LEADERSHIP AND GREENER AGRICULTURE IN THE ARENA OF CLIMATE CHANGE

Edited by
Dr. Kirit Shelat

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NATIONAL COUNCIL FOR CLIMATE CHANGE, SUSTAINABLE DEVELOPMENT AND PUBLIC LEADERSHIP (NCCSD)

An International Conference on "Global Warming, Agriculture, Sustainable Development & Public Leadership" was organized at the Gujarat Vidyapeeth – Ahmedabad in March 2010 by the International School for Public Leadership along with other organizations. This was in response to a felt need to strengthen agriculture's niche as an integrated intervention to tackle mitigation and adaptation challenges while complementing other sustainable development initiatives. The Conference had the benefit of significant insights from about 400 participants including some eminent public leaders, agricultural scientists, teachers, students, farmers, NGOs, Industry, Government officials and representation from national and international organizations. The outcome of this conference is known as the "Ahmedabad Declaration 2010". The Ahmedabad Declaration articulated an action plan to promote sustainable livelihood and simultaneously mitigate impacts of global warming through appropriate use of agriculture; involving public leadership in that task.

This was followed by a meeting of a "Think Tank" on these aspects in New Delhi in April 2010. Representatives from international organizations, Officers from Govt. of India, distinguished scientists and representatives of the civil society organizations further deliberated on these and related issues. During this meet, it was decided to constitute a voluntary organization to facilitate action and implement activities that are strategically important to enable sustainable development in addition to mainstreaming agriculture as a mitigation option. The International School for Public Leadership (ISPL) Ahmedabad, Puri Foundation for Education in India, Gandhinagar, Shroff Family Voluntary Organization Consortium (SFVOC), Mumbai and The Environmental & Consumer Protection Foundation (ECPFO), New Delhi, jointly agreed to promote the new organization. Accordingly, Justice B.P. Singh, President of Environmental & Consumer Protection Foundation (ECPFO), New Delhi, announced the setting up of the "National Council for Climate Change, Sustainable Development and Public Leadership" (NCCSD)".

LEADERSHIP

AND

GREENER AGRICULTURE

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Leadership and Greener Agriculture in the Arena of Climate Change

Editor:
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Concept by Dr. Kirit Shelat

Foreword

The topic of climate change and its impacts has caught the attention of people all over the world. In this context, it is only logical to expect people directly affected by the unpredictable patterns of climate and its impacts at the local level will be keen on knowing about the ways and means of tackling such impacts. This aspect of impacts management is critical from a public policy point of view and has to be given its due attention. It is, therefore, appropriate to communicate with all concerned stakeholders about the spread and depth of issues along with useful information about the roles they can play to tackle challenges at the local level. This can be aligned with information on the science and management of interventions so that stakeholders will be able to function in a well informed manner. It is equally important to deliver information in a timely manner based on insights about the preparedness of stakeholders to receive and comprehend messages. The present initiative is a need based response to communicate in a simple manner about some important and emerging understanding of climate change and its impacts along with information on some locally relevant solutions. The case in point is of climate change, its impacts and management with respect to agriculture.

Three important aspects highlight the uniqueness of this publication.

1. Examples of unique mitigation and adaptation action by communities in India have been presented. These initiatives provide hope for communities with comparable challenges. Of equal importance is the opportunity for decision makers to know about locally relevant and feasible interventions that can be up-scaled and sustained through appropriate institutional arrangements with communities. This also establishes to local connect between the communities, real – life issues and the need to tackle them expeditiously.

2. The need to strengthen community leadership through suitable training and capacity building programmes has been highlighted. This is essential to complement awareness and other science and management communication so that communities can reach out to elected leaders and institutions in the process of consolidating individual and collective action. Elected leaders, non – elected youth and other dynamic individuals are important players in this scene and have to deliver through their respective niches so that collective action is achieved. Elements of such leadership initiatives are stated in this book to assist others engaged in these tasks.

3. Most often the photosynthetic role of agriculture crops is not adequately highlighted as an important mitigation phenomenon. It is well known that carbon dioxide is captured by crops and is therefore the only natural process that removes it from the atmosphere. From a public policy point of view it is essential to recognize this fact so that agriculture can be promoted and fostered by recruiting larger tracts of land relegated as waste lands. Wetlands too can be suitably managed to deliver their eco system services. This leads on to the possibility that climate – efficient cropping and management of water, land and bio resources will only enhance productivity and livelihood opportunities. This is essential to cater to the challenges of food and livelihood security and view agriculture and its practice as an integrated mitigation and adaptation tool. This is an important consideration for decision makers, national and international institutions that develop regulations, fiscal and non – fiscal tools and institutional mechanisms that will impact agriculture.

In addition to these three aspects the present publication is also timely because of the launch of India's missions and focused efforts aligned with the 12th 5 – Year Plan. It is important to help communities with information that can guide action.

The National Council for Climate Change, Sustainable Development and Public Leadership has spearheaded this integrated framework. A large number of specialists in this area deliberated on these aspects at its round tables across the country and enriched the process of learning.

New Delhi
February 7, 2012

Justice B. P. Singh
Former Judge of Supreme Court
and President of NCCSD

Preface

Discussions about the impacts of climate change on agriculture have been at the centre stage of India's planning initiatives over the last few years. In this context, there is a growing emphasis on preventive and remedial action and rightly so, based on the precautionary principle. The call for collective action is getting momentum. This is the most important stage of development of initiatives to deliver appropriate information in a timely manner to the farming community and related stakeholders to improve their preparedness to come together and engage in well informed action.

The present publication can be considered a technical primer with messages in a simple manner. The contents will help the target groups recognize the fact that

- It is feasible to develop and implement locally relevant productivity enhancement practices to reduce vulnerability of soil, water and bio resources to the impending impacts. This can be understood by the farming community from the examples of initiatives cited in this publication.
- The scope for leadership by individuals and communities through concerted action is also stated. This is to help communities and individuals optimize on institutional mechanisms at the village, district and state levels and with the involvement of elected and non – elected leaders through a better understanding of the issues and opportunities to overcome them.
- Decision makers can develop location – specific institutional mechanisms to foster such interventions considering the specific challenges they need to help tackle across locations.
- The central and cross cutting highlight is the fact that agriculture is a dynamic tool by which carbon dioxide is fixed by crops through photosynthesis. This is also true of related vegetation. This recognition will further inspire the farming community to play increasingly proactive and positive roles to promote agriculture that is efficient on multiple fronts. This could result in better management of natural resources, development of waste lands, improved returns and additional livelihood options. This integrated perspective will be in the larger interest of a dynamic public policy for sustainable development.

We have to recognize the resilience of India's farming community that is rich in knowledge and is willing to act. It is essential to foster this and facilitate well informed action for collective good through greater and timely transfer of appropriate information and perspectives. This technical primer is precisely to enable this process. The spinoff is the added advantage for students in centres of basic and higher learning in agriculture

and such related sectors as fisheries and livestock management. I also fondly hope that other publications will follow on specific themes related to this area. Importantly they too should highlight locally relevant action and opportunities for improved knowledge transfer and networking.

Vigyan Prasar, Government of India recognized the importance of the proposal to develop this publication. I am indeed grateful for this and for the opportunity to communicate on the science and related management implications for the benefit of stakeholders across India in this context. I am inspired by the counsel given by Honorable Justice B P Singh that helped me consolidate my insights on agriculture – climate change impacts management and livelihood dynamics; one of the mainstays of this publication. Param Pujya Kaka Kantisen Shroff encouraged me to network, gather empirical information and showcase them. My sincere thanks are due to the large number of farmers associated with the initiatives cited and scientists from several agricultural universities who strengthened my perspective on the aspect discussed here. Dr Sadamate, Planning Commission, Government of India and I had significant discussions on the planning frameworks and the timeliness of this initiative; for which I am indeed grateful.

This is in fact a summary of deliberations that started from the International Conference held at Gujarat Vidyapith in March 2010 followed by series of Round Table Meets across the country. I have taken number of extracts from these deliberations of distinguished scientists and scholars like Dr. Oliver Shatter, Dr. Y. S. Rajan, Prof. Mukul Asher, Dr. A.K.Singh, Shalin Shah, Er Anuj Sinha, Prof. Rama Rao, Dr. Dipayan Dey, Dr. Sanjay Deshmukh, Dr. A R Nambi and others.

Our objective is to highlight & communicate the Changes in Climate, its possible causes & adverse impacts. Further, to identify ways to outcome them and equip our farmers, animals holders and fishermen with scientific knowledge. Involve future generation and public leadership in this. More precisely, to prepare our country to take up this challenge and convert it into an opportunity. While doing this, we have tried to simplify and also add about how nature forces operate.. If there are any ommisions or mistakes in presenting some of these ideas- they are my own and I am responsible for it.

I acknowledge my gratitude to all the distirguished scientists from whose work I have borrowed.

I sincerely thank Shri Shreyasbhai V. Pandya of the Sahitya Mudranalaya Pvt. Ltd., Ahmedabad who readily extended his support in putting this book together well on time.

I take this opportunity to express our gratitude to Param Pujya Pramukh Swami Maharaj with whose blessing, we have initiated the National Council.

Ahmedabad
6/2/2012

DR. KIRIT N SHELAT, (IAS-Rtd.)
Executive Chairman, NCCSD,
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Round Table meet at Delhi

Round Table meet at Kolkata

From L Er. Anuj Sinha, Dr. Y. S. Rajan, Dr. Dipayan Dey & Justice B. P. Singh

INTRODUCTION

Agriculture in our country is indeed growing significantly. Although the growth is not high, it is steady. However, due to global warming and climate change, growth in entire agriculture sector is under threat. At the same time, considering its impact on overall agriculture sector of the world, this situation can provide an opportunity to our country if dealt with appropriate planning, policy framework with certain effective programmes. The central feature, for that involves improved management of land, water and bio resources to strengthen productivity and enhance livelihood improvements with focus on poor farmers. This has implications for reducing poverty and related social upheavals. Agriculture is an integrated sustainable development tool and needs to be promoted by all means.

The GDP growth is likely to be 8.2% for the 11th Plan period. The average annual growth rates of agriculture and allied sector during the first four years of 11th Five Year Plan is estimated at 3.2%. This is an improvement on the earlier plans when it was at 2.2%. .

The significant development is in the states of Andhra Pradesh, Jharkhand, Nagaland, Bihar, Haryana, Maharashtra, Gujarat, Karnataka and Tamil Nadu at 4%. The last three have exhibited more than 6% growth. The other states are lagging behind. Rajasthan, Kerala, Madhya Pradesh and Uttaranchal for instance are below 2% while a few others have shown negative trends. There is a wide disparity between states in the growth of agriculture.

India has achieved self sufficiency to meet her requirement of food. She also exports food. But the micro level growth in agriculture is far behind the service and industry sector. This is so over the last two decades. This has a direct impact by continuously increasing the rural – urban divide and attraction to leave farming and move to urban centers. Farmers find farming increasingly un-attractive in almost all states. According to the NSSO report – 2005, 60% of farmers do not like farming.

Within rural areas the disparity is much more. There are some (perhaps a few) farmers who make money, achieve higher yields and are prosperous. The majority of small farmers (80% of total farmers) lag behind with no or minimal growth at about 1% as indicated above. Those with negative growth land in the debt trap. Some amongst

them leave farming and migrate to urban centers. With same land and water resources, some farmers make profit but others commit suicide. The young and educated are attracted to Naxalism and their number is growing.

Agriculture is under threat. Increasingly area under agriculture is being reduced due to rapid urbanization, indiscriminate growth of industrial townships, mining including illegal mining, infrastructure projects-roads-highways, railways, ports so on so forth. The worst threat is due to speculative value of land; land developers go on buying land outside urban townships for investment. Even retail investors and wealthy farmers are attracted to this. The greener areas are getting increasingly reduced at an alarming rate all over the country.

This is further aggravated by climate change. Its adverse effect is well known and is being experienced by one and all. Heavy rain episodes with fewer rainy days, un-timely or delayed rains, variation in temperature or frost, as un-predictable phenomena have already affected productivity of farm lands, milch cattle and fish catch. The worst affected continue to be small and marginal farmers.

The over all impact of above – if not taken care of properly, would have disastrous consequences:

- The current growth rate of 2% to 3% may reduce further and create problems of food security for the country and would further enhance the already high inflation and create greater dissatisfaction.
- A larger number of small farmers will slide again below the poverty line. Educated rural youth will get frustrated as their urban counter parts enjoy higher income and becoming prosperous. This may perhaps enhance Naxalism and the Naxalite – infested areas in particular and enhance social turmoil. Naxalism has already affected the democratic systems of Panchayati Raj in such districts and that is a threat to the constitutional framework of democratic system of our country.

This may increase further migration by farmers to urban centers – leaving land fallow. But all is not that bad.

- India is the only country which has preserved democracy- despite having 80% of population below poverty line at the time of independence in 1947 and its leadership has successfully brought down the poverty level to 20%. And India has come out of dependence of imports of food and is now exporting. India's strength is her farmers.
- Further, India has rich and significant experience of tackling adverse climatic conditions across the various agro climatic and bio geographic regions. With local initiatives of government officials and NGOs, our farmers have converted drought prone areas into green-ones in the states of Gujarat, Rajasthan, Andhra Pradesh, Karnataka and Maharashtra. Similar initiatives have for instance, turned

around local level economy of areas affected due to the Earthquake (Kutch-Guj) & Tsunami – (Tamil Nadu & Kerala).

- The country has significant knowledge, successful research, well developed technology and empirical experiences in this regard. It has the capacity to meet the challenges of lop sided development referred above and not only stop reduction in green areas but enhance the green cover. Although all states are not growing equally, it is possible to have enhanced growth in all states with determined and consistent efforts by its Public Leadership and that it is feasible to achieve growth rates of 6% - 8%, as already achieved by some states, by the entire country as the recent example of the Gujarat shows. The country has overcome obstacles to its growth in the past and can do so again. It has dynamic leadership and responsive farmers.
- Food security can not only be achieved; the country can supply food to other parts of the world where problems are already worse. There is also high and growing demand for food, dairy, meat and fish products due to a burgeoning middle class worldwide and with significant efforts, it is also possible to eradicate poverty in rural areas.
- But for achieving this it is necessary to recognize that the agriculture is the main tool to tackle the problem of poverty and that of global warming – the enhanced release of CO_2 in atmosphere. Agriculture – the green cover is nature's factory to absorb CO_2 from atmosphere and release Oxygen through photosynthesis. There is no other such technology to reduce CO_2. This nature ability has to be strategically enhanced to reduce imbalances in the atmosphere. This can be achieved by enhancing land areas under agriculture by development of waste lands, wetlands, grasslands and compulsory green cover in open areas of urban centers and townships which are increasingly reducing vegetative cover.
- Make public leadership at all levels from village, state and centre both (elected and non-elected members of public governance system) fully involved and responsible for collective fostering of agriculture.
- All the above stated dimensions have to be based on learning from empirical experiences / insights derived through location and system – specific research on related aspects. By using our own technical manpower in an optimum manner and having faith in our farmers and grassroots level leaders like Sarpanches, cooperative leaders progressive farmers, village level workers and even school teachers and NGOs. They have played significant role in many parts of our country but this has to happen in every village of our nation and we can make it happen.
- Productivity enhancement has to be achieved by reducing the spread and depth of natural and artificially induced perturbations. Even the observed growth of 2 – 3% is highly skewed within the farming community. Small farmers (who represent

about 80% of the community) in particular have to be enabled to overcome challenges through diligence.

- With prosperity there is a increasing gap between leaders and communities. This gap has to be bridged through focused community leadership enhancement initiatives that focus on "Awareness for Action & Leadership that enables Participatory Sustainable Development". Particularly awareness has to be created in all stakeholders right from the highest level: say Chief Minister and Chief Secretary to lowest level viz. Sarpanches of villages and village level workers (VLW). For example, the Government of India may invite Chief Ministers and Chief Secretaries to review progress of small farmers and enhancement of green cover at-least as an annual feature.

In the following pages all these are discussed in detail with real life examples of individual and community efforts to lay a path ahead. Every one who reads this will find her/his own role, perhaps to make our country not only self reliant but support other nations of the world. In our hurry for faster growth and rapid industrialization, we have forgotten the basics of nature's forces and without understanding them, have disturbed the balance. This imbalance could be a cause of very many problems. But still there is wisdom within our own system. Time has come to look back and nurture 'vegetation' – "Vanaspati" the basic force of nature which is loosing its space due to avaricious human interventions.

SUSTAINABLE DEVELOPMENT AND AGRICULTURE

Sustainable development is a pattern of natural resource use that aims to meet human needs while protecting the environment simultaneously. This ensures that the need for resources can be met not only in the present, but also in the indefinite future.

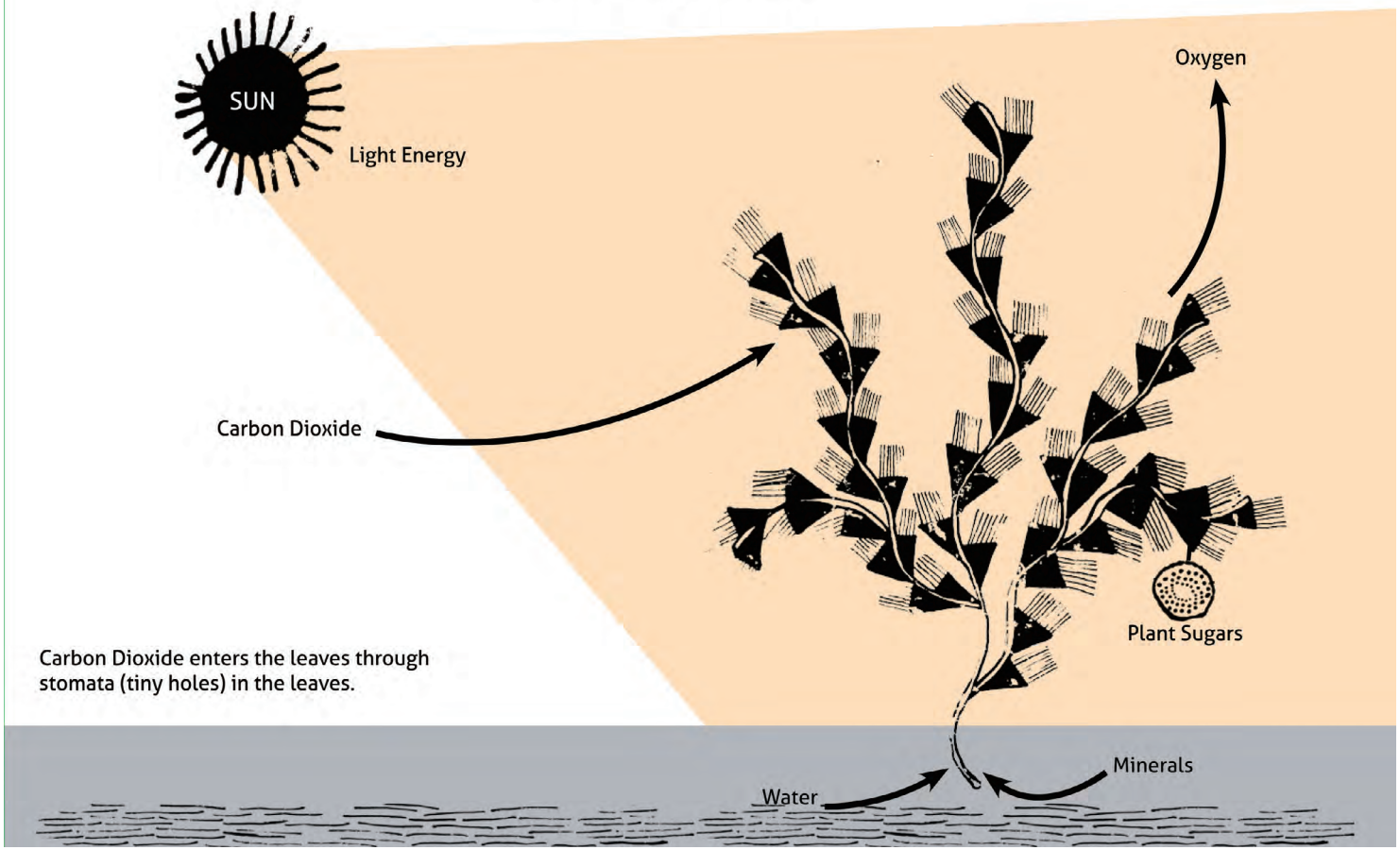
The word “Sustainable development” has well-known implications. It is a long-term activity. It involves the use of natural resources. It implies economic growth with socio and economic content.

It means to provide enough of what one needs in order to live or exist and implies its gradual growth in size, quantity and quality without diminution.

It envisages gradual growth in the income of people through development of wealth of an area, of a society or for that matter of the country. It endeavors to provide better quality of life to all participants, especially to poor families in remote areas. Empowerment of the poor is the key to socio-political stability. A huge divide between the rich and the poor creates political turmoil and instability in the country. Many a times, it results in the emergence of local terrorist groups.

The programme for sustainable development varies across regions, families and countries. The development aspirations of an area and the status of the poor within the community are the principal factors that determine the components of such a programme. The process involves social, economic and infrastructure activity as a part of special initiatives of ‘developmental programmes’ initiated by the government. In a well established democracy, the civil society and the individual exert equal influence.

Photosynthesis



Sustainable Development: Nature's Forces

The sustainable development is centered on nature's principles. Nature has five important forces – Sky (atmosphere), Sun, Earth, Water and Vegetation. These forces are inter-dependent and maintain equilibrium in nature. They are also responsible for different seasons round the year – including weather cycles and climate.

Appropriate use of these forces of nature to generate basic resources for livelihood is important, which in turn helps sustain the habitat and promote sustainable development.

Improper use and reckless exploitation of these resources disturbs the balance of nature and affects sustainable development. For example, overdrawing of underground water leads to salinity ingress and advancement of desert while excessive use of fossil fuel leads to excess of gases in the atmosphere disturb heat balances. Inequitable use of resources leads to social turmoil and political instability.

How Nature Operates its System

It is well known that the water vapor mobilized by sun's heat generate clouds. They are moved by winds in the sky and influence rain on earth – land. Due to moisture in land, the seeds germinate into plants, which in turn grow through the process of Photosynthesis.

Photosynthesis is a process by which green plants use sunlight to make their food. They use sunlight along with carbon dioxide and water to create simple sugar or glucose. Plants absorb CO2 from the atmosphere and release oxygen.

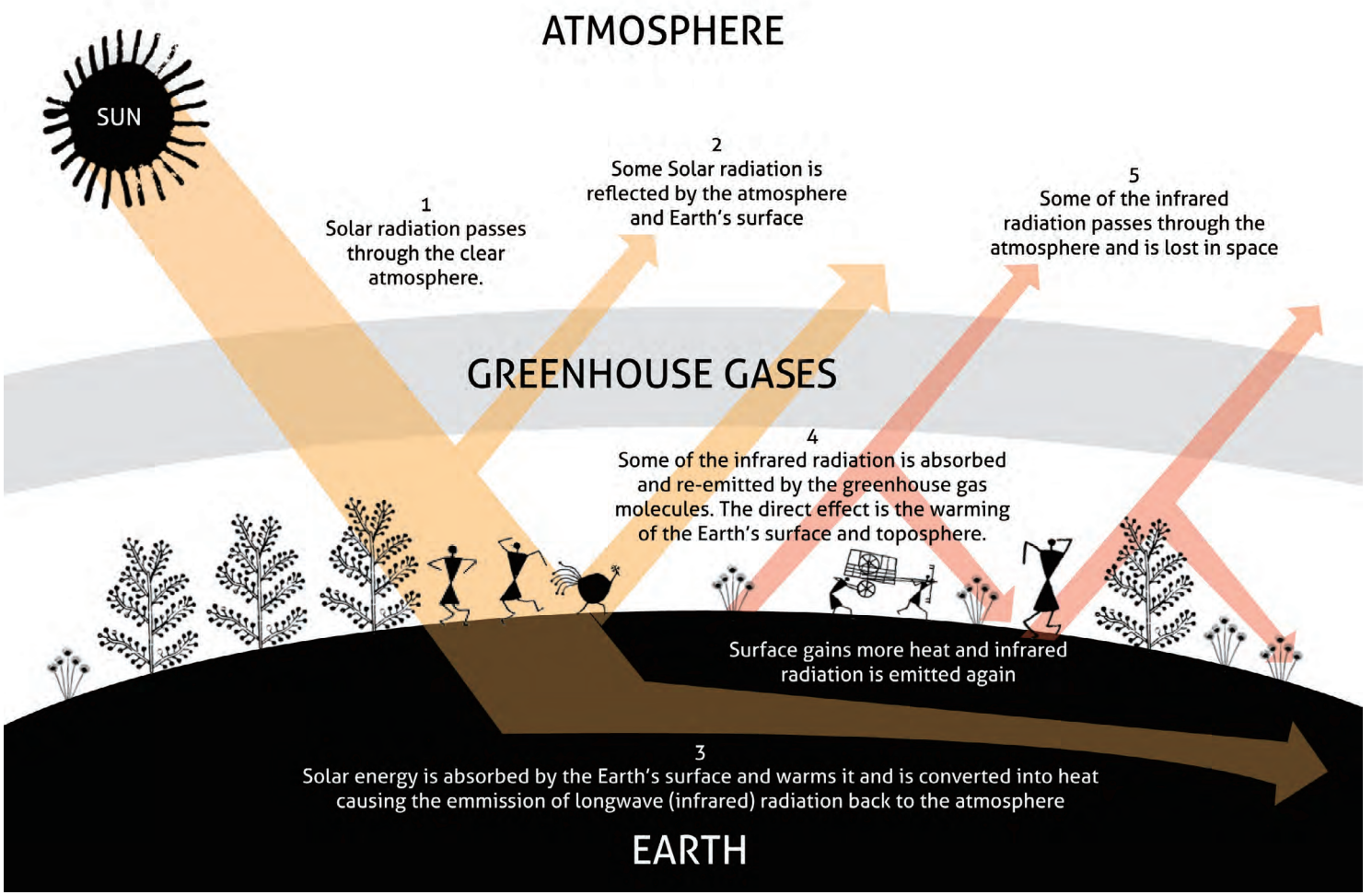
Plants produce millions of new glucose molecules per second. They use these to build leaves, flowers and fruits and seeds to convert glucose into cellulose – the structural material in their cell walls. Most plants produce more glucose than they can use. Hence, they store it in the form of starch and other carbohydrates in roots, stem and leaves. Nutrients are also transferred by plants into the soil, which increases its fertility. This is a part of the process of carbon assimilation by plants.

The ancient by-products of photosynthesis are fossil fuels such as natural gas, coal and petroleum essential for the energy needs of human.

Humans and other animals too depend on glucose as an energy sources, but they are not capable of producing it on their own. They are dependent on plants for glucose.

Thus, virtually all life on earth, directly or indirectly, depends on photosynthesis – the process of interaction between the five forces of nature.

Whenever nature's balance or equilibrium of its forces is disturbed, the weather cycle is adversely affected, resulting in climate change. The normal cycle of atmosphere is affected and this includes changes in weather, un-timely or excess or no rain, sea level changes etc. This increases the vulnerability of our systems including agriculture to impacts of other natural calamities like earthquake or Tsunami so on so forth. In present times, this is called 'Global Warming' due to 'Greenhouse Effect'. Climate change often enhances natural calamities and has a direct impact on sustainable development.


ATMOSPHERE
SUN
1
Solar radiation passes through the clear atmosphere.
2
Some Solar radiation is reflected by the atmosphere and Earth's surface
5
Some of the infrared radiation passes through the atmosphere and is lost in space
GREENHOUSE GASES
4
Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the Earth's surface and toposphere.
Surface gains more heat and infrared radiation is emitted again
3
Solar energy is absorbed by the Earth's surface and warms it and is converted into heat causing the emmission of longwave (infrared) radiation back to the atmosphere
EARTH

IMPACT OF GLOBAL WARMING

THE GREEN HOUSE EFFECT - The discrimination against agriculture
The interface of global warming, climate change & agriculture:

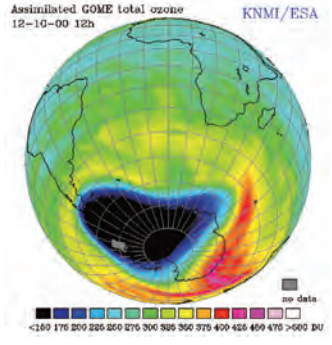
We are familiar with the fact that our earth is heated by sunlight. Most of the sun's energy passes through the atmosphere, to warm the earth's surface, oceans and atmosphere. However, in order to keep the atmosphere's energy budget in balance, the warmed earth also emits heat energy back to space as infrared radiation. A natural system known as the "greenhouse effect" regulates temperature on Earth. Just as glass in a greenhouse keeps heat in, our atmosphere traps the sun's heat near earth's surface, primarily through heat-trapping properties of certain "greenhouse gases".

Over the past thousands of years the amount of greenhouse gases in our atmosphere has been relatively stable. A few centuries ago, their concentrations began to increase due to the growing demand for energy caused by industrialization and rising populations, and due to changing land use and human settlement patterns.

The greenhouse effect refers to the change in the steady state temperature by the presence of gases that absorbs and emits infrared radiation. The greenhouse gases trap heat within the troposphere. The gases are water vapor, carbon dioxide, ozone, methane, nitrous oxide and chlorofluorocarbons.

Nitrogen, oxygen and argon make up 98 percent of the Earth's atmosphere. But they do not absorb significant amounts of infrared radiation and thus do not contribute to the greenhouse effect.

Carbon dioxide (CO_2) constitutes about 72% of total GHG and contributes the bulk of radioactive forcing. Increase of burning of fossil fuel like coal, oil, gas, wood etc caused by industrial activities and deforestation have increased its concentration in the atmosphere. The concentration of carbon dioxide (CO_2) in the atmosphere has increased from 285 ppm at the end of the nineteenth century before the industrial revolution, to about 385 ppm in the new millennium.



Climate change is caused by natural forces and human orientd activities

- Methane is produced when vegetation is burned, digested or decayed with no oxygen present. Garbage dumps, rice paddies, and grazing cows and other livestock release methane. It is about 18% of total GHG.
- Nitrous oxide is released when chemical fertilizers and manure are used in agriculture. It is about 9% of total GHG.
- Other gas is SF-6.
- Most interesting part of these major emitters is CFC12 1 unit = 7000 CO2), SF6 (1 SF = 23900 CO2) are largely from industrialised nationals.

One of the most important issues relating agriculture to climate change impacts and greenhouse gas releases is the apparently iniquitous treatment meted out to it in international deliberations. While there is no debate that industrial establishments are responsible in a major way for the net high levels of emissions, it is important to recognize that agriculture absorbs CO2 and releases oxygen through photosynthesis. It is also true that some fertilizer – centered releases of CO2 occur due to related agriculture practices. Nevertheless while calculating the overall scenario it is essential to examine and highlight the CO2 absorbed in soil, stem, leaves and grains or fruit for appropriate apportionment. Our present understanding is that it is not adequately represented and there are significant gaps in our understanding of related dynamics in different systems of production across the globe. Agriculture, therefore, tends to be targeted through a biased perspective and in simple terms also inappropriately blamed. Importantly a significant part of international and national policies provide market based opportunities / incentives to large scale polluters instead of strictly regulating them and overlook the need to support agriculture with suitable incentives. Going further, it is important to also ask if the net impact of agriculture can be positive considering the links it has with sustainable livelihood especially in the developing countries. It even appears less prudent to place industry and agriculture on similar emission terms, considering the apparent anomaly. If agriculture is given due weightage for its capacity to absorb CO2 from atmosphere and considered as a prime tool for integrated mitigation and adaptation, the entire international policy and dialogue could be on a different platform.

Hope to mainstream agriculture in international negotiations:

International community has taken up global warming seriously. United Nations initiated series of meeting of all the countries to come for certain common policies to adopt by all nations. This is known as “United Nations Conference of Parties (COP).

- The Montreal Protocol (1987) was considered to be landmark in International Agreement designed to protect stratospheric Ozone Layer.

- In Kyoto (Japan) had COP in December 1997 which formally adopted binding targets for GHG emissions reduction by member countries under what is known "Kyoto Protocol".
- Thereafter this was been followed up every year like in Nairobi, Bali, Pozhan, Copenhagen, Cancun in last December COP 17 in Durban.
- There are formal discussions with representatives of National Governments. Simultaneously interested parties also hold dialogue with civil society members.
- At Durban in 2011 world leaders agreed on some provisions for adaptation, a green climate fund, and a deadline for governments to adopt a legal agreement on climate change by 2015. Some of these may eventually help poor farmers deal with climate change that threatens food security among the most vulnerable.
- COP's Ad Hoc Working Group on Long-term Cooperative Action (LCA) concluded that a decision on agriculture will be made at COP18 which takes place November 2012 in Qatar.
- Agriculture is an important part of the Reduction of emission from de-forestation and degradation of forest (REDD+) discussions in the UNFCCC negotiations because emissions reductions cannot be done without addressing agricultural productivity. However, agriculture could get sidelined should the negotiations in Qatar fail.

This slows progress on agriculture in the negotiations reinforces the need for action on the ground. It's important to strengthen the confidence and capacity of nationally and community-led efforts to address food security, development, natural resource management and climate change together, as interlinked issues. We need the creativity, leadership, resources, expertise and solidarity to find solutions to the common challenge of food security and livelihood of millions of hungry families across the world in the context of climate change. As someone predicted that unless Carbon cuts are made effective, there will be collapsing iceburgs, melting frost, displaced ocean currents with disappearing coastlines, sizzling atmosphere and, ofcourse, recurrent and devastating tornedos, heavy rain, drought and temperature variations – all these which can not be predicted easily.

AGRICULTURE VEGETATION HAS THE SUCCESFUL TECHNOLOGY TO ABSORB CO_2

The only known technology, which can absorb CO_2 is "agriculture" through photosynthesis process. While no data are available about reduction in vegetative cover and related reduction in absorption of Carbon dioxide and release of Oxygen, the agriculture – vegetative cover – both as agriculture land and forest areas are reducing rapidly due to increasing.

- Urbanization,
- Industrialization & infrastructure and mining.
- Fallow agriculture land due to farmers' migration to urban centers for better and assured income.
- Soil salinity and soil erosion along with un-timely or reduced rainfall or floods resulting in crop failures.
- Large scale purchase of agricultural lands by land developers – attracted by phenomenal increase in land prices.

This is also the main reason for decline in production of food crops; posing a challenge to food security in many parts of the world. Some related reasons for Global Warming and disturbance to nature's balance of forces include

- Increasing global population,
- Increase in the proportion of middle income people of developing world, who have increased demand, for equipment using energy and consequently release greenhouse gases
- Increase in transport vehicles and transportation due to better infrastructure and increase in industrialization, mining and urbanization.

The factors which increase Global Warming will continue to grow with a multiplier effect in the future. In many countries of the world like India, energy needs in rural area and poor families are yet to be met with. This requires further setting up of power plants and rural industrialization to add wealth in rural areas and people residing there.

THE IMPACT

Unpredictable Climate is a threat to sustainable development: Every single day, there is breaking news about natural calamities hitting some region in the world. This unpredictable climate is creating havoc around the world, destroying habitats and disturbing people's livelihood. Some of the recent natural disasters related to this phenomena in India are narrate below. It must be noted that our country is not new to drought, cyclones etc., but its frequency and intensity have increased abnormally in the new millennium. India like other countries in the world had its share of natural disasters.

Gujarat Earthquake, 2001

The Kutch earthquake that shook Gujarat was one of the deadliest earthquakes to strike India. The region continues to simmer and has experienced several mild earthquakes and tremors since 2001.

Trail of Destruction

- The death toll : 19,727
- Injured : 166,000
- Homeless : 6 lakhs
- Houses destroyed : 3,48,000
- Cattle killed : 20,000
- Estimated losses at : 1.3 billion

Tsunami December 2004 – affected the Andaman & Nicobar, Pondicherry, Kerala and Andhra Pradesh causing loss of Agri crops, cattle wealth, housing and livelihood.

Mumbai Floods – 26th July 2005 –city was paralyzed and floods in Maharashtra

Surat Floods (2006) – Estimated loss of Rs.22,000 crore. City's infrastructure affected, high individual losses and crops like sugarcane (Rs. 4,000 crore)

Heavy rains in 2007 in Rajasthan with flooding and consequent breakout of diseases, loss of crops and cattle wealth.

Bihar – 2008 – Koshi river overflow with dam in Nepal giving way and large areas of Bihar - UP got affected.

Droughts 2009: Delayed monsoon caused drought in some states.

2010 : Heavy floods in Northern India & Un-seasonal showers and snow falling in some parts of India like Gujarat in 2010, the most important is that weather has become totally unpredictable.

Some consider impact on climate change is only related to increase in temperature –but as mentioned, it is due to disturbance of equilibrium of nature's forces, that tsunami or earthquakes have increased or sea-water level is increasing hence this impact have to be understood in two ways – first is the actual increase in natural disasters as mentioned above. Second is the concurrent impact due to change in weather as low or heavy or no rain or impact of increased temperature on productivity of crops, animal or fish catch. For the first case we have Disaster Management post disaster - for the second we need to take preventive steps and it can certainly be managed by timely action, convergence of efforts and with involvement of local level leadership. By leadership, we do mean only political or elected leaders. It includes all members of Public governance System – at the village level Sarpanch, Chairman of Cooperative or Self Help Group, village level worker, teacher similarly at taluka & district level. It also includes non-Government organizations involved Voluntary assistance, Entrepreneurs even Judges.








ADAPTING TO A WARMER, WILDER WORLD

The worldwide impact is equally grave.

- In the U.S. alone, nearly 1,000 tornadoes have killed many people and inflicted $9 billion in damage.
- The 2010 heat wave in Russia killed hundred of people and led to a 40% fall in the harvest of food grains.
- Floods in Australia and Pakistan killed thousands of people and devastated agricultural lands.
- Re-current droughts in China have eroded millions of acres of farmland.
- Tsunami in Japan – Nuclear plant affected & played havoc to the local habitat
- Recurrent and continuous famines in Ethiopia - Somalia and riots for Food by hungry millions.
- Recurrent floods in South East Asia, Philippines, Indonesia, Thailand.
- Almost all nations small or big are affected, one way or another
- This is continuously happening with increasing intensity.

CLIMATE CHANGE ENHANCES IMPACTS OF NATURAL DISASTERS:

Such Disasters creates:

- Severe famine or heavy floods
- Loss of life
- Loss of Agriculture crops and animals
- Loss of livelihood
- Increased risk of diseases outbreak
- Damage to infrastructure and communication particularly in rural areas.
- Setback to social and economic development and emergence of social turmoil with increased rural urban divide.
- Pushing farmers in rural areas again back below poverty line.
- Impact in productivity of various crops, thereby creating a challenge to food security. Recent research carried out at the Anand Agricultural University provides clues on the deficits that may arise.

Anand Agricultural University – Research on impact:

Sensitivity of CERES-Peanut (Groundnut) model to ambient temperature under optimal condition (cv. JL-24)

Change in mean ambient temperature (°C)	Simulated grain yield (kgha-1)	% Change from base (2200 kgha-1) yield
1	2152	2.1
2	1888	14.2
3	1514	31.2

The area under groundnut crop in Gujarat is 19 lac ha. Therefore, due to increase in temperature by 3°C, reduction in groundnut yield would be around 31.2% i. e. 13.2 lac ton per year.

Anand Agricultural University – Research on impact: Sensitivity of CERES-wheat model to ambient temperature under optimal condition (cv. GW-496)

Change in mean ambient temperature (°C)	Simulated grain yield (kgha-1)	% Change from base (5825 kgha-1) yield
1	4078	- 30
2	3675	- 37
3	3266	- 44

The area under wheat crop in Gujarat is 24 lac ha. Therefore, due to increase in temperature by 3°C, reduction in wheat yield would be around 44% i. e. 12.5 lac ton per year.

CURRENT INDIAN SCENARIO

Dr A. K. Singh, Deputy Director General of Indian Council of Agriculture Research has analysed the overall Indian scene. He has indicated concurrent impact on entire agriculture sector.

- No significant change in monsoon rainfall at All India level, some regional variations noticed
- Increase in rainfall in west coast, north AP and NW India, decreasing trend in east M.P. and adjoining areas
- Increase in surface air temperature by 0.51 0C during 1901-2007, accelerated warming during 1971-2009
- Mean temperature rise by 0.2 0C per decade during 1971-2009, greater rise in minimum temperature than maximum
- One day extreme rainfall events are increasing
- Cyclonic storms in Bay of Bengal showed declining trend of 2 cyclones/decade during 1891-2008
- Deglaciation in the Himalayas
- Sea level rise in Indian Ocean 1.63 mm/year during 1993-2009

INDIAN SCENARIO : FUTURE PROJECTIONS

- Change in rainfall pattern by the end of the 21st century
- Increase in temperature by 3 to 6 0C
- Warming will be more pronounced over most of the land areas
- Maximum increase over northern India
- Relatively greater warming in winter and post monsoon seasons
- Frequency of cyclones during post monsoon seasons (2071 to 2100) is projected to much higher than baseline scenario (1961-1990)

IMPACT OF CLIMATE CHANGE ON WATER RESOURCES IN INDIA (2100) *

Region/Location	Impact	Reference
Indian sub-continent	Increase in monsoon and annual runoff in the central plains No substantial change in winter runoff Increase in evaporation and soil wetness during the monsoon and on an annual basis	Lal and Chander, 1993
Orissa and West Bengal	One-meter sea level rise would inundate 1700 km2 of prime agricultural land	IPCC, 1992
Indian coastline	One-meter sea level rise on the Indian coastline is likely to affect a total area of 5763 km2 and put 7.1 million people at risk	JNU, 1993
All India	Increase in potential evaporation across India	Chattopadhyay and Hulme, 1997
Central India	Basin located in a comparatively drier region is more sensitive to climatic changes	Mehrotra, 1999
Kosi Basin	Decrease in runoff by 2-8%	Sharma et al, 2000, a,b
Southern and Central India	Soil moisture increase marginally by 15-20% in monsoon months	Lal and Singh, 2001
Damodar basin	Decreased river flow	Roy et al, 2003
Rajasthan	An increase in Earth temperature	Goyal, 2004

** Dr. A.K. Singh - Deputy Director General of ICAR*

River basins of India	General reduction in the quantity of the available runoff, increase in Mahanadi and Brahmini basin	Gossal and Rao, 2006
River basins in northwest & central India	Increase in heavier rainfall and reduction in number of rainy days	Singh et al, 2008

OBSERVED IMPACTS ON AGRICULTURE IN INDIA

- Drought in 2002 reduced 15 million hectares of the rainy-season crops and resulted in a loss of > 10% in food grain production. Last year, delayed monsoon rains caused reduction under rice cultivation.
- Terminal heat stress is lowering yields of late-sown wheat yields
- Cold waves during December 2002-January 2003 caused significant impact on crop production in northern India (mustard, mango, guava, papaya, brinjal, tomato and potato).
- Cold wave during 2006 damaged 50-60 % of young and 20-50 % of old trees of mango.
- Other fruit crops like guava, aonla, banana, papaya, bael, karonda, chironji, khirni, mahua, tamrind, wood apple and jamun were also affected.
- High rainfall in 1998 & 2005 (> 1500 mm) affected kharif and late kharif crop of onion and spoiled rabi nursery leading to price hike.
- In cashew, untimely heavy rain in March 2008 in west coast reduced the yield and nut quality.
- Shift in apple cultivation to higher elevations due to non fulfillment of chilling requirement
- Rise in sea surface temperature (2-2.5oC) in May 1998 led to bleaching in 85% coral reefs.
- Extension of northern boundary of oil sardine due to rise in sea surface temperature

HEAT WAVES

Custard Apple is tolerant to High temperature

Andhra Pradesh : *20 lakhs birds died in May & June 2003*

Continuous higher temperatures during critical growth stages of rabi crops reduces the crop yields considerably

Live stock : Heat wave can reduce a milk yield by 10-30% in first lactation and 5-20% in second and third lactation periods in cattle and buffaloes. It also affect the growth, puberty and maturity of crossbreed of cows and buffaloes

Fish : Mortality of fishing in shallow water ponds and reduction in fish catch in the water bodies due to movement of fish into the deeper layers.

But we can and have to meet these challenges.

THE WIN-WIN SITUATION

One solid way to meet all these challenge is to promote and mainstream agriculture – the vegetation cover

- This has been lost sight off in development and efforts are focused elsewhere – but not looking back at nature that provides solutions.
- Says Shri. Kantisen Shroff "the Veteran NGO", In our sunlit tropical areas all our natural resources are through the process of photosynthesis which is natural process of each and every plant cum grass. That means the CO_2 from the atmosphere forms the basis of all resources absorbed through this process and we get back oxygen which is released as its consequence. We have measured these conversions and seen the positive changes in the environment at local level". The case studies of this vision are in the following pages.

The interesting aspects of carbon assimilation by plants are:

- The atmospheric CO2 stimulates the process of photosynthesis and consequently plant growth, as extensive experimental research has shown (IPCC, 2000)*
- The extent of this stimulation varies for forest (up to 60 percent), for pastures, and crops (about 14 percent).
- There are three basic types of photosynthesis: C3, C4, and CAM. Each type has its own advantages and disadvantages. Approximately, 35 % of the terrestrial plants are C3 species, while 1 % are C4 and 4% use CAM pathway of photosynthesis. (Bowes, 1993).*

(Bowes G. 1993: Facing the Inevitable: plants and Increasing Atmospheric CO2. Annula Reviews of Plant Physiology and Plant Molecular Biology, 44:309-332)

(IPCC 2000: Land use, land use change and forestry. A special report of the IPCC Cambridge, UK, Cambridge University Press:)

- According to one estimate, a single row of trees with or without shrubs can reduce particulate matter by 25% and each hectare (2.471 acres), of plantation can produce enough oxygen for about 45 persons.

- The foliage of a single mature beech tree(Fagus sylvatica), for example, can extract more than 2.5kg of CO2 from the atmosphere, and produce 1.7kg (3.7lb) of oxygen in one hour, which in theory is enough for the needs of ten people in a year

CARBON SEQUESTRATION

- Action taken to sequester Carbon in biomass and soils increase the organic matter content of soils.
- This has a positive impact on environment and biodiversity.
- The increase in soil carbon storage increases the soil fertility, land productivity and prevents soil degradation.

Therefore, this constitutes a win - win situation, but we need to notice it and make it happen. In fact we have gone through such adversities due to change in climate or otherwise over last centuries and in many places, we have overcome such difficult situation by persistent efforts by balancing management and use of soil, water and vegetation in sun-lit areas of our own country India. Let us look at some experiences:

THE KUTCH STORY

In the 19th century, a devastating earthquake struck Kutch on June 1`6, 1819. Before the earthquake, Sindhu River flowed in the region. Kutch was a green land which produced paddy. Agriculture and livestock flourished.

After the earthquake, the Sindhu River changed its course and disappeared from Kutch. The earthquake caused a nine-meter vertical displacement, which came to be known as the Allah Bund. Sea water made huge ingress into the land through this displacement, converting the entire area into a huge saline desert which came to be known as the little and great Rann of Kutch. The vegetation cover was slowly lost with high occurrence of famines.

Crops failed, drinking and irrigation water became scarce, health and sanitation was affected. Survival became difficult in this arid land. Farmers left agriculture and land soon became fallow. This resulted in large-scale human and cattle migration over the years, a trend which continued in the last century. In fact happened here is what we visualize this will happen in many parts of the world due to climate change. But the situation was changed in Kutch with persistent efforts by the people who were determined to make the desert green again.

The Shroff Initiatives

Shri Kantisen Shroff came to his motherland Kutch in the early seventies from Mumbai. He was the Chairman of the agrochemical firm Excel Industries Ltd in Mumbai. He has been now staying at Bhujodi – Kutch since last two decades with his wife Chandaben. They are popularly known as Pujya Kaka and Pujya Kaki.

The Shroff's were the first to work for rural development in Kutch as a voluntary group. When Shroff started visiting Kutch, the region was facing recurrent droughts that led to scarcity of water and huge cattle and human migration. The government was running a few relief projects to provide livelihood and create community assets such as ponds, roads etc. The villagers remained occupied in such projects whenever monsoon failed – from September till the beginning of monsoon next year. The most severe droughts occurred between 1968-70 and 1973-75. This was when Shroff thought of a solution to the problem on a long term basis.

Shroff set up a number of voluntary organizations to involve people in sustainable development projects. These included the Vivekananda Research Training Institute (VRTI) at Mandvi in Kutch, Shrujan – Bhujodi-Bhuj and Shroff Foundation Trust in Vadodara.

Shrujan was developed by Chandaben for promoting assured livelihood and self-respect amount rural women of Kutch, who were highly skilled in traditional embroidery work.

Pujya Kaka developed a participative approach which involved people as well as government agencies. This, in turn, created a local committee of participants who implemented the programmes. All these were done with convergences of efforts and active involvement of Government agencies and by taking up development programmes initiated under different government schemes.

A clinical approach was taken, which involved the diagnosis of a problem, a prescription for its solution and its implementation. The programmes were planned taking into consideration the local requirement and involved the use of modern technology. Some of the success story replicating above of Mundra, Lakhpat and Mandvi block of Kutch district are as follows.

Salinity Reduced By The "Trench" System
Dhrub village, Mundra – Kutch

The story of Mundra Taluka is a tale of how exploitation of resources can drain the prosperity of a land and its people. Mundra was a green belt where crops such as banana, groundnut and sugarcane were cultivated and villages such as Zarpara, Dhrub, Bhujpur, Navinal and Siracha were flush with natural reserves of sweet water.

Dhrub, situated east of Zarpara village, witnessed large-scale migration of Turks in ancient times. With Turks, came dates from the Middle East. As time passed, the Turks started sowing date palm seeds in Dhrub – a land with soil, water and climate perfect for growing dates. The success story of date cultivation in Dhrub spread to nearby villages and soon date palms covered the entire Mundra Taluka,

Ground water was the major source of irrigation. Earlier, water was drawn by using leather bags. The seventies saw the use oil engines and electric motors. As a result of proper irrigation, farming progressed. But this success lured farmers to dig deeper and draw more and more ground water.

This, unfortunately, was the beginning of a vicious cycle. The greed to have "more" water brought down the level of ground water. Saline water ingresses in these areas increased the salt content in ground water. The water was then unfit for irrigation purpose. Farm produce drastically declined.

People then realized that it was a grave mistake to use water without discretion. Their greed to exploit resources had cost them dear.

Vivekananda Research and Training Institute (VRTI), the voluntary organization run by

Kantisen Shroff, has been working on land reforms since three decades. Shroff visited Mundra Taluka and carefully examined the farming areas. Zarpara village had 3.554 hectares of farm land, of which 998 hectares was under irrigation. Around 10,000 chickoo trees and 3,000 date trees used to cover almost 90 per cent of this farm land, in addition to guava, jujube and bijora trees. Crops such a Lucerne, jowar, carrot and cotton were also sown in the past. But over exploitation of ground water had left these as only memories of the past. Shroff felt that a new system should be used to revive Mundra's glorious past.

Trench System:

Shroff and Mavjibhai of VRTI talked to the Sarpanch and villagers about the water scarcity problem. They suggested a trench system to solve the problem. Under the system, a one-and-a-half foot trench is built, which encircles the trees under irrigation. It is filled with biomass, which helps in the growth of fruit. The approximate expenditure for building a trench is as follow:

Expenditure for trench around 1.1/2 feet around tree	Rs.30/-
Expenditure for filling farm waste	Rs.15/-
Expenditure for 7 to 10 kg organic fertilizer	Rs. 30/-
Total expenditure on a trench	Rs.75/-
Expenditure on sowing 40 trees (per acre)	Rs.3000/-

Around 40 trees can be cultivated in each acre and the expenditure is around Rs.3000. Approximately 1000-1100 liters is saved in irrigation. Trees can now bear fruits with less water and give permanent income to farmers.

If we talk about the water-basin in this area, then,

- One bed for Chickoo is 5 m x 6 m (l x b)
- 4 to 5 inches of water to be filled, thus one bed will utilize 3000 to 3,600 litres of water
- It can be irrigated twice in a month
- Water to be filled in a trench around the tree
- First round of 2 meters around three (2 x 3.14 x 2) 12.56 square meter
- Second round (2 x 3.14 x 1.55) 9.73 square meter

More water is supplied in the trench system, but the total quantity of water used is actually less than that utilized in the furrow system.

Villagers adopted the suggestion and followed the instructions of volunteers of VRTI who visited these areas regularly.

The work started in 2004. At present, there are 45,000 fruit giving trees in this village. The average annual income of the participating farmer is Rs.12,000.

Jakhani village – Mandvi-Kutch

Saving water and soil nutrition by making changes in the system of growing dates

Dates are know in Gujarat as "the Kalpvruksh of Kutch" (Kalpvruksh is a mythological and an imaginary tree satisfying every desire). Usually, dates are cultivated on the sea strip in the areas of Anjar, Mundra, Mandvi and Abdasa. Among these places, the major area covered by date trees is in Anjar and Mundra Talukas. Even today, dates from Dhrub village are popular all over India. As discussed in the proceeding section the credit for brining dates to Kutch goes to the Muslims of Dhrub. They migrated years ago from Turkey. They had brought dates with them. As dates were used by them as a part of food, they began sowing the seeds. Even today, eating dates is customary in Kutch. While traveling by bullock carts, people in Kutch use dates for snacks.

Gradually, dates became an important crop. People started growing dates on the border of their farms. A distance of one or two meters between two trees was maintained. The male and female trees are separated and the process of pollination is done by hand. Secondly, only after inflorescence can it be decided whether the tree is a male of female. But all the trees do not give uniform fruits. However, the farmers do not uproot trees even when they bear poor quality of fruits, as they have leased the entire orchard on a contract basis. The lease is based on the number of trees in an area. Contractors are concerned with the quantity of the dates rather than quality. As a result, their orchard started yielding poor quality fruits. The matter came up for discussion when Pujya Kaka came on a visit.

- The solution was removal of trees of inferior quality. Vivekanand Research and Training Institute agreed to help bring about changes in the system of growing dates and raise farmers' income

Shri Kishorebhai Shroff and his wife Ranjanben selected a farm near Mandvi at Jakhania village in 1995. They selected 'Kinuwadi' for giving guidance to the farmers and brought an Israeli expert for developing a model farm. Every year, the Israeli expert come here during the date season and educated the farmers in growing dates in a scientific manner. The farmers also sowed new culture based date plants.

The farmers in the areas around Bhujpur, Zarpara, Dhrub and Samaghogha started experiments based on 'Israel Technology'.

The Institute resolved to grow more than one tree of the same features using Tissue Culture; remove the trunk of bad dates and to bury it deep under the soil so that it became a fertilizer. They would also terminate the contract system of selling dates. Farmers were encouraged to sell dates themselves. By doing this, they would know

about good quality dates and market needs too. More income would be available by removal of middlemen. They urged farmers to clean dates, remove bad dates and old fruits and to undertake systematic farming, use fertilizers according to the age of the trees in the month of November-December and ensure better quality dates by growing male flowers. They would maintain bunches of dates depending on the strength of the tree and eliminate the extra to maintain quality.

- Inferior quality dates would be used as fodder for animals.
- Obtain good organic fertilizer by drying the dates leaves. The leaves could be mixed in the trunk of the trees, with a residue of fodder eaten by animals. The farmers would also observe the growth of good dates and record their history to help in growing similar trees
- Steps should be taken to prevent infestation and disorders brought about by fungus, harvest date crops on time and arrange to pack and sell on time

Results

- Farmers started the process of selling and packing dates according to market needs
- Dates came to be regarded as an important crop. Sowing was made by keeping a distance of 8.8 meters of 7 x 7 meters between plants
- Farmers started removing trees of inferior quality
- Production went up and reasonable profits were available as quality of dates improved.
- Average income increased as bad dates were removed and
- Underground water was now judiciously used, and nutritive elements were made available.

It would not be a surprise if in the near future, dates become “Kalpvruksh’ not only for Kutch but also for Gujarat!. Modern technology was obtained and adopted and the benefits were explained to farmers. In modern days, this is known as Knowledge Economy using successful technology from one who has it by providing to another who needs it. The Shroffs provided leadership to get this and transformed the date crop.

Abdasa & Lakhpat Taluka - Kutch
Fodder Bank : A boon in times of crisis

Abdasa and Lakhpat Talukas of Kutch are well-known for cattle-rearing. But people there are gradually saying good-bye to this profession due to recurrent failure of rain and water scarcity because of which cattle rearing was difficult. During such times, relief work is undertaken and grass depots are set up by the Government to protect people as well as cattle. Despite the fact that almost Rs.100 crore is spent on these measures, the situation remains the same when rains fail.

A 'Drought prone area development programme' was launched by Rural Development Department (Government of India) operated by District Rural Development Agency at local level. Its purpose was to organize people along with work and resources needed to prevent droughts.

The Programme was to preview water problems of the villages, see to it that enough grain is available from farming and that fodder for animals is made available in the village itself and employment for locals is also created. The programme was undertaken in villages of Abdasa and Lakhpat talukas. The impact was visible. The community was involved, there were inter-action at village level with experts of different disciplines.

Progress was visible. Local discussions with experts were encouraged

- Uncultivated land in the village was to be improved
- Better quality grass-seeds to be sown
- Jowar seeds should be sown on uncultivated land and even as a regular crop and
- More fodder should grown and stored when the times are good. Some of the guiding principles were that if the village water storage remains in the village,. The problem of water deficiency gets solved. Similarly, if the village fodder remains in the village, availability of fodder will not be a constraint. On the basis of this, it was decided to have a fodder bank in three villages by VRTI (Nalia)

Associations for animal husbandry were formed in Ashapar, Sudahdro Moti and Sudahdro Nani. Every cattle owner became a member by paying a membership fee and by contributing two to three measures of fodder. The association opened a separate bank account. A revolving fund was set up.

The year 2003 saw good rains and plenty of fodder. The committee procured and stored 64,280,41,000 and 88,080 kilograms of jowar in Sudahdro Moti and Sudahdro Nani respectively. Insurance was also taken against any loss due to accidental fire.

The following year, rainfall was scare resulting in an acute shortage of fodder. But, for once, villagers had no worries, as enough was in store.

In the absence of a fodder-bank, villagers would have been forced to depend solely on fodder from Bulsar. The villagers from these three villages did not have to go out to buy fodder. Now they had better quality fodder at a reasonable price.

Thus, the fodder bank proved to be a boon in times of crisis. Any crisis can be resolved with commitment and joint efforts, also did this?. The local community – the villagers themselves what was needed was to bring them together, identify common interest to prove the way for joint efforts.

Mohadi village – Lakhpat Kutch

Cultivation of Green Vegetables on the sea-shore

The speciality of VRTI is to set a challenging goal and to achieve it.

In a way, the entire Kutch district continuously faces challenges. As indicated the whole area was under green cover before the 1819 earthquake. The swirling water of Sindhu made lush green paddy fields. But the earthquake changed everything. Sindhu River changed its course and disappeared from Kutch. Lakhpat Taluka became completely dry, facing vagaries of continuous droughts. Every five years, on an average, one year used to be good: two years would be average, while the next two years would witness droughts. This led to wide-scale migration of people and cattle.

The imminent question was whether can farming be done in such a area?. This challenge was taken up VRTI with the help of Oxfam India Trust. VRTI started a programme called "small Scale Agriculture". The land was sandy and affected by salinity – hardly suitable for farming. But the idea was to use local condition.

Pujya kaka called a meeting to get the views of farmers. At the meeting in Mohadi on May 3, 2005, elderly farmers said that Haji Ismail used to grow vegetables and sell them in the past. Pujya Kaka asked Shri Dhirubhai to find out details from the village and visit Haji Ismail.

It came to be known during the discussion that there was some sweet water in the sand dunes. These dunes could be converted into 'recharged wells" during monsoon. During summer, water could be obtained by digging around the dunes. Many un-built wells were seen around the dunes. If these wells could be widened and re-built, harvesting of water could be done to meet day-to-day requirement. With proper use of water, vegetables, corn and fodder could be cultivated.

All the farmers agreed to take up the task of water harvesting and re-charging of wells. A well was required to be built. Initially, four farmers took the lead in digging the well, but three quit the project later on, as it involved a lot of hard work. Only Ardhemanbhai Jat remained committed to the project. The brave and patient man was prepared to fulfill the task, despite all odds.

It was decided to build a well on Ardhemanbhai's farm. This is when the workers realized that a well built by the Panchayat already existed, just 300 feet away from the farm. So, a tank was placed 300 feet away from the farm and a 'Micro Irrigation System' was installed. Water was collected and used to cultivate green beans, okra, drumstick and spinach.

In the second phase, the tank was filled regularly, vegetables were grown and every other care was taken. Fifteen days later, sucking pests were detected on the farm. Cow urine and neem leaves were sprayed to bring the insect attack under control.

Thanks to the efforts of Ardhemanbhai and his family, there was a profusion of green vegetables on the land. The villagers were astonished to see green vegetables flourishing on the desert land. They wondered how Ardhemanbhai had managed to accomplish this and wanted to follow his methods. A transformation took place in this arid and difficult terrain due to joint efforts. Many a times, individual determination paves the way for a new beginning for the community.

Zapara village – Mandvi-Kutch

Praiseworthy Attempt to re-establish farming

Mundra Taluka is situated in the southern part of Kutch district. The land is made up of sedimentary rocks. Mundra Taluka is the last one to emerge from the sea. Rivers and rivulets are in the last phase in this district. The profile consists of layers of sand and earth. Innumerable sea creatures are also present.

In the distant past, a lot of water was present in the layers of sand. In the past, Maldharis used to dig deep wells (5 to 10 feet) and draw water with the help of bullocks. Crops of cotton, sugarcane, nuts, vegetables and bananas were cultivated, as the layers were fertile and water was of good quality. But as time passed, Kutch was affected by recurrent droughts. With modern technology, farmers started pumping underground water – the result was depletion of water level and salinity ingress. The TDS content in water increased from 2500 to 3000.

Pujya Kaka, during his visit to villages, noticed that the problem could be solved by controlling salinity. The 'Salinity-ingress project' was started in the monsoon of 2003, with the financial help of Sir Ratan Tata Trust and Shree Vivekanand Research and Training Institute and the help of farmers. A detailed micro-level plan was prepared.

- A check dam to be built in a rivulet at the cost of Rs.7 lakh
- Take water to the lake through the canal
- A local committee was formed. Villagers were encouraged to join the effort and the project started.
- The committee of farmers was registered. It supervised the work
- The local committee was assigned the task of maintenance of the structures, the distribution of water and its judicious use.
- The work was finished before the monsoon of 2004. The rainfall recorded was 400 mm

Results

- Beneficiary farmers' families - 17
- Total accumulated water - 1,03,792 cubic meter
- Benefited areas - 47,48 acres
- Crops sown : Cotton, Pearl millet, wheat, Lucerne, carrot
- Produce/production from 47.48 acres: - Cotton (8.66 acres) - 8992 kg
  - Pearl millet (8.63 acres) - 13780 kg
  - Wheat (2.19 acres) - 32380 kg
  - Jowar (fodder 8.00 acres) - 13800 kg
  - Lucerne (fodder) (20.00 acres) - 1500 kg

Lessons learnt

A great deal was learnt in this experiment done, South of Zarpara

- It was not possible to impact water
  - either for farming or drinking
  - lesser than 20 to 25 feet in the areas near seashore but it is possible to control salinity ingress
- There should not be overcrowding of wells in these areas
- Farming should not be expanded haphazardly
- As the quantity of water declines, seawater enters those layers, turning water into saline water. Hence, drawing of water by pumps should be restricted/banned. The width of a river or a rivulet can be seen more in these areas.
- The location of a check dam should be carefully selected because it is difficult to cold storage structures considering the height of the banks.

The challenge lies in controlling salinity both on ground and underground. This can however be done by the community through disciplined and joint efforts.

It is possible to sort rainwater. It is also possible stop salt water mingling with water by constructing a bund. There are two uses (1) farming should be done in such areas using wells as an irrigation source, as wells provide the benefit of recharging (2) Lift irrigation should be undertaken from the lake only.

The most important thing is to estimate the water balance, the availability of water from the catchments areas and ensure judicious use of this water. If the requirement is more, the water balance can be maintained by using water-saving techniques and

reducing the farming areas. This experiment raised the spirits of farmers.

The problems of difficult terrain can be solved by adopting technology and through the joint effort of the community.

Kemtharpur – Village Mundra – Kutch

Saline Area, Saline Water, Drip System

Mundra Taluka: Salinity here has increased due to proximity to sea. Farming is no more remunerative. Efforts are on to prevent this salinity. The Vivekanand Research and Training Institute accepted the challenge. The objectives were,

- Prevent salinity due to sea water ingress
- Develop farming in this area and
- Make arrangements for water access for irrigation

Experiments 'to improve upon the salinity" and 'drip irrigation system' were undertaken.

Dates, mangoes, guava and sapota were cultivated. The organization explained the benefits of accepting the "Drip System' to the farmers. Farmers were worried that the 'Drip system" would not be enough and trees would dry up in the course of time. It was then decided to take the farmers on visits to places where these experiments were being carried out.

Farmers were taken to the farm of Shri Vikram Sinh Jadeja, a leading and progressive farmer of Khedoi village in Anjar Taluka, where the 'Drip System' was used for guavas (on 10 acres) and mangoes (on 5 acres) of land. Farmers presented their problems and got satisfactory replies. Their faith was revived in the Drip System.

Ten farmers from Dhrub, where there is estimated 5000 to 5500 TDS water, fixed the 'Drip system'. A small beginning was made in the new date plantation – land was not very hard and small date plantations required less water.

Such a system was also installed in a farmers' orchard in Kemtharpur, where the land is full of and there are 20 years old Sapota trees. The farmers did not have faith in the beginning, but they also agreed to adopt the system. They were provided detailed guidelines on installing and using the Drip system.

Gradually, moisture gathered in the land because of organic manure and bio-mass. Today the farmer is more than satisfied. Their trees are stronger, productive, attractive and water is saved.

TRANSFORMATION OF DAHOD-GUJARAT

Dahod is a remote tribal district in Gujarat with a difficult terrain

Prior to 1974

It was the poorest district in the country and drought prone.

- The tribal villagers migrated every year after monsoon
- The irrigation coverage was just about 5% in reality compared to 10 % on records.
- Agriculture yields were poorest with predominance of Maize crop and milk production lowest despite high cattle population.
- Literacy rate very low.
- The undulating terrain was barren land with hardly any tree cover, no forests in the designated lands or any other farm of cultivation.
- Most of its forest land has without tree cover
- No horticulture, vegetable or floriculture

In 2010

- The same desolate area achieved food security, the housing conditions improved
- School enrolment and attendance increased manifolds
- 68000 ha of land were brought under irrigation. 17000 wells re-charged and the irrigation coverage rose to around 30 %
- 700 community water resources developed & were managed by 325 village level irrigation cooperative societies.
- 2,700 village institutions - users groups managed their affairs & assets

- 65 rivers and rivulets were made perennial through series of structures connected to lift irrigation system and the migration dropped to 10-15 %
- Cropping pattern changed with introduction of horticulture – mangoes, floriculture, roses and vegetable crops.
- six crore trees planted with 50 % survival at long run
- About 25,000 farmers opted for horticulture with average income of Rs.50,000/- with continuous increase in income of poor families also.

Socio-economic- ecological impact - The Sustainable Development was achieved by initiative taken by Jagavats of Sadguru Development Foundation promoted by Shri Arvind Mafattlal in the early seventies. Their efforts were converged with the Government programmes and promoted local level initiatives and leaders to manage their own affairs. The end result is an increase – continuous increase in income of families, food security, nutritional security, financial security, fodder and timber are available in their vicinity along with water. Reduction of pressure on forest, reduction in drop out in school, higher education for the girl child and a healthier life, stable/ pucca house, drastically change in number and days of migration, empowered and confident community, transferred into a drought proof area.

MANAGEMENT OF AGRICULTURE AND CATTLE WASTE COMMUNITY BIOGAS PROJECT – CHHOTA UDEPUR

The cow-dung and agriculture waste are the major cause of Mythane

The Chhota Udepur, a remote Tribal Taluka saw a major community initiative in which about 3 to 4 slurry was utilized appropriately. It network of gas pipelines was laid for supply of gas to all of households.

- A Community biogas plant set up after interaction with village community. The State Government provided financial assistance though a registered cooperative society in the village.
- Animal holder paid price for cow dung per kg. Per month Rs.200/- for gas connection - 70 householders.
- A Vermicompost was bed set up and slurry used for it. Liquid slurry is not marketable but when it converted into vermicompost, and transported to urban centers in bags after meeting local demand. Thus it becomes marketable product, which is the key to success of the project.
- The gobar and Agri waste emanates methane gases which affect environment but converted in Biogas has different value addition to environment and is a solution to problem.
- The Shroff Foundation took this initiative with convergence of resources and efforts and participation of local community. In fact such efforts needs to be incentivised as we have agro wasted and cow dung in all our villages which is in-efficiently used either as a fuel or fertilizer.

BIOGAS PROJECT – CHHOTA UDEPUR

COLD DESERT – SELF SUSTAINING VILLAGE NANG – LADAKH, J & K

Other NATIONAL Case Study
GREENING OF LEH VALLEY *

Cold Desert – Nang – Ladakh – how a Self sustaining village J&K

Army needed regularly a huge quantity of vegetable daily at Ladakh – where it has a big base. The DRDO with Dr. Pillai CEO, DRDA took an open initiative to green Ladakh that is a barren land, with community efforts and involving Armed forces with local population.

- The Field Research Laboratory (FRL) (DRDO) introduced the village co-operative as a vehicle
- Activities undertaken were
    - Water Harvesting (3 reservoirs)
    - Afforestation in 25 ha. waste land
    - Potato seed Production for Leh
    - Greenhouse Cultivation in the valley
    - Introduction of improved Agro-technology &
    - Machinery
- Within two years, with these initiatives annual income from Rs. 2200 to Rs. 44OO per family per season
    - Large Scale Afforestation
    - Valley is covered with snow in winter but is lush green in summer Fresh Vegetables Armors Co-operatives supply vegetables worth over Rs. One Crore Annually to army . The leaf and vegetables are also available
- Surplus Production 50 % beyond army requirements now used locally

GREENING OF LEH VALLEY

Climate Resistant Agriculture - Rajsthan & Andhra Pradesh

Prof. M S Swaminathan, the veteran scientist has set up Swaminathan Research Foundation which is working on climate resilient agriculture on many part of our country. Dr. R R Nambi Director of the Institute describes its approach as under for its projects in Rajasthan and Andhra Pradesh.

Catalytic Interventions

- Design of Cropping system based on appropriate
- Promotion of locally suitable best practices

- Establishment of Village level Agro-meteorology Observatories
- Training of 'Climate Risk Managers'
- Training of Panchayat leaders / Village Sarpanchs
- Development of a training module for Extension Agents in collaboration with MANAGE, Hyderabad
- Awareness
- Strengthening of Village Institutions

Land use based interventions

- Control of erosion losses –sloppy land treatment
- Crop advisory based on weather forecast
- Development of cropping systems based on weather codes
- Testing of option sets (SRI, mixed cropping, varietal trials)
- Treatement of alkaline soils
- Kitchen gardens for nutritiona

Learning Hypothesis – Land Use: Updated village level land use maps and a basket of option sets for different rainfall scenarios (drought, normal, excessive) can provide information for appropriate agronomic practices that can stabilize yields from rain fed farming thereby providing greater food and/or economic security

Activity	Output	Outcome
Best practice – System Rice Intensification (SRI)	• 30% Reduction in water usage as compared to conventional method • 20% Increased productivity	• 52 Rice farmers (60 acres) adopted SRI against 150 rice growers
	Output indicator	**Outcome Indicator**
	• Quantity of water used for crop duration • No. of productive tillers / hill, no. of grains / panicle and test weight.	No. of acres and farmers under SRI

Benchmark	Conventional submergence rice was practiced

Water based interventions

- Lining of irrigation channels
- Reduction of irrigation intensity
- Groundwater monitoring
- Strengthening water harvesting structures / revival and restoration of traditional/community based water conservation measures
- Revival of traditional harren System
- Formation and revitalization of water user

Learning Hypothesis – Water: Community's access to weather monitoring and prediction data combined with community managed water resource systems can lead to greater water use efficiency and improve adaptive capacities

Activity	Output	Outcome
Lining of Harren, awareness & capacity building	Year - 2007 •780m lined channel (Harren) constructed •24 acre area brought under irrigation •41 farmers irrigated wheat crop, 6 times/crop	•Group of farmers evolved norms for efficient water use
	Output indicator • Length of water channel lined • Area brought under irrigation and No of irrigation provided	**Outcome Indicator** • Ability to manage the irrigation channel by functional group • Increase in water productivity • Time saved for irrigation
Benchmark	During 2006, 0 m lining, 39 farmers irrigated wheat crop in 20 acre area by using 6 irrigation	Rainfall 2006 – 1158mm 2007 - 566mm 2008 - 672mm

Mangrove Conservation

- Started in Tamil Nadu in 1996
- Extended to all the major mangroves of the east coast of India

Tamil Nadu	2 Sites
Andhra Pradesh	2 Sites
Orissa	2 Sites
West Bengal	1 site

Mangroves: Development of restoration method

- Pichavaram mangroves;
- Reserve Forest in 1897; managed by Forest Department
  – British and Indian
- Working plans available since 1897; degradation started 1930s
- Attempts to restore them could not yield much result
- Started working on restoration in 1993 - 55% degraded

Before restoration 1998

After restoration 2004

PUBLIC PRIVATE PARTNERSHIP

A project for Sustainable Dairy Technology Education

SMC College of Dairy Science, Anand Agriculture University, Anand.

The Genesis

University Provided 20 acres land for the Dairy and Students' hostel.

NDDB, Anand

- Provided necessary financial and technical support

KDCMPU Ltd. (Amul Dairy), Anand

- Provides raw milk and market for sale of liquid milk

GCMMF Ltd., Anand

- Marketing the products manufactured by Vidya Dairy under 'Amul' brand
- Under Section – 25 of the Company Act (1956)

  Acquired status of Company in 1998

Modality for Hands-on-Experience

The entire Dairy operations have been divided into several modules including: Milk Processing, Cleaning-in-places (CIP), Milk packaging, Cheese and fermented milks, Ice cream, Butter and ghee, Quality assurance, Engineering services and plant maintenance, Vidya shoppe (a retail outlet of the dairy, Commercial function, Marketing and dispatch, MIS automation and house keeping, students are trained in all disciplines, A training of 10 days is arranged at Mansingh Institute of training, Mehsana to enhance the knowledge of engineering, Students are also sent to Amul dairy for 7 days to gain experience in milk powder and chocolate production. Trainings are also arranged for the students regarding, ISO, HACCP, TQM, HOUSE KEEPING etc.

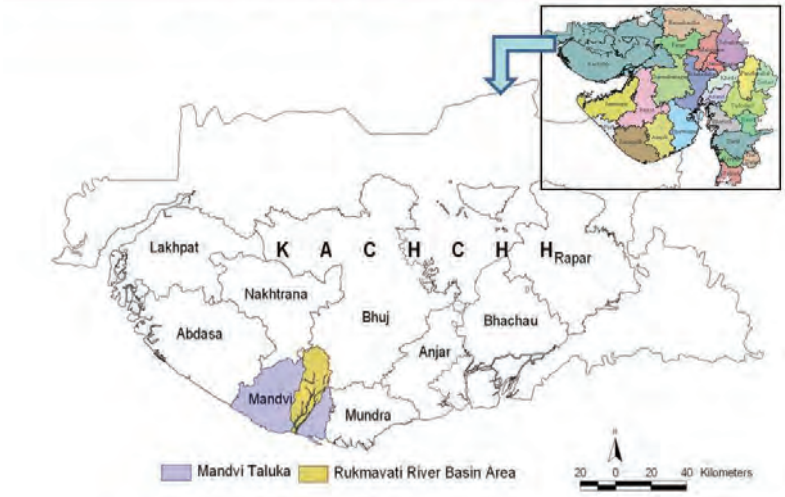
THE PRODUCTS

PRODUCTS	UNIT	CAPACITY PER DAY
MILK	LITRES	1,00,000
GHEE	KGS	1,000
ICE CREAM	LITRES	8,000
PANEER	KGS	650
CHEESES	KGS	1200
CANDY	PIECES	2000

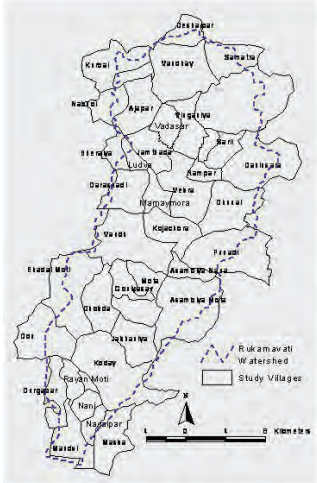
PUBLIC PRIVATE PARTNERSHIP

SUSTAINABLE DEVELOPMENT & AGRICULTURE
INTEGRATED RIVER BASIN MANAGEMENT (IRBM)

RUKMAVATI RIVER BASIN



BASIN AREA PROFILE



No of Villages	46
Total population	108033
Total Area	59075 Hac.
Total Agricultural Land	33477 Hac.
Irrigates Land	10268 Hac.
Cultivable Wasteland	5649 Hac.
Forest Area	4282 Hac.
Other Land	15671 Hac.

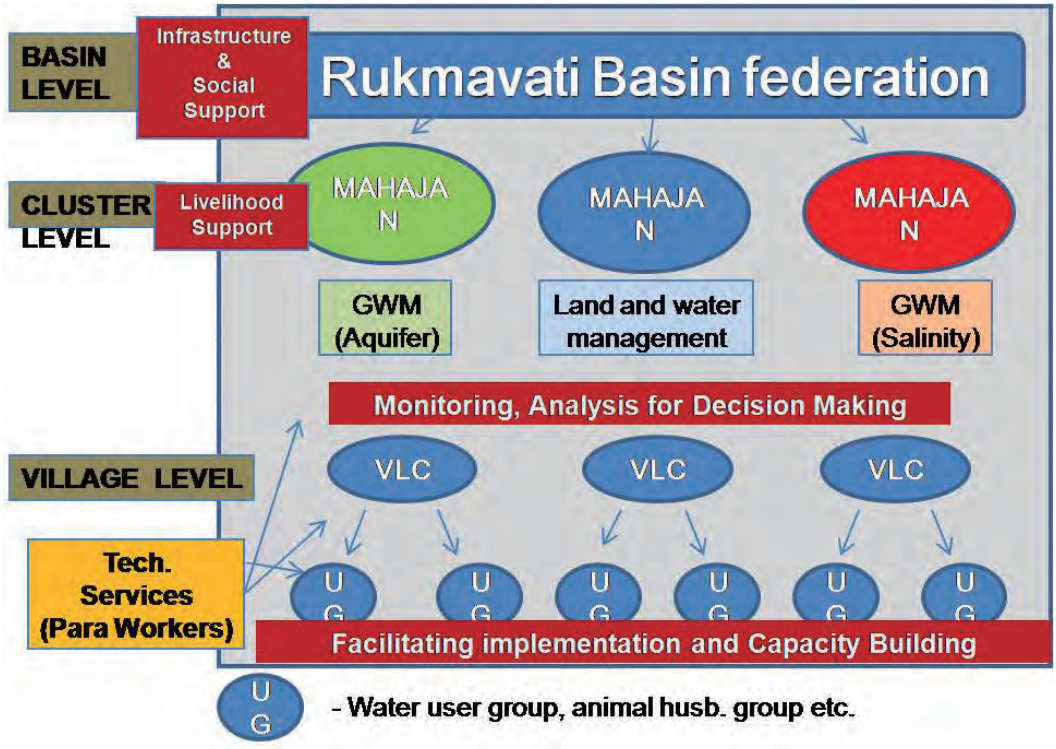
RIVER BASIN MANAGEMENT

One of the Approaches :

The important area which causes concern is depletion of water resources. We have depleting water resources. Hence, major initiatives are necessary to combat this issue.

The Integrated River Basin Management can be one such approach. It is bigger step from existing watershed approach and its process of coordinating conservation, management and development of water, land and related resources and agro industries across sectors within a given river basin."

An integrated approach using the whole River Basin as a basis for holistic & sustainable planning, can provide a good solution to ensure Economic, Social and Environmental sustainability and ensure Food & Water security and generate wealth in rural areas through value addition by local processing of Agri-produce and remove disparity



A Case Study – BASIN MANAGEMENT

Rukmavati River Basin – Mandvi – Kutch district - Gujarat

Aim:

- Create an integrated and sustainable development model on Rukmavati river basin

Objectives:

- Understand potential of various natural resources like water, land, vegetation etc. within the basin.
- Educate the stakeholders about the situation
- Understand issues and challenges of the river basin management
- Institutionalize decentralized and people centered resource management mechanism
- Generate economic well being along with human well being and environmental well being
- Manage micro climate in the basin area

Over flowing check dam in basin area

Approach & Methodology

There are four phases of the entire project:

– Community Awareness

– Planning

– Implementation

– Management

However there is overlapping of activities of these phases

Major problems

- Due to over exploitation of ground water, Mandvi block is declared as dark zone
- Ground water quality is degraded i.e. TDS - 3000 to 10000 ppm
- Degradation of agricultural land and reduced productivity
- Soil erosion in basin area due to mining activity
- Due to unequal allocation of resources like water and land, difference in socio economic condition

Activities

- **Water Harvesting**
  - Check dam
  - Renovation of old structure
  - Desilting
- **Soil moisture conservation**
  - Continuous Contour Trench
  - Staggered Trench
  - Silt Trap
  - Farm pond
- **Agriculture/ Horticulture**
  - Farm bunding
  - Land leveling
  - New Plantation
  - Drip irrigation

- **Forest area development**
- **Animal Husbandry**
  - Grass land development
  - Cattle feed units
  - Milk collection units
  - Veterinary services
- **Training and awareness**
  - Farmers training
  - Women - Self Help Groups (SHG)
  - Workshop/Seminar
  - Exposure visits
  - Rural industrialization
  - Promoting locally & Marketing
  - Promoting young educated farmers to set up micro-enterprise.

Impact

Improvement in Agriculture

- Improvement in crop productivity due to improved water quality.
- About 250 hectares of land benefited and there is about 10-15% increase in crop productivity (cotton)

Achievements

- Implementation Phase:
  - Desilting – In 9 structures, 2.8 MCFT water storage. 200 hectares of land benefited from this fertile soil.
  - Roof Top Rain Water Harvesting Structures – 19
  - Distribution of Kitchen Garden kits - 100
  - Compost preparation using 'Madhyam' - 13
  - Animal vaccination – 1691 animals
  - Formation of SHGs – 21 (301 members)
  - Exposure tour - 6

Forward & Backward linkages for A&H

- CFC – 6 – 273 members
- Average monthly cattle feed sale – 750 bags

- About 5 to 8 % reduction in cattle feed cost
- Linkage with dairy for milk collection
  - Villages – 12
  - Members – 522
  - Milk collection – 4050 lit /day
- Increase in milk price – 20 to 30%

Improvement in water quality

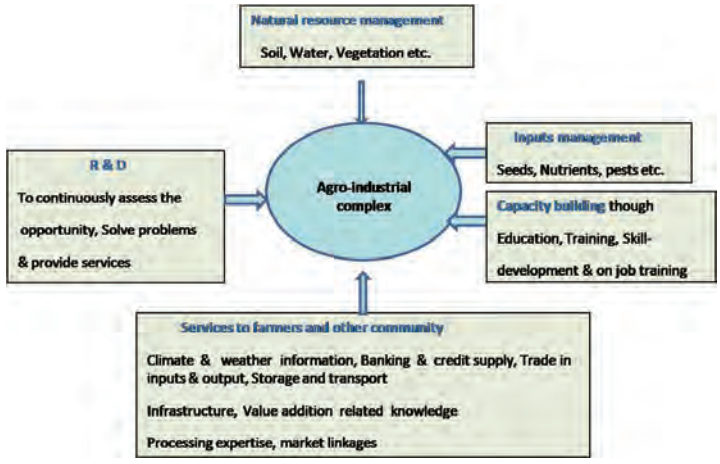
- 54 bore wells were set for monitoring around 18 structures
- Water samples here collected from monitoring wells show the following result

TDS (ppm)	Minimum	Maximum
Pre monsoon	882	9080
Post monsoon	326	4180

- TDS (ppm) value reduced due to ground recharge from 190 ppm to 6815 ppm

pH	Minimum	Maximum
Pre monsoon	7.14	9.14
Post monsoon	7.06	8.81

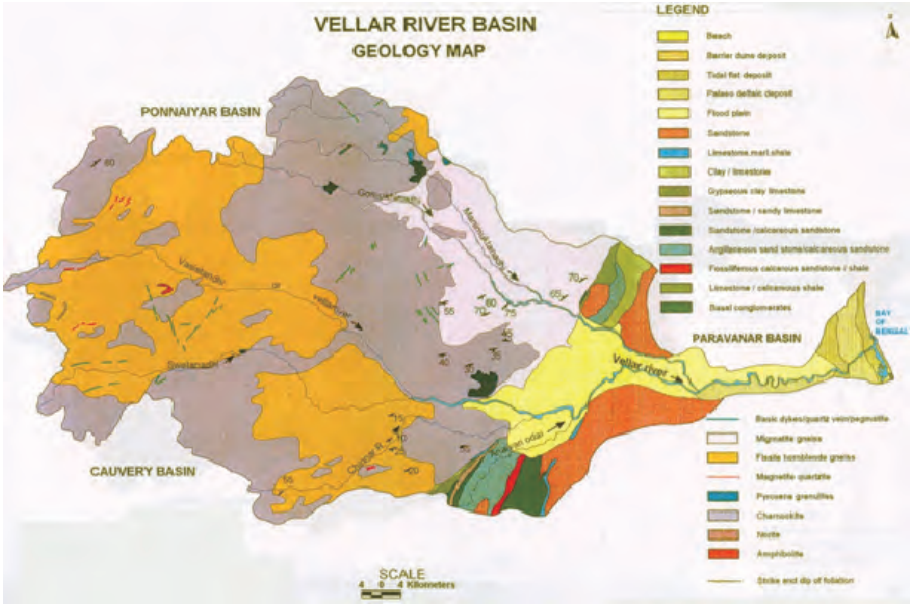
- pH value reduced due to ground recharge from 0.11 to 1.21



All this with farmer and his family particularly young members at centre of activities both for individual activity on their own farm and in community efforts combined with Government Schemes. The initiative is taken by Vivekanand Research and Training Institute – (VRTI), Mandvi to make this happen.

Integrated River Basin Management

The problem in South



The Vellar River Basin: One of the 17 major river basins of Tamil Nadu. The Western part of Vellar river basin receives significant rainfall during south west monsoon Due to elevation (1300 m) and Compactness of hard rock, surface water goes as runoff to the eastern sedimentary formation. Despite this, there are problem of scares of water resources and summer or impact on crop if there is timely rainfall.

Due to compactness recharge is not possible in the western and central portions as geological conditions and geomorphologic conditions are not favorable. But a comprehensive river basin management can solve the problem.

In the upstream side of western part of the river basin artificial recharge structures like check dams percolation ponds, recharge pits needs to be constructed to retain water in upstream side so that south west monsoon water will not go to down.

In the Eastern side the water level could be lowered for irrigation purposes so that Northeast monsoon rain water will reach the aquifer and recharge.

By these procedures the surplus water running to the sea could be prevented. Heavy water logging in the coastal region can be avoided. The link between salty water, nutrient and water management for locally adopted agriculture could be undertaken. The solutions are known however combined initiative of Government, Local Administration and Community, NGOs needs to be mobilized to make it happen through River Basin Management.

CONSUMPTION OF CO2 PER HECTARE

- If a hectare of soil 33.5 cm deep, with a bulk density of 1.4 tonnes per cubic metre is considered, there is a soil mass per hectare of about 4,700 tonnes. (Tony Lovell)
- If appropriate management practices were adopted and these practices achieved and sustained a 1% increase in soil organic matter (SOM), then 47 tonnes of SOM per hectare will be added to organic matter stocks below the soil surface.
- This 47 tonnes of SOM will contain approximately 27 tonnes of Soil Carbon (I.e. 47 tonnes at 58% Carbon) per hectare.
- In the absence of other inputs this Carbon may only be derived from the atmosphere photo-synthetic process. To place approximately 27 tonnes of Soil Carbon per hectare into the soil, approximately 100 tonnes of carbon dioxide must be consumed out of the atmosphere by photosynthesis.
- **A 1% change in soil organic matter across 5 billion hectares (estimated waste land in the world) will sequester 500 billion tonnes of Physical CO2.**

(Tony Lovell – Soil Carbon P/L Australia)

THE INTERNATIONAL VIEWS

The American Perspective

- Agriculture can
  - Remove CO2 from the atmosphere (via photosynthesis)
  - Store carbon in soils &
  - Reduce emissions in other sectors by displacing fossil fuels with bio-fuels.
- Through agricultural best management practices, one can reduce emissions of
  - nitrous oxide from agricultural soils,
  - methane from livestock production and manure &
  - CO2 from on-farm energy use.

(Ref: Keith Paustian et al 2006: Pew Centre: Multiple benefits through mitigation / offsets)

IN THE UNITED STATES OF AMERICA

- About 70 to 220 MMT of carbon could be stored in (U.S.) agricultural soils annually If farmers widely adopt the best management techniques.
- With nitrous oxide and methane reductions, these mitigation options represent 5 to 14 percent of total U.S. GHG emissions.
- To achieve maximum results, however, policies must
  - Attract farmers to
    - Adopt practices that increase soil carbon
    - Efficiently use fertilizers, pesticides, irrigation, and animal feeds.
  - Ensure funding to improve the measurement and assessment methods for agricultural GHG emissions and reductions, including expansion of the National Resource Inventory.

PARLIAMENT (2009)

- Affirms that EU agriculture can contribute to the Union's mitigation. The Objectives are to:
  - promote carbon storage in soil
  - develop production of sustainable renewable energies & ;
  - reconcile economic, social and environmental imperatives with the natural potential of each ecosystem
  - provide information, training and incentives – practices that limit GHG emissions and/or fix carbon, including

- simplified cultivation techniques that provide plant cover (such as reduced or no-tillage / leaving crop residues on the ground)
- facilitate intercropping and crop rotation,
- maximize photosynthesis &
- help enrich soil with organic matter

The European Common Agriculture Initiative (2009)

- Will offer financial incentives for EU farmers to implement agronomic adaptation measures in each region that will
  - Optimize water resource management (more efficient irrigation systems, hillside reservoirs, etc.)
  - Choose crop varieties
  - practice crop rotation according to drought and disease considerations;
  - protect the soil from water and wind erosion by ensuring organic matter content;
  - plant hedges or wooded areas on the edges of farmland to retain water, limit runoff, act as windbreaks and provide shelter for crop auxiliaries such as pollinating insects
  - monitor and control insects and disease

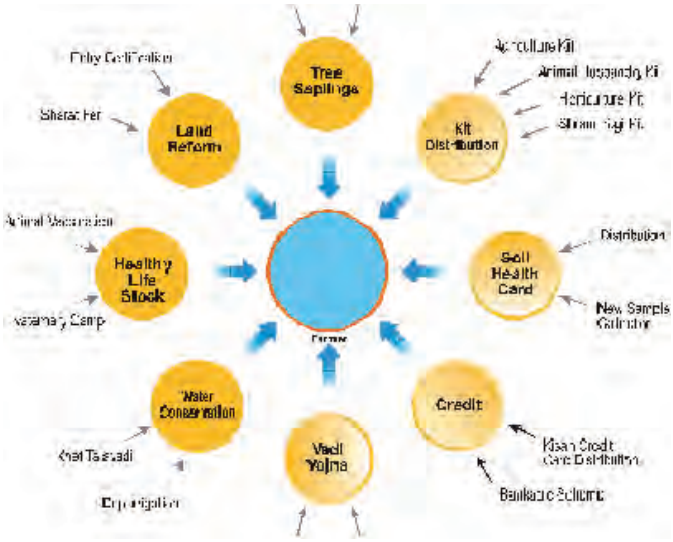
THE GUJARAT STORY

THE GUJARAT EXPERIENCE
SUSTAINABLE AGRICULTURAL DEVELOPMENT

Gujarat is a state situated on the west coast of India. Diverse in its topography, it boasts of a 1600 km coast line and is home to the largest desert in the country known as Rann of Kutch. The state has all possible handicaps faced by agriculture such as 70% of agriculture being rain-fed, recurrent droughts, untimely/irregular rainfall and some areas receiving rain only three to four days in a year. Gujarat's agriculture suffered heavily whenever there were droughts. The growth rate of agriculture used to be negative during such years. In a normal year, the agricultural growth rate used to be 2 to 3%. Agriculture was not sustainable in many parts of the state due to recurrent crop failures. However, this is a story of the last millennium.

In the new millennium, Gujarat, with determination and persistent efforts, changed the agriculture scenario. From 2004 onwards, agriculture witnessed a major turnaround with a growth of 11% per year. The state became a front-runner in agricultural production in the country. This turnaround became possible due to certain effective experiments and steps taken by people on the basis of the experience of Pujya Kaka mentioned earlier, government's experience and that of agricultural universities. Such successful experiences did not remain specimen or model projects, but became a base to launch an overall initiative in all 18,000 villages in the state, known as "Krishi Mahotsav". The author was responsible for developing this new extension approach.

NEW EXTENSION APPROVED - GUJARAT-1

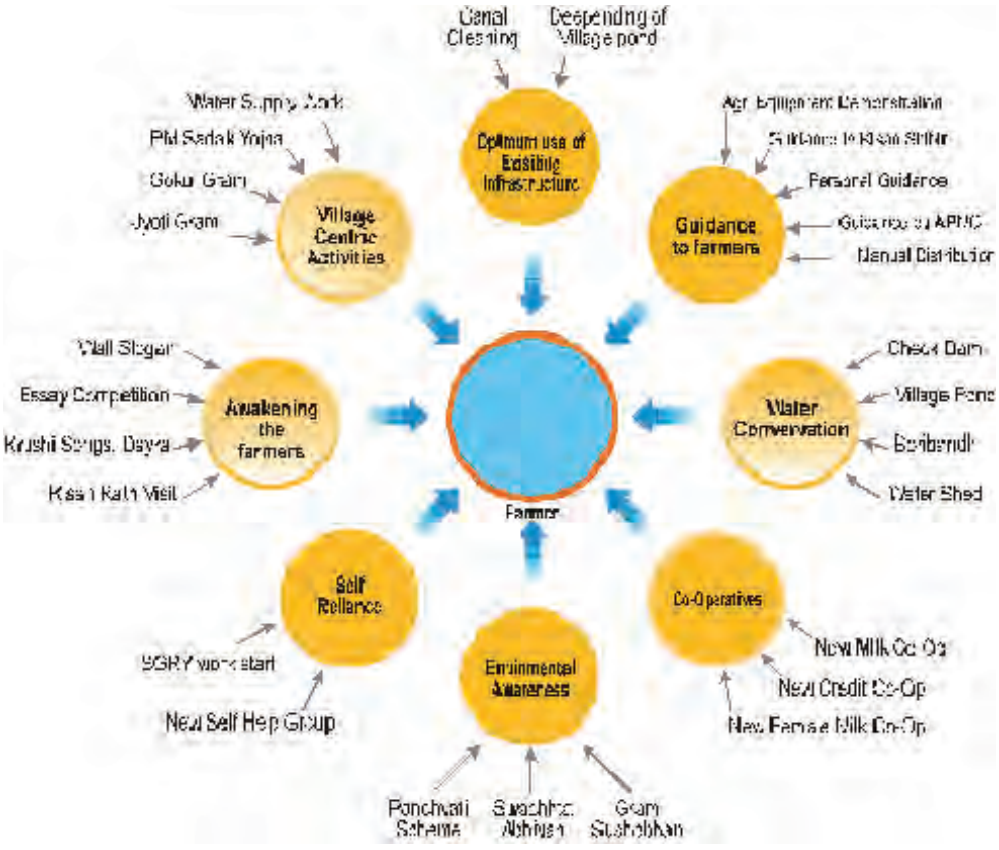


The key to this success was direct involvement of public leadership both elected and non-elected members of Public Governance System. Effective soil and water management and proper land use by using mass communication approach-based, micro level management model was introduced. On the water front, more than 100,000 check dams got constructed. In the last decade, the numbers of check dams were only 6000.

It inter-linked rivers such as Mahi and Sabarmati. These rivers, in turn, were linked with Narmada and Mahi canals. In its rain-starved areas, such as North Gujarat and Kutch, a special scheme for irrigation known as "Sujalam-Sufalam" was introduced.

Scientific agriculture was introduced by distributing Soil Health Card to every farmer. From 2004 onwards, 50 farmers from each village were given such cards every year including soil moisture analysis and past five year's average market price of the crop grown in their area. This helped them make informed choice in the selection of crops. Farmers now sowed crops that gave them higher return and were sustainable in the soil of their farms.

FARMESRS FIRST - 2



A direct door-to-door extension programme for guiding the farmers at village level was introduced under a pre-Kharif (pre-monsoon) programme, known as :Kirishi Mahotsav'. Every village was visited by a development team comprising agri-scientists and officers from the veterinary department, co-operative, irrigation department, rural development department and local banks etc. High-yield crops were identified. The farmers were guided about using certified seeds and looking at price of APMCs before selling their farm produce.

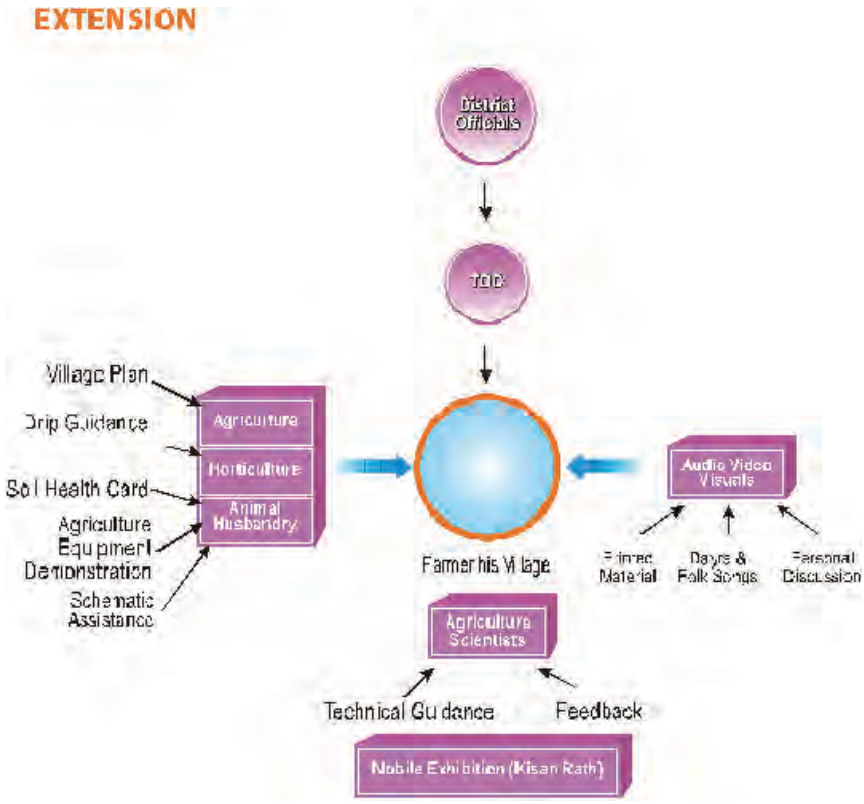
Bhaskaracharya Institute For Space Applications and Geo-Informatics, a institute set up in collaboration with Space Application Centre (SAC), Ahmedabad, by the Government of Gujarat, prepared a micro-level plan for land use by identifying sites for check dams and village ponds for every village.

Information and Communication Technology material was made available to the farmers in their mother tongue for crop management, including use of fertilizers and pesticides.

Free telephonic help lines were introduced to answer the queries of farmers.

All these initiatives were backed by total involvement of public leadership, both elected and non-elected. Chief Minister village Sarpanch, the Chief Secretary village level worker,

EXTENSION



voluntary agencies, input dealers and co-operatives and bankers – representing the rank and file of institutions were involved in the projects.

The join initiative brought about sustainability in Gujarat agriculture, bringing about overall growth in all important crops and an increase in the per capital income of the average farmer. The major transformation occurred in the state's most difficult areas of Saurashtra, Kutch and North Gujarat.

It is necessary that such experiences are replicated all over the country – in all its villages. The turnaround in Gujarat was due to effective public leadership. At international level, similar landmark achievement has been made by Israel – in the most difficult terrain of the world.

THE PATH AHEAD

These are stories - real life stories of success of very small people in remote villages of our country. Normally, when we talk about "success', we look at people in high echelons of the society and their achievements – The President or Prime Minister of the country, the CEOs of multinationals or large industrial organizations so on and so forth. We identify their good qualities, the way they have grown and become successful and their efforts they made to reach at top. We suggest to future generations, to follow their examples. This is certainly a need of time to prepare the future generation. But we need to remember that the majority of our people are at the grass root level, in the rural areas. They have wide range of problems despite sixty years of development. There is dissatisfaction among rural youth, their aspirations are not met with. Villages do not have infrastructure and people face all odds including added difficulties of the adverse climate conditions. Not withstanding this, we have many stories of success of people at the village level. Where the major challenge of sustainable livelihood met with successfully. There are achievers, the individuals like Desharbhai and his wife, Vikramsinh Jadeja, Hasabhai, house wives, village committees, Sarpanches – all have quality of leadership as described earlier. What is needed is to ignite their leadership qualities to face challenges and that is what Ngo Shri kantisen Shroff did in Kutch and others have done in different parts of our country.

The villages of Kutch & Dahod had several adversities, but they were turned around by local people and their leaders with convergence of efforts with government officials and programmes clubbed by dedicated voluntary agencies and local officials of development administration.

Gujarat story of developing sustainable agriculture is an extension of this, for all its 18000 villages of the State. Normally, there is criticism that when we talk about "a success story" that it is a well implemented programme at one place by some agency and that it is not replicated all over. It is an exhibition piece. But Gujarat – had – all adverse climate conditions – recurrent drought – erratic rain fall – cyclone, soil erosion – increase of salinity, water table going down, frequent failure of crops and negative agriculture growth, soon and so forth, all that is predicated to happen due to adverse impact of global warming.

In Gujarat, the public leadership, elected and non-elected members of Public Governance System worked together with all the stakeholders for making its agriculture sustainable in last few years. The key to its success is the policy of its leaders who learn from success stories from its own villages like that of Shroff experience and govt's own programmes and research by its Agricultural University's Scientist, to covert it into an Implementable programme with participation of all and got implemented well at all level. This is a remarkable example where the leaders decided and joined to make sure things happen, everybody joined together and made it happen. If this can take place in Gujarat, why not in all the states?.

A similar approach is needed today by countries, to meeting the challenge of providing sustainable livelihood or for that matter, meeting the challenges of adverse impact of Global Warming. It is the national leadership, which has to go down at grass root level to villages and efforts should happen in all the villages of a nation, with full involvement of State level leadership, district leadership, taluka leadership with people and their leaders at the village level. India has an example of doing this, under IRDP (Integrated Rural Development Programme) which was introduced in late seventies and early eighties. This programme had focused its approaches on the individual rural poor family and their need to grow economically was met with by convergence of efforts of government, financial institutions and voluntary agencies. This brought about a massive reduction in rural poverty in our country, which is a significant achievement. But still there are poor families – about 20% which have some handicaps and have been left out of development process. They need focused attention. If agriculture can be brought back into centre stage of development policy with focus on individual farmer, probably all these areas and people can be enabled to achieve sustainable development. This will generate simultaneously viable solutions to tackle challenges of Global Warming and for that matter, meet challenges due to social unrest including Naxalists, Maoist, etc. This will also provide opportunities of becoming both future and present generation and lay a path sustain such efforts on a long term basis.

THE KNOWELDGE ECONOMY

Application of knowledge is the key to bring about rapid growth and to usher in sustainable development Says Prof. Mukul Asher, Professor of Public Policy, National University of Singapore. The term knowledge Economy (KE) reflects the importance of knowledge for development process. It involves countries, organizations and people to acquire, create, disseminate and use knowledge more effectively for greater economic and social development. It includes application of successful technology of one field to another field. It provides more efficient ways of producing goods and services and delivering them more effectively and at lower costs to a greater number of people. It includes developing a market mechanism strategy for remote – rural areas – within a country and merging it into global market.

It requires transfer of Knowledge Economy from Advanced Countries who are generating most of this knowledge to developing countries, which need it because of their limited awareness, poor economic condition and weak institutions and within developing countries from its manufacturing center to agriculture sector.

Knowledge revolution has a major role to play in the meeting challenge of global warming and development of agriculture and through that sustainable development.

Indian Space Research Organization (ISRO) played an important role in using knowledge developed for betterment of the rural economy. Under the guidance of Prof. Yash Pal, ISRO introduced development communication, distant learning, micro-level planning, watershed, crop forecasting, etc for the benefit of farmers.

APPLICATION OF KNOWLEDGE ECONOMY TOOLS IN AGRICULTURE INCLUDES

- Provision of information to the farmer about farm prices by use of ICT mobile phone, TV & Radio news bulletins & web-based technologies.
- Specific product feature choice and requirements of the market (example of straight chilies, reddish tomatoes being more preferred than their ordinary counterparts so that farmers can plan accordingly to secure high prices
- Introduction of village level micro irrigation plans for Contour banding, Gully plugging, check dams and village ponds and farm ponds based data from satellite imagery.

- Development and use of cheap mass produced sensor technology that can detect spoilage in food stored particularly perishable food.
- Mapping increase in salinity, affected and eroded land, wasteland and wetlands and agricultural land reduced due to urbanization.
- Arial seeding in margin areas of descent and coastal areas.
- Developing marketing modules. If we can supply tooth paste and match boxes or cigarette at same price in all over the country, why not vegetables? Why onion are sold in Maharashtra and Gujarat at Rs.10/- and in Delhi Rs.50/-? Why only price come down after agri season is over? Expertise of industrial products supply - storage, delivery can be replicated.

USE OF AGRO-ECOLOGY AND BIO-DIVERSITY TO MEET THE CHALLENGE OF CLIMATE CHANGE

Dr. Olivier De Schutter "Special Rapporteur on The Right to Food"

The special Rapporteur on right to food presented on 19th December 2010 to UN General Assembly. Some of the important extracts are as under:

- Agroecology is both a science and a set of practices of the convergence of agronomy and ecology. It seeks to enhance agricultural systems by mimicking natural processes, thus creating beneficial biological interactions and synergies among the components of the agroecosystems.

Agroecology raises productivity at field level where in

- Many techniques have been developed and successfully tested.
- These approaches involve the maintenance or introduction of agricultural biodiversity (diversity of crops, livestock, agroforestry, fish, pollinations, insects, soil biota and other components that occur in and around production system) to achieve the desired results in production and sustainability.
- Integrated nutrient management reconciles the need to fix nitrogen within farm systems with the import of inorganic and organic sources of nutrients and the reduction of nutrient losses through erosion control.
- Agro-forestry incorporates multifunctional trees into agricultural systems.

Some of the successful experiences are:

- A recent sustainable agriculture projects in 57 poor countries covering 37 million hectare (3 percent of the cultivated area in developing countries). Such interventions increased productivity on 1`2.8 millions farms, with an average crop increase of 79 percent, while improving the supply of critical environmental services.

- Following Hurricane Mitch in Nicaragua the experiment demonstrated that farming plots cropped with simple agro ecological methods (including rock bunds or dikes, green manure, crop rotation and the incorporation of stubble ditches, terraces, barriers, mulch, legumes, trees plowing parallel to the slope, no-burn, live fences, and zero-tillage) had on average 40 percent more topsoil, higher field moisture, less erosion and lower economic losses than control plots on conventional farms. On an average, agro-ecological plots lost 18 percent less arable land to landslides than conventional plots and had 69 percent less gully erosion compared to conventional farms.
- The agro-forestry programme developed in Malawi protected farmers from crop failure after droughts, thanks to the improved soil filtration it allowed. Farm experiments in Ethiopia, India and the Netherlands have demonstrated that the physical properties of soils on organic farms improved the drought resistance of crops".
- Agro-ecology also puts agriculture on the path of sustainability by delinking food production from the reliance on fossil energy (oil and gas). It contributes to mitigating climate change impacts both by increasing carbon sinks in soil organic matter and above ground biomass, and by avoiding carbon dioxide or other greenhouses gas emissions from farms by reducing direct and indirect energy use.
- The intergovernmental Panel on Climate Change (IPCC) has estimated the global technical mitigation potential for agriculture at 5.5 to 6 Gt of CO2 equivalent per year by 2030. Most of this total (89 per cent) can come from carbon sequestration in soils, storing carbon as soil organic matter (humus), something which can be done through agro-ecology

DEVELOPMENT OF WASTELAND

The strategy is to bring non-cultivable wasteland, cultivable fallow land and marshy areas under vegetation cover by taking acue from successful experiments in India and abroad. India has vast tracks of such lands on margin areas of Deserts and inland saline areas.

Each land area has to have its own strategy for land use and soil management, based on scientific agriculture and precision farming. It has to be based on soil health and moisture analysis for selection of suitable crops and special plants and agronomy practices, micro-irrigation for water use and watershed approach for land and water management and even aerial seeding wherever needed.

It is necessary to take up this task on a massive scale. However, farmers cannot afford to invest in such waste land. A rough estimate of the cost of developing one hectare of land is anything between Rs.2 lakhs to Rs. 2.5 lakh. It is, therefore, necessary to bring in public private partnership (PPP) to sustain such projects. It can create huge employment opportunities and go along way in meeting food security challenge of hungry millions apart from creating vegetative cover which will absorb CO2 from atmosphere and make soil fertile with right agronomic practices.

USE OF WETLAND

Wetland is an area of land, where soil is saturated with moisture, permanently or seasonally or covered by shallow water.

Wetlands are equally important just like Agriculture lands as

- Main food source and Resource recycling
- Predominant occupation of two-third of working population for their livelihood residing in coastal areas.
- Scientific research & Educational initiatives.
- Recreational activities and Nature Services
- In terms of products, they are source of fish crops, vegetable & rice crops, medicinal plants and other organic products.

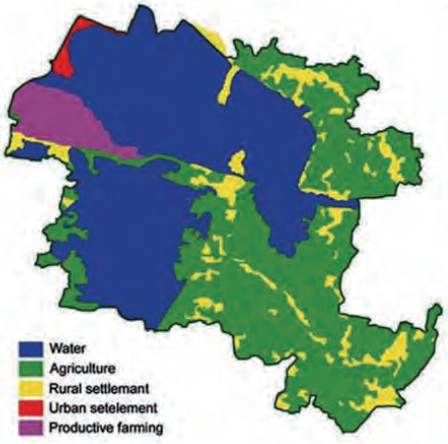
Wetlands have the highest carbon density of all terrestrial ecosystems. With the exception of peat lands, wetlands are among the most productive ecosystems in the world, and have properties that reduce the rate of organic matter turnover.

Two ways for controlling carbon sequestration are high rates of organic matter input and reduced rates of decomposition. The case of EKW is as follows

East Kolkata Wetlands (EKW), the only Ramsar site in the state of West Bengal in India. (19TH August; 2002)




Different land use classes in EKW



Land use	Area
Water body	5,852.14 ha of which fish farming roughly constitutes about 3,898.70 ha.(45.93%)
Agriculture Land	Approximately 4,959.86 ha.(38.92%)
Garbage Disposal Site	602.78 ha. (4.73%)
Urban Settlement Area Rural Area	91.53 ha.(0.73%) 1234.99 ha.(9.69%)
Total Area	12500.00 ha*

*Additionally 241.30 ha. Are being added to the system for making the system integral.

EKW through its bheries / fisheries caters to the food, sanitation and livelihood security of its nearly a lakh inhabitants by recycling 980 million Lrs of Sewage per day with a detention period of 30 days. About 150 tonnes of vegetables, 10500 tonnes of table fish per day in addition to nearly 11 Mt Tonnes of Rice per year. This intricate link of eco system productivity based on recycling and livelihood has created a favorable market mechanism that rewards conservation initiatives. This is called the Bio rights framework and is a model that can be suitably adapted in systems with comparable profiles of form and function. South Asian Forum for Environment (SAFE) led by Dr. Dipayn Dey has played catalyst role in this entire development which can be replicated.

RESEARCH & DEVELOPMENT

There is urgent need to initiate research in all our agro climatic zones on following;

- Develop crop practices under increased temperature conditions based on soil health and moisture analysis.
- Research to know absorption of CO2 and release of Oxygen by different crops, grasses, plants and trees under different agro climatic conditions; and identify plants, species, grasses, which can absorb maximum CO2 from atmosphere and from that identify plants which are suitable to urban & industrial township.
- For value addition options in agriculture particular with focus on using all parts of the plant.
- Identify crops which improves productivity with enhanced consumption of CO2.
- Tissue culture and cloning in as many varieties as possible and its rapid multiplication. e.g. banana tissue culture exists but not available for farmers all over country.
- Diagnose nutritional deficiency in plants and soils for precise application of fertilizer.
- Identifying crops which flourish in saline soil and saline water and even sea water.

- A study by Rodale Institute - United State of America has established that organic farming can play a very important role.

  In one example of organic farming, a 23-year experiment by the Rodale Institute compared organic and conventional cropping systems in the United States found that organic farming increased soil carbon by 15-28 percent and nitrogen content by 8-15 percent.

- The researchers concluded that if the 65 million hectares of corn and soybean grown in the United States, were switched to organic farming, a quarter billion tons of carbon dioxide (or about 4 percent of annual U.S. emissions) could be sequestered. (Source: Cittion: Lotter D.W. 2003, organic agriculture J Sustain Agric 21)

  The recent study by Worldwatch Report 179 by Dr. Sara Seherr and Dr. Sajal Sthapit of USA on "Mitigating Climate Change through Food and Land use" confirms that global warming challenge can be met through agriculture.

  It would help identify perennial crops, grasses, palms, and trees which maintain and develop their root and woody biomass and associated carbon, while providing vegetative cover for soils.

SPECIAL PLANTS

Vetiver Grass – Rolls Royce of Plants

Application for erosion control: India losing 5,334 million tonnes of soil annually due to erosion. Vetiver's capacity to reduce erosion and improve soil texture – trapped top soil 40cm in 30 months. Indian farmers in Mysore have been using the grass for generations for erosion control and farm boundary demarcation. Very few people realized this until the World Bank Agriculture experts intervened.

Application for Dune Stabilization: Preparation of a raised-bed banana plantation using vetiver to reduce root disease and excessive soaking during heavy rains. The roots of the banana trees move decidedly towards the vetiver roots.

Application for Organic Farming:

It helps in soil conservation and improvement. The sandy soil can be easily converted to rehabilitation using vetiver multh.

One plant – multiple benefits

- Water conservation with mulch
- Erosion control
- Soil moisture retention
- Good quality fodder – rich in protein
- Leaves & Cums – optimum for mushroom
- Helps treat wastewater

SPECIAL PLANTS - BAMBOO

Bamboo – the king of grasses and popularly known as 'friend of the people' is the fastest growing plant on earth. There are over 1250 species of bamboo and can be found on every continent other than the poles. It also grows right from the sea level to an altitude of about 13,500 feet and is used widely as a "green" material in a wide variety of products. Importantly bamboo

- Is also capable of significant CO2 sequestration because of its typically large and rapid biomass growth at 10-30 percent annually (compared to 2-5 percent for most trees)
- Can be selectively harvested in a relatively short span of 3-5 years unlike several other softwood at 10-20 years
- Helps environmentally safe and reliable disposal for excess nutrients in waste waters including the streams from livestock farming and sewage plants
- Provides its net-like root system that protects watersheds, reduces rain runoff, prevents soil erosion
- Can be grown in soil damaged by overgrazing or poor agricultural techniques
- Can withstand droughts, grows in rainfed / semi-arid regions, acts as a windbreak or shelter-belt for crops when mature and tall; allows under-cropping of cash crops such as ginger, tuberous crops and some legumes
- Supports a wide range of end products.

Conservation Tillage

- Conservation tillage is an integrated tillage system in which large amounts of crop straws are used to cover the soil and minimize all the possible tillage activities.
- Conservation tillage, which employs the technologies such as no tillage or minimum tillage, micro-terrain rebuilding, land covering, and controlling weeds with herbicides, is aimed to reduce the disturbance and increase the straw coverage to soil (Gao HW, 2005; Gao WS, 2007; Li HW, 2008).
- It is composed of four essential components (Di Y, 2008):
  - o Planting techniques without tillage;
  - o Covering soil with straws or plant residues;
  - o Deeply loosing the soil; and
  - o Integrated control techniques on weeds and pests.

Conservation Tillage – Increase in Soil Organic Carbon (SOC)

- reduce the disturbance on soils to protect soil organic matter from oxidization and mineralization
- Straw coverage adds more soil organic carbon, which means conservation tillage may increase soil organic carbon in different degrees
- affects soil temperature and moisture status, which in turn affects soil carbon stock indirectly. Soil temperature affects micro organisms' activity, and determines the decomposing speed of soil organic matter
- Different tillage practices may have different effects on micro organisms' activity, which may lead to varying accumulation of organic matter in soils.

Bio char

Bio char is the solid remain of heating biomass in an oxygen-depleted environment. Unlike the carbon found in most organic matter, biochar carbon is chemically altered during the heating process and forms in to "benzene-type" ring structures that are very resistant to attack by microorganisms. As a consequence, biochar carbon can remain stabilized for long periods of time – hundred to thousand of years – and could be an important way of storing carbon that has been scavenged from the atmosphere during photosynthesis. What is more, biochar can enhance soil health and has been demonstrated to promote plant growth in some situations.

Bio char, its proponents suggest, offers potent ways to meet pressing challenges across agriculture, climate change and energy – and moreover, to address all three domains simultaneously in an unprecedented 'triple win'. This is the 'magic' around which biochar's political economy of promise has emerged.

Sources of Biomass for Bio char

- Charcoal and ash from crop residue burnt in the fields (traditional practice)
- Charcoal produced from Prosopis Juliflora
- Rice husk charcoal – a by-product from cook stoves / parboiled rice mills
- Charcoal from cook stoves
- Other biomass

Bio char has got multiple applications and Bio char mulching has got multiple advantages

- Retention of the soil moisture, reduction of evaporation of water from the soil
- Reduction in leaching of the bio / chem fertilizers applied
- Increase in the soil microbes / worms at the bio char and soil interface
- Regulation of the soil temperature
- Suppression of weeds by blocking the sunlight the weeds sprouting and growth is suppressed.
- Repulsion of the termites / ants which might attack the live plants
- Over a period of time due to various activities the bio char mixes with the soil.
- Prevents soil erosion too.
- Can increase the ph of the soil towards neutral (mulch very good for acidic soils)

WET LAND
Rich rainwater available in coastal area

THE LIVESTOCK – BACK TO ORIGINAL BREEDS

In livestock sector, country has made considerable progress. India is a major dairy & meat producing country in the world. It adopted and introduced cross-breeding and frozen semen technology in late seventies. Global warming increase in temperature affects milk yields of cross breed animals which are quite sensitive to heat. Hence emphasis has to be back of our original breeds like Gir and Kankaraj cows of Gujarat. They are tolerant to heat, can walk long distance for grazing, and, survive even only on grass. In fact Brazil has adopted this breeds and it has largest breed of Gir cows in the world. Similarly Kathiawadi horse and Patanwadi sheep can walk long distance for grazing and survive in extreme heat condition. The focus will have to be on pure breeds and farmers may have to be given incentive to adopt them.

GIR - COW

KATHIYAWADI - HOURSE

CARBON CREDIT

There is now an international Incentive policy to provide Carbon credit for industries and organizations if they reduce emission of harmful gases as per established norms. The current policy generally encourages industries and commercial establishment.

Kyoto Protocol which is mainly for developed countries to meet their obligations to reduce emission has Clean Development Mechanism (CDM) which is the only mechanism where developing country can participate.

Meaning that developed country can provide technical and financial assistance to help reduce emissions in the developing country and same emission reduction can be considered by developed country as part of their accountability of reduction. This transaction is done through systematic process designed by United Nations Framework Convention on Climate Change (UNFCCC) and is more popularly known as Carbon Credits.

- A policy framework is required for an incentive scheme for farmers, NGOs and even to State Governments, if any may take up reduction in CO2 through agriculture/Vegetation including fisheries with special emphasis on development of wastelands and un-used wetlands. This has to be very simple. The intentional organizations need to encourage and support developing countries to take to agriculture/vegetable on all available land resources. There is a need to assimilate all available technology- knowledge experiences from all over the world and disseminate all over-with the aim that a major part of the open land to brought under cover to absorb Co2 from atmosphere and support this entire programme by raising funds from developed countries.

Urban Agriculture – Soil + Compost (75 + 25 %), excellent result

OPEN AREAS IN URBAN CENTRES

- Increasing urbanization and development of infrastructure, highways, express highways and railways has led to reduction of cultivable land.
- Due to an abnormal increase in land prices, there is an increasing tendency by land developers and now even retail investor to invest in land on the outskirts of even small urban centres or developed villages. If one looks at metropolitan towns like Mumbai, Ahmedabad or Hyderabad land obtained as an investment are spread over approximately 50 to 100 Kms on outskirts of such cities. This has a massive impact on resulting such lands as fallow land. The impact of this in atmosphere is that less and less Co2 gets absorbed- thereby increasing its proportion and creating an imbalance in the atmosphere.
- Town Planning rules need to develop a policy a certain minimum requirement of plantation of perennial crops on all such open areas and terraces of housing, business centers, Infrastructure projects and manufacturing activities even educational centres, before granting building use permission.
- Similarly whenever an agriculture land is converted into non-agriculture land, NA permission must ensure minimum level of plantation and green cover.
- It can also be thought of put aside 5% from development charges under TP scheme or from premium charges for NA permission to be allocated made available for expanding vegetative cover on waste land or wet-land for which a public-private partnership scheme could be introduced.
- Urban waste water is general discharged into adjoining river basin or sea-Technology exits to recycle such water and use it for agriculture. It should be made compulsory as urban areas are now increasing using water from 'Dams' meant for irrigation for farming.

Sow and Reap, Grow and Eat

Creating green spaces

Mumbai Port Trust Terrace garden at Victoria Dock

Presented by : Uday Acharya
Trustee, Vidya Vaaridhi Trust (Urban Leaves)

City: Mumbai
16th July 2011

URBAN AGRICULTURE

There is need to promote Urban Agriculture

- This exists almost with majority of urban households who have some open land.
- Even in the multistoried building, residents like to plant trees, grasses and ornamental plants in their apartments.
- Even people staying in the flats like to keep plants in pots in the lobby area and even in drawing room or near windows.
- But there is a gap about knowledge of agricultural practices, about plants they should grow and how to treat them. There are no urban agriculture extension centers or even Agro Service centers where such guidance could be available along with basic inputs of seeds, fertilizers, farm equipments
- People end up buying high cost ornamental plants with high mortality and then periodically replace them.
- Kitchen garden could be promoted to meet the requirements of vegetables and wherever more open areas are available, suitable local horticulture and floriculture plants can be grown. However, at present there is no government department which could be said to be responsible for promotion of urban agriculture or a policy framework to meet and / or create demand for agriculture within urban areas.
- There is a need to take urgent initiative on urban front. This will go long way in enhancing green cover in urban centres and reducing CO2 level in atmosphere.

Soil Health Card

This is the key to greener agriculture. This has to be provided to all small & marginal farmers free of cost at their door step. The card can have details of soil health characteristics and moisture content along with details of crops that can be grown depending on soil types, nutrients needed and market price of prevalent crops over the past few years. This is an inter-disciplinary task – State Agricultural Universities (SAUs) can prepare the software for crop option, nutrient requirement and market price at Central Computer Centre. The local level Extension Administration can then send by internet. The soil and moisture data of each land holding and ownership details and receive back complete data analyses through Information and communications technology (ICT). This approach already exists in Gujarat where it has successfully brought about sustainable agriculture and improved productivity of crops which already have the capacity to withstand adverse climatic conditions. This has also reduced expenses on fertilisers due to dropping of un-required fertiliser and has enhanced agriculture growth & income of farmers. This approach also envisages directing fertiliser companies to sell fertiliser on per-kg basis moving away from the present bulk packages and stringent measure against companies/persons who sell spurious seeds.

Krishi Vigyan Prasar

Krishi Vigyan Prasar is a specific need of our centre for communication of Science and technology to farmers. This can be a new centre or existing institute like Central Research Institute for Dryland Agriculture (CRIDA) could be up-graded for this purpose. This will have Knowledge Bank of :

- Existing research and development experiences existing in the different parts of the country, ICAR, SAUs, State Governments. cooperatives NGOs and both private & public organisations.
- Empirical experiences to progressive farmers.
- International experiences that exist in many parts of the world including countries like Israel, China & Japan.
- It can compile and disseminate all information related to climate change – its adverse impact, remedial measures – to all tehsils through a Centralised Computer net-working system.
- It will also have linkage with Indian Space Research Organization (ISRO), District level Meteorological stations of Ministry of Earth Care and could track details of local level changes in climate and pass it on for analyses and feedback to research stations of different crops of ICAR and SAUS. This centre can be a link with SAUs and KVKs ATMA and Local level State Extension Services. This can in turn be linked directly with village based computer networks wherever feasible.

Village level Extension

Strengthen extension services to sensitise farmers about impact of climate change at the village level by team of Agri. Scientist and local agric and veterinary extension team. This could also involve the local non-Government organizations, APMC (Agricultural Produce Market Committees), Cooperatives, Self Help Groups, dealers of inputs and the traditional Village Level Workers. This can complement action considering the fact that

- Farmers below poverty line need to be provided certified seeds without any cost at least once in five years.
- At present they use their-own produce year after year and hence productivity is low
- Focus on providing assets through credit to poor farmers individually, through programmes of Small & Marginal farmers development Programme.
- Traditional Extension Services Involve VLW who most often are now involved in multifarious activities. Often they are not agriculture diploma holder. They only provide knowledge about production. But the need is (a) choosing right crop

which can sustain itself based on Soil Moisture and Health Analysis and Market price (b) to provide information needed on market requirement including packaging (c) understanding about impact of climate change and use of eco-agriculture and bio-diversity. Specific attention needs to be paid for women who are now increasingly responsible for farming as men go out for earning under NREGA.

The key is the fact that the farmers need extension support prior to Khariff. Our country has a large number of scientists engaged through the under Extension Education of SAUS, Kisan Vikas Kendra (KVK) and different centers of ICAR in all the states of our country. It must be ensured before pre-khariff season i.e. in the month of May, Scientist along with extension team of district level, consisting of VLW extension officers, APMC representatives NGOs, progressive farmers and Bank visit village and interact with farmers at village level, answer their questions and guide them about crop they need to take based on soil health and moisture analysis and change in climate that has already taken place. This can be followed by regular interaction on local cable T.V/Internet/Telecommunication-mobile-phone-sms and toll free phones for the rest of the season. Again prior to Rabi crop, similar exercise need to be undertaken of direct contact at the village level. Radio FM stations to provide information market price of AMPC on day to day basis.

- The farmers also need to be linked with new supply and value chain of retail market of vegetables and grains set up across the country by private players. Establishment of cold chains i.e. cold storages and refrigerated trucks, especially for perishable crops, on Private sector / cooperative / PPP model needs to be promoted, to minimize post harvest losses. The Energy for cooling should preferably be renewable energy – based on Agro Waste, Solar, Wind etc. refrigerated trucks can be powered by solar panels mounted on truck top / sides. All ready successful experiences exist-they must be institutionalized.

North East Region Climate Resilient Agriculture

North East region of our country has abundant potential. It possesses unique and large water and forest resources – Majority of farming is organic and has the potential to meet the country's demand of fruits, flowers, vegetables and herbs. However, there are constraints. Despite heavy rainfall – water runs off and results in heavy soil erosion. With increase in temperature, the requirement for water is simultaneously growing. Bio-diversity is in danger due to germ-plasm piracy across borders. The actual potential for diverse use is yet to be fully explored. There is little or no involvement of public governance system to address the plight of poor farmers or meeting aspiration of young and educated farmers. This is could be a cause of social unrest-that currently prevails in these area.

ICAR Research Complex in Meghalaya with its sub centers has done outstanding research and development work. This is with reference to regular development and to meet the challenges of climate change impacts. Scientists have studied these impacts and prescribed solutions. The transfer of these successes to the entire region by local level administration is a major up-hill task. Same is about use of water harvesting techniques from watershed to river basin and river valley management and pumping water from low level water bodies. It needs an integrated research cum development approach with special resources allocation directly under supervision of the Planning Commission. Some of the priority areas for Research, Development and Education in this context could be:

(a) Potential of Biodiversity to make agriculture sustainable – e.g. identify crops which can stand-up high velocity of water during monsoon.

(b) Suitable adaptation of experiences of conservation of water resources by community ponds, farm ponds and pumping water from lower level water bodies and river basin and river valley management. This could be true for other interventions too.

(c) Multi level skill development for youth with focus on agricultural operations. Setting of Seed Certifying Agency and Seed Corporation and Agro industries Corporation for Agro processing and Agri Produce market yard (APMC)&

(d) An integrated development plan for each of North-Eastern States which can be monitored directly by Planning Commission.

Small Farmer Development Agency

One of the main reason of slow and tardy growth in agriculture is that small farmer is forgotten. In seventies this was realized after green revolution and the special SFDA (Small Farmer Development Agency) was set up in selected districts of the country. Later on, this was converted into Integrated Rural Development Programme (IRDP) for all districts of the country. Special programme implementation agency called District Level Rural Development Agency (DRDA) was set up in every district. It was focus on individual poor family and this was a great success not only for technology transfer but also for provision for much needed assets. But Rural Development Ministry moved focus to non-farm activity and original focus on small farmer has been lost. Small farmer own 80% of farmland and unless they become profitable by enhancement of productivity and reduction of cost overall growth will tardy. Hence there is need to revive SFDA but it has to be under the Ministry of Agriculture at central and state level.

The new SFDA needs to be more of scientific, technology and information communication organization linked with proposed "Krushi Vigyan Prasar". It should have an integrated management and Programme pool and soil moisture analysis facilities. . It can also provide small farmers

a. Soil & Moisture analysis card

b. Crop related guidance including market price & quality of product in demand

c. adaptation measures needed for changed climate and obtain information related to its impact

d. Link to supply chain for inputs and demand chain for their products; disburse subsidy including free inputs and provide link with Banks – Kisan Credit Card.

e. Implement door-step approach to farmers at village in pre-Khariff season

f. Monitor and inspect spurious seeds and fertilizer-mix and pesticides.

This can be set up by merging different Deptt currently working at a parallel level like ATMA MANAGE, KVKs, ICAR, District Agri. Officers and its Extension staff & SAUs Extension Team . This will have mix of development administration and Agri Scientists. This will avoid duplication of efforts and schemes and can be set up by re-organization

AGRO INDUSTRIES IN VILLAGES

- We have rapid industrialization – in fact very good growth in agro industries, but it is only in urban centers . But if agro industries based in villages, that can play a major strategic role by providing local employment, better price to agri produce and support wealth creation and economic growth in areas that have been affected by internal conflicts, natural catastrophes or out-migration resulting from uneven development.
- It will reduce migration, especially of young unskilled labour. It can also reverse migration trends by offering new employment opportunities. It can alleviate social pressures and demands on public services within the city. But for achieving this rural areas – remote area will have to be connected with good road and 24 hours three phase electrical supply. This has already happened in Gujarat and can be replicated with little push from the top – in entire country and this can be speeded up by :
- Promoting Innovation
- Use of knowledge economy
- Training rural youth for entrepreneurship and skill capacity building of existing traders.
- And providing support infrastructure & energy.

POTENTIAL FOR DEVELOPMENT

- Many countries in the world experience a decline in the growth of agriculture especially food crops due to increasing urban areas migration leaving agriculture behind. Heavy corporatisation of farming in some developed economy is another such reason.
- There is increased demand not only for food but also for other Agri. Produce particularly processed products which include dairy products, food supplements, meat etc.
- There is national and international demand for bio-fuel, which has diverted growing of food crops.

There is a need to think about global warming and greener Agriculture from a new angle including

- Sustainable development
- Agriculture – Strengthening the farmer and brining all open areas under its cover.
- Agro processing involving rural youth – young educated farmers in micro processing enterprises at local level.
- Involvement of Public Leadership and future generation through an integrated perspective.

Sustainable development is the key to social and economic stability. Global Warming has had an adverse impact all over the world. It disturbs social tranquility. The major sufferers are, of course, poor families and the small farmers. In India, agriculture is growing at 2% to 4% compared to service and manufacturing, which are above 8%. This has created urban and rural divide.

As per NSSO 2005, 60% of farmers do not like farming. Within rural areas also, there is disparity in productivity of crops with same land and water resources. Some farmers are becoming prosperous while others are committing suicide or embracing Naxalism. This is due to the failure of public governance system – both elected and non-elected – to reach out to farmers and youth and provide them with sustainable development. On the other hand, nature has provided un-utilized wasteland, resources and unlimited sunshine in tropical areas of our country. Its scientific use provides a new dimension to meet this challenge through agriculture, which is the key to sustainable development in majority of developing countries.

We do not have data about reduction of absorption of CO2 due to loss of vegetative cover, which has occurred due to reduction in vegetative cover, de-forestation , decrease of area for agriculture activities, increased industrialization and urbanization and increase of fallow agriculture land due to migration to urban Centres. But in reality, due to this, there is substantial reduction in natural photosynthesis process, which has increased CO2 in the atmosphere. Unfortunately the experts so called experts of Global Warming – Whether ours or international and organizations responsible for this-have not bothered about this.

As mentioned, in fact, there are vast waste lands, which could be brought under vegetative cover to absorb CO2 from atmosphere, which in turn can provide sustainable livelihood and also provide capacity to meet challenge of food security. More importantly, it can bring back balance – the equilibrium in nature's five forces, the sky, the earth, the sun, water and vegetation – and its inter action and inter dependence and clam the unpredictable weather.

The combination of photosynthesis and ability of plants to lay down Cellulose and Lignin acts as a powerful concentrator of carbon from the atmosphere into a fixed form. There is no parallel human technology that is capable of performing this kind of carbon concentration. With appropriate use of knowledge economy.

Several countries in the world are witnessing a decline in the growth of agriculture, especially food crops. In Africa, this is due to re-current droughts and internal turmoil. Elsewhere , it is due to increasing urban areas and migration to urban centers leaving agricultural land uncultivated. Heavy corporatisation of farming in some developed economies is another reason. All this is creating a food shortage and hungry millions.

India's share of arable land in the world is 11.5% (only second to USA). There is ample scope for improving the yield of major crops. India's yield per Ha. Of world average

estimates in some major crops is: paddy – 75%, wheat – 65%, Cereals – 73%, Pulses – 79%, Soya – 48% and Maize – 38%. In cotton seeds, we have reached the world's highest yield with BT cotton seeds. We need to first reach the world average and then the world's highest yield in all crops. This is possible as country has rich experience, of not only adverse climatic conditions but of its some farmers producing their crops equivalent to or higher then world highest, it has rich pull of agricultural scientists and educated young farmers. But Success lies only in pockets. It has to be uniformly spread over entire length and breadth of country to each of its of village and for that responsibility lies with its Public Leadership.

LEADERSHIP FOR GREENER AGRICULTURE

Global warming is a threat, but it can be converted into an opportunity. It is possible to create a win-win situation for all, if all efforts are channelised for sustainable development with greener agriculture at its centre. The unique aspect of this initiative is that it has to be a bottom-up approach at grass-root level and using modern technology with information communication techniques adapted to local needs – irrespective of the fact they differ may differ from tehsil to tehsil or even village to village.

The international school for public leadership (ISPL) , a non profit organization set up by NRI Prof. Nathu Prui, has conducted more than 200 programmes for competence building of existing leaders from the village level and above as well as for students – the future generation. During interaction with participants at the local level by author , it was revealed that they are aware of the impact of climate change and global warming, but do not know the specific role they can play. The same thoughts and dilemma were voiced by many other members of the public governance system. Most importantly it must be realized while some of them are aware of good agricultural practices, not all including even village level workers, understand what it is and how to go about it.

Therefore, the key to meet the challenge of Global Warming is LEADERSHIP, which has to become motivated and committed for promotion for sustainable development through greener agriculture. It needs to have clarity, adopt detailed planning and implement the strategy based on knowledge economy. Our earlier narration of local initiatives show how the local leadership can be ignited at the village level to bring about transformation. How this transformation can be replicated in an entire state has been highlighted by the Gujarat story. If one state can successfully bring about sustainable development once its leaders, from the top to bottom levels, are determined.- why not all? Why country can not take this as a challenge?

The leadership at all levels – village, taluka, district, state and centre the Chief Ministers and even Prime Minister– needs to be ignited and motivated to focus on farmers. This includes: Non elected leaders, owners entrepreneurs, managing directors of companies, NGOSs, civil servants, for VLW, Taluka Development Officer, Collector and the Chief Secretary of State governments and Cabinet Secretary of Union Government, the educational leaders (teachers, research scientists, Vice Chancellors and students) the spiritual leaders and the international organizations.

It is necessary to bring out the hidden capacity of our farmers, rural youth and our leaders and mobilize all the available resources including those of the government, industry and voluntary organizations. With people's participation and local leadership, transformation can be brought about. Leadership qualities in the future generation need to be aroused to promote sustainable development. Sustainable development ensures that every individual has enough to live on and has that opportunity must grow on a continuous basis.

Such transformation meets the challenges of poverty and global warming which seems to be insurmountable. But in reality, this is not so. It requires determined and persistent efforts to overcome these obstacles. If all of us act together with a common goal in mind, there will be all round prosperity, despite the adverse impact of global warming.

Countries-government-all over world will have to view the impact of Climate with grave concern, the Change which is creeping in rapidly-with dangerous consequences to habitat – its stability. This modern war is on Natures front and nuclear weapons or army is no solution. The solution lies in bringing bank balance in nature's forces-the atmosphere, the sun, the earth, the water and vegetation. The solution lies at local level. Our endeavor should be to overcome this challenge – convert it into an opportunity and as Dr. Y. S. Rajan (Distinguished Professor, ISRO, Saysad, Bangalore) has rightly quotes from Arthavaveda : create a world where:

Atharvaveda Hymn LXVII

१. पश्येम शरदः शतम् ॥

1. May we see for hundred years. (4960)

२. जीवेम शरदः शतम् ॥

2. May we live for hundred years. (4961)

३. बुध्येम शरदः शतम् ॥

3. May we acquire knowledge for hundred years. (4962)

४. रोहेम शरदः शतम् ॥

4. May we go on prospering and progressing for hundred years. (4963)

५. पूषेम शरदः शतम् ॥

5. May we go on being nourished for hundred years. (4964)

६. भवेम शरदः शतम् ॥

6. May we remain strong and sturdy for hundred years. (4965)

७. भयेम शरदः शतम् ॥

7. May we retain our prestige and influence for hundred years. (4966)

८. भूयसीः शरदः शतात् ॥

8. May we retain all these powers of sight etc., for greater numbers of years than hundred. (4967)

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Inaugural function of International Conference, Ahmedabad

Reading out of Ahmedabad Declaration by Dr. Kirit Shelat

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