups or Self Help Groups (SHGs). These farmers/groups are trained in different techniques of Organic Farming, Certification Process, preparation of organic inputs such as compost, botanical pesticides, post-harvest management, methods of use of biofertilizers. Exposure tours are useful way of introducing other farmers to organic ideas. Organizing interactions with scientific communities, workshops/ seminars, organizing buyer-seller meetings also help in building the confidence and capacities of the Organic farmers. Facilitating the farmer groups in establishing forward and backward linkages with minimum influence of middlemen.. Forwards linkages with processors, wholesalers and retailers, and backwards to suppliers of inputs such as seed and biofertilizers.

14. Documentation of the success stories of the Organic Farming Groups in the form of evaluation reports, case studies, analysis reports, preparing IEC material from these experiences for wider spread the concept of Organic farming. Assist the farmers in sharing their learning on organic farming methods with other villages and farmers.

15. Providing financial assistance to small and marginal farmers at individual basis or group basis for purchase and preparation of organic inputs, supporting the cost of certification for Organic Farms. Declaring compensation for declining yields for the first 2-3 years during the conversion period under Organic Production to gain the confidence of producers. Also facilitate Bank linkage for credit support and possible convergence with relevant line departments for dovetailing the technical and subsidy assistance through programs/ schemes of line department.
16. More extensive studies are required to assess the crop specific relationship between various farmer invented practices and Climate Change. The exiting knowledge and database are inadequate and more extensive studies, data base and documentation are needed to develop climate resilient production system.

17. Public policies and research support is highly required to promote Organic Agriculture. In general, Organic Agriculture practices are labour intensive and needs government support through appropriate policies. The main drawback in adopting organic practices is non-availability of sufficient quantity of organic inputs and high labour cost. For example, policies for MGNREGS support to prepare and incorporate compost and vermicompost in the soil. Example 2- Government support in the form of subsidies for organic inputs and labour cost in the manner supporting the chemical inputs. Government can take up the large scale production of inputs on Government land such as community composting will generate employment and ensure timely supply of input to Rainfed farmers. Example3- De-silting activity needs greater support from the government and non-governmental agencies for achieving multiple outputs like employment generation for landless, rejuvenating of the tanks and for enhanced productivity of dry land crops.

18. In a wider vision, large scale establishment of paid storage facilities may also be thought of in collaboration with banks.

19. There should be clear Exit policy with the Organic Farming promoting organization. Hand hold support may be provided to the organic farmers during the conversion period atleast for initial 3-4 years. Organization support may be withdrawn when the Farmer groups are self-reliant.

To conclude, Organic agriculture has great potential to reduce farmers’ risks. A single organically grown crop might yield less than if it were grown conventionally, but the total value of all the organic crops, in combination with drastically reduced input costs, many give farmers a similar or (somewhat higher) profits. The organic farmer also is cushioned from price fluctuations of
individual crops, bad weather and environmental degradation under diversified farming systems as well as under diversified crops and cropping systems.
REFERENCES


Bhakta R, Palikhe. ‘Relationship Between Pesticide Use And Climate Change For Crops’. Registrar of Pesticides, Pesticide Registration and Management Office, Plant Protection Directorate of Department of Agriculture, Harihar Bhawan. Email: pesticide@wlink.com.np


Iowa Commercial Pesticide Applicator Manual-Seed Treatment (Category 4) 2006. Iowa State University, University Extension.


Vandana Shiva. ‘Organic farming in India’, In: Sustainable agriculture –A pathway out of poverty for India’s rural poor. a manuscript by Navdanya NGO in Uttaranchal, India. Publisher: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Postfach 5180, 65726 Eschborn, Germany, Available at http://www.sustainet.org/download/sustainet_publication_india_part1.pdf

Venkateshwarlu B V 2008. Climate change and Rainfed farming, with a particular focus on small holders: In National Workshop on Climate Change & Sustainable Agriculture 3-4 November, India International Centre, New Delhi.


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