WATER ENERGY AND FOOD SECURITY NEXUS

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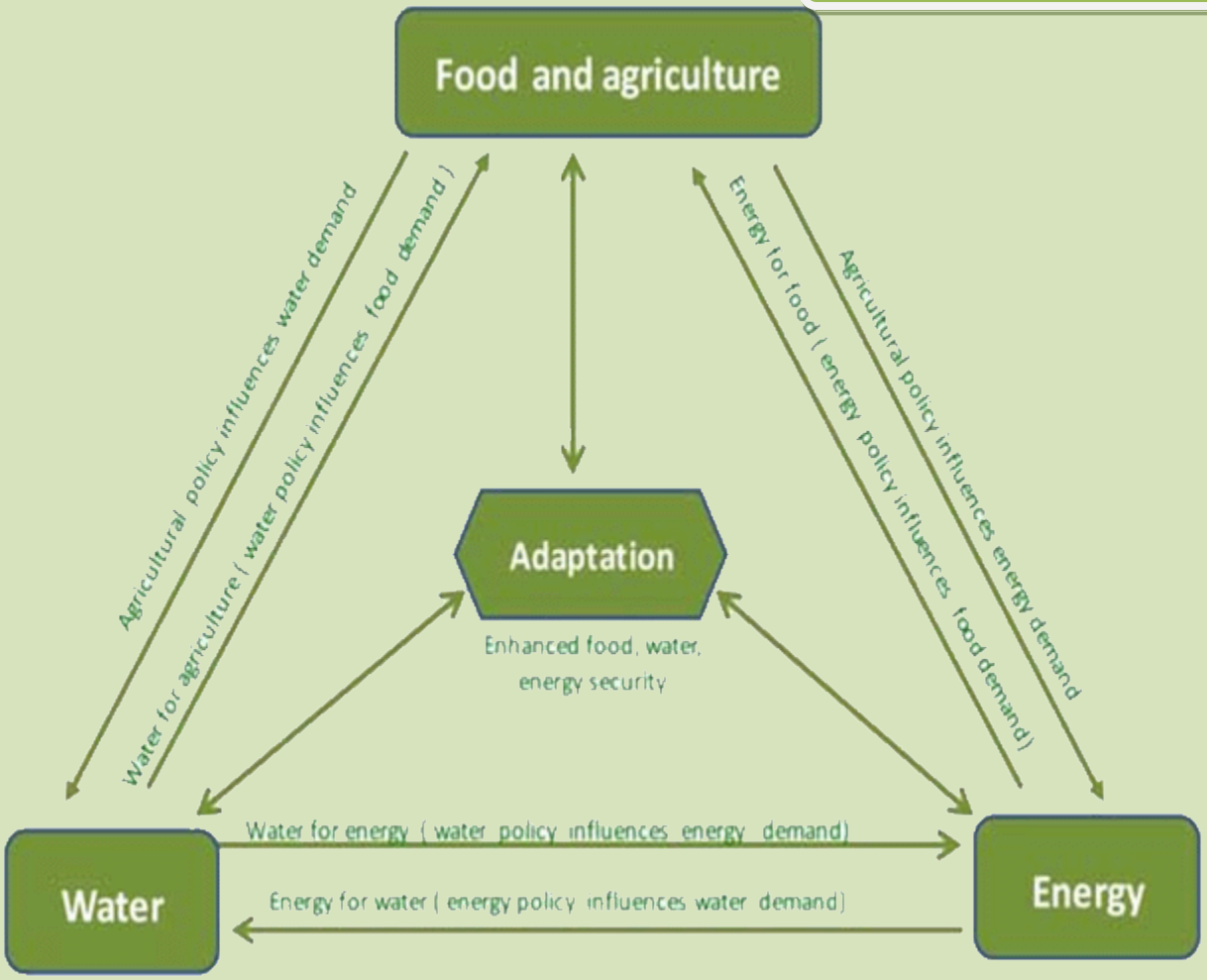

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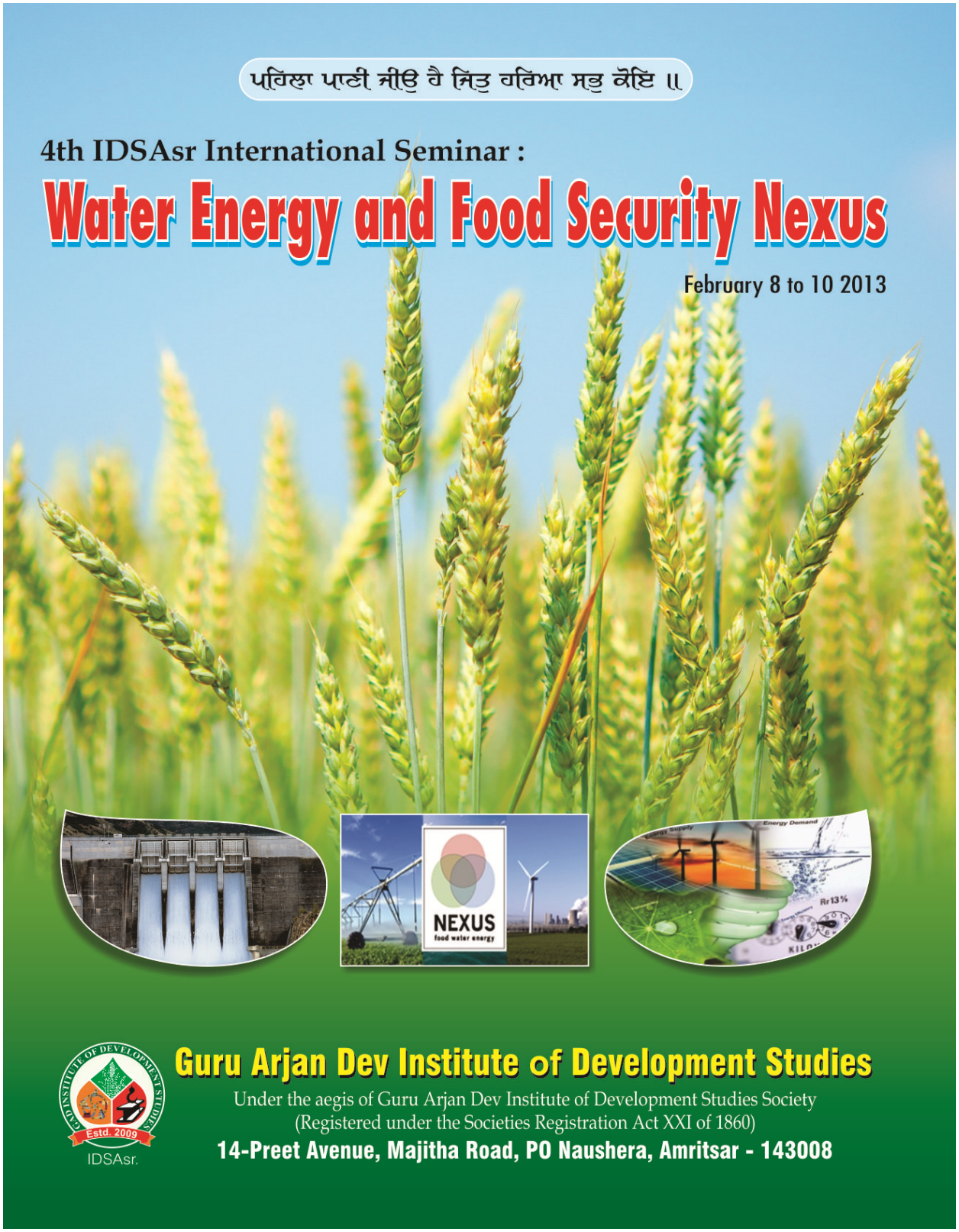
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4th IDSAsr International Seminar :
Water Energy and Food Security Nexus
February 8 to 10 2013
NEXUS
food water energy
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IDSAsr.

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MESSAGES

Prof. K. V. THOMAS

सत्यमेव जयते

MINISTER OF STATE
(INDEPENDENT CHARGE)
FOR CONSUMER AFFAIRS,
FOOD and PUBLIC DISTRIBUTION
GOVERNMENT OF INDIA
NEW DELHI-110001

MESSAGE

I am very happy to know that Guru Arjan Dev Institute of Development Studies (GADIDS), Amritsar is organizing its 5th national seminar on ***"Water Energy and Food Security Nexus"*** *in the first quarter of 2013, in continuation of the series of seminars which it organized on related subjects.*

Food security is a very critical issue being discussed in various national and international forums, of late. Equally important are issues like water energy which contribute in their varied ways towards food security. It is a fact that despite achievements which mankind has attained so far, the 'scourge of hunger' is one challenge which has been eluding us still. Only that will be a golden day in the history of the world, which can declare that no one man goes to bed in hunger any more. When institutes of higher learning like the GADIDS get themselves involved in analyzing such topics having a deeper impact on the welfare of society, thereby creating an awareness among our youngsters, it makes a huge difference and contributes in an enormous way towards finding ways and means of reaching the goals of hunger-free world.

I congratulate the GADIDS, Amritsar on their proactive efforts in educating our students on vital issues like food security, water energy etc. and hope that the seminar will turn out to be a great success in taking across relevant messages to every nook and corner. I also convey my best wishes to the college authorities for success in all their future endeavors.

(Prof. K.V. Thomas)

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

MESSAGE

Breaking the Unholy Nexus between Poverty, Water Scarcity and Food Security

The key challenges of the 21st century are to ensure global food security for the ever-growing population that will cross the 9 billion mark by 2050, and also to reduce poverty with limited land and water resources.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) works in the semi-arid tropical areas in 55 developing countries, home for two billion people one half of which is food insecure. Our mission is to reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics where water and land scarcity are predominant.

Water scarcity generally refers to the scarcity of blue water for irrigating the crops. Most efforts in the past have been directed towards increasing supply of blue water and enhancing blue water use efficiency for crop production. However, taking into account that 72 per cent of precipitation is stored as green water, efforts for enhancing the green water use efficiency for crop production have been disproportionately low. The only way forward to achieve food security with limited water resources is to enhance the efficient use of both green and blue water.

Long term experiment data at ICRISAT's Heritage Watershed site has established that integrated watershed management (IWM) interventions resulted in average crop yields five times higher compared with traditional farmer's practices. Similar results have also been recorded at Kothapally watershed and other watersheds in the country where science-led IWM approach has been adopted.

To harness the potential of rain-fed agriculture, a new paradigm to operationalize integrated water resource management by adopting watershed approach has been proposed. The ICRISAT-led consortium in partnership with Government of Karnataka through Bhoochetana project has demonstrated that productivity of rainfed agriculture on over 3 million hectares can be substantially increased by 23 – 66 per cent by adopting science-led interventions along with enabling policies and institutions, capacity building, women empowerment and adopting public-private partnership in the state.

During the 2011 rainy season alone, the benefits accrued in the state of Karnataka through Bhoochetana were about US$ 130 million with a benefit cost ratio of 1:6 at macro level. At the

individual farmer level, the benefit cost ratio of improved management practices which included soil test-based nutrient management, improved seeds with seed treatments and appropriate land and water management practices showed the benefit cost ratio of 1.2 to 14.6 for different crops in the state. This approach has now also been adopted by the government of Andhra Pradesh and other states are looking forward to unlock the potential of rainfed agriculture to achieve the food security through increased green water use efficiency.

What we need is climate resilient agriculture which uses crops which are tolerant of heat, drought and pests, along with efficient water management practices and socio-economic and institutional support. Beyond that, there is an urgent need to link the farmers with markets to reduce poverty. Our vision for 2020 is Inclusive Market Oriented Development (IMOD) through science-led participatory research by building public private partnerships to benefit the farmers and by improving their livelihoods.

The international seminar on the theme "Water Energy and Food Security" is therefore both timely and urgent. We extend our congratulations to the participants and the organizer, Guru Arjan Dev Institute of Development Studies (IDSAsr), Amritsar, for this worthy initiative. We look forward to collaborating more with you to promote climate resilient agriculture to ensure food security especially for the world's poorest populations.

(William D. Dar)
Director General

DR. J. S. SAMRA
Chief Executive Officer

Government of India
Planning Commission
National Rainfed Area Authority
NASC Comples, 2nd Floor
Dev Parkash Shastri Marg
Opp Todapur Village, Pusa,
New Delhi-110012

MESSAGE

Agriculture Sector utilising about 80 per cent of India's water resources, is contributing 15 per cent to the GDP and supporting 58 per cent of the population. Indian agriculture witnessed highest average growth rate of 3.3 per cent during the 11th Plan and is a significant improvement over to 2.5 per cent during 9th Plan and 2.4. per cent in the 10th Plan. Out of all the inputs, elasticity of water is the highest and its efficiency is crucial for realising long range sustainability of growth. Ground water being most productive was developed through private investments by the farmers after rural electrification with public investments. It is also apparent that energy is absolutely necessary for extracting and utilising ground water for realising food, nutritional, environmental, livelihood and income securities. The 12th Plan discussions in the National Development Council meeting concluded that highest priority should be given to energy and water for sustaining growth in the country. Appropriate fuel policy was emphasised for improving supply of energy whereas enhancing efficiency of all water services was considered crucial for curtailing demand of water. The ultimate macro policy analysis revealed that energy and water nexus is very important for enhanced sustainable growth. This unique nexus of water and energy is specifically highly relevant to the north-west and other pockets depending heavily on the ground water services. This seminar is, therefore, timely and in-tune with the Macro Economic Policy of the Government of India for the 12th Plan period. Undersigned wish very fruitful discussions and grand success of your endeavours for steering befitting regional policies in the matter.

With regards,

(J.S. SAMRA)

सत्यमेव जयते

Government of India
Department of Agricultural Research and Education
Indian Council of Agricultural Research
Ministry of Agriculture, Krishi Bhawan,
New Delhi-110 001

Dr S Ayyappan
Secretary and Director General

MESSAGE

The sustainable management of water resource is crucial for ensuring food and environmental security of the country. The mounting anthropogenic pressure on water resource has already led to its degradation in many parts of the country. The concern is already being voiced by agricultural researchers, planners and farmers alike on population of water bodies, ground water imbalances, rising and falling water tables, secondary salinization etc. leading to water scarcity and consequently threatening food security. The situation is getting further compounded with the recent climate change impacts on natural resources affecting agriculture.

The water productivity in India is still very low at the country level. However there is large scope for enhancing water productivity through multiple uses of water, efficient on farm water management practices, aerobic rice cultivation, micro irrigation, resource conservation in agriculture would be of great significance as supplies of fresh water would face grim competition in future from fast growing domestic and industrial sectors.

It is a pleasure to note that Guru Arjan Dev Institute of Development Studies, Amritsar is holding its 4th IDSAsr International seminar on Water Energy and Food Security at Guru Nanak Dev University Amritsar to deliberate on diverse issues of water resource management and food security during February, 2013.

I wish the seminar a grand success.

(S. Ayyappan)

M S Swaminathan Research Foundation

Center for Research on Sustainable Agriculture and Rural Development
Third Cross Street, Taramani Institutional Area
Chennai - 600 113 (India)

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PROF M S SWAMINATHAN
Member of Parliament (Rajya Sabha)
Chairman

MESSAGE

The Bengal Famine of 1942-43, which claimed over 2 million lives, provided the backdrop to India's independence in 1947. No wonder, Jawaharlal Nehru remarked soon after taking over as the first Prime Minister, "everything else can wait, but not agriculture". Our population was then a little over 300 million, i.e., 25 per cent of the current population of over 1.2 billion. In 1947, not more than 30 persons could be fed in a wedding, while today money is the limit to the number of people who can be entertained on such occasions. Government has now about 60 million tonnes of wheat and rice in its godowns, in contrast to the "ship to mouth" situation which prevailed during the fifties and sixties. How did this transformation come about?

In 1947 our soils were both thirsty and hungry and to quote Aristotle, "soil is the stomach of the plant". Hardly, 10 per cent of our cultivated area had assured irrigation at that time and the average consumption of NPK nutrients was less than 1 kg per ha. The average yield of wheat and rice was about 800 kgs per ha. Mineral fertilizers were mostly applied to plantation crops, and food crops were fed with whatever organic manure that farmers were able to mobilize. During the first two Five Year Plans (1950-60), emphasis was placed on enlarging the area under irrigation and on the production of fertilizers. Scientists began extensive experiments in the nineteen fifties to assess the response of rice and wheat varieties to fertilizer application. The varieties cultivated then had tall and thin straw and the crop lodged when even small quantities of fertilizer were applied. It became clear that we will need varieties with short and stiff straw, if we are to get positive response from water and fertilizer.

It is in this background that Dr K Ramaiah, an eminent rice scientist, suggested in 1950 that we should cross japonica varieties of rice obtained from Japan with our indica rice varieties. The logic behind this suggestion was that the japonica varieties were even then yielding over 5 t per ha, while our varieties gave 1 to 2 t per ha. Thus began the indica-japonica rice hybridization

programme at the Central Rice Research Institute, Cuttack in the early 1950s. I worked in this programme for a little while in 1954. This programme lost its priority after genes for developing semi-dwarf varieties of rice became available in the sixties from Taiwan and the International Rice Research Institute, the Philippines.

After World War II, American scientists were examining the significant findings made in Japan both in agriculture and industry. Dr Solomon, a biological scientist, was fascinated by the semi-dwarf wheat varieties developed by Dr Gonziro Inazuka at the Norin Experiment Station. This variety had short and stiff straw but long panicles and consequently a high yield potential. Dr Solomon gave seeds of the Norin wheat to Dr Orville Vogel of the Washington State University, who developed the semi-dwarf winter wheat variety Gaines, with a yield potential of over 10 t per ha. Dr Norman Borlaug, working in Mexico, obtained the seeds containing the Norin dwarfing gene from Orville Vogel and started the famous Mexican dwarf wheat breeding programme. Winter wheats like Gaines do not perform well under our growing condition. On the other hand, Borlaug's material was suited for the Rabi *season in our country. I therefore approached Dr Borlaug in 1959 for giving us some of his semi-dwarf wheat breeding material. Borlaug wanted to see our growing conditions before making up a set of breeding lines and his visit materialised in March 1963. We tested the material sent by him at several locations all over North India during rabi 1963. The multi-location trials revealed that the semi-dwarf wheats of Mexican origin could yield 4 to 5 t per ha in contrast to about 2 t per ha of our tall varieties. It became clear that we now have the tools with which we can shape our agricultural destiny.*

In July 1964, C Subramanian became the Minister for Food and Agriculture and he gave his whole hearted support to spreading the new high yielding varieties on a large scale together with irrigation water and mineral fertilizers. Shri Lal Bahadur Shastry, the then Prime Minister, approved the import of wheat seed from Mexico as a "purchase of time" operation. All these steps helped to raise the area under dwarf wheats from 4 ha in 1964 to over 4 million ha in 1970. In 1968, our farmers harvested about 17 million t of wheat, in contrast to the earlier highest harvest of about 12 million t in 1964. Such a quantum jump in production and productivity led Indira Gandhi to announce the birth of "The Wheat Revolution" in July 1968.

In addition to the yield breakthrough in wheat and rice, hybrids of maize, jowar and bajra developed by our scientists in partnership with the Rockefeller Foundation, opened up new opportunities for increasing the productivity and production of these crops. This led to the introduction by the Government of India in 1967 a High-yielding Varieties Programme in wheat, rice, maize, jowar and bajra. For the first time in independent India, an yield consciousness was born in farmers' minds and this resulted in farmers organising a National Tonnage Club of Farmers, the membership eligibility criterion being the production of an agreed minimum quantity of food grains per ha. In October 1968, Dr William Guad of USA coined the term "green revolution" to signify the revolutionary progress made in increasing the yield potential of major food crops.

The term "green revolution" is applied in situations where higher productivity is the pathway for increasing production. The Green Revolution involved synergy among technology, services, public policies and farmers' enthusiasm. Farmers, particularly Punjab farmers, converted a small government programme into a mass movement. This is why the process is often referred to as the Green Revolution Symphony.

The green revolution was criticised by social activists on the ground that the high-yield technology involving the use of mineral fertilisers and chemical pesticides is environmentally harmful. Similarly, some economists felt that small and marginal farmers will be bypassed by the new technologies, since although the technologies are scale neutral, they are not resource neutral. This led to my coining the term "ever-green revolution" to emphasise the need for enhancing productivity in perpetuity without associated ecological harm.

Looking ahead, the bright spot in Indian agriculture is the availability of a large untapped production reservoir. For example, the productivity of foodgrains in China is currently 5332 Kg per ha, while it is 1909 Kg per ha in India. A "bridge the yield gap" movement is needed urgently. The dark spots in Indian agriculture relate to ecology and economics. The heartland of the green revolution, namely Punjab, Haryana and Western UP is in deep ecological crisis, as a result of the over-exploitation of ground under and spread of salinity. This region will also suffer most if the mean temperature rises by 1 to 2°C as a result of global warming. Conservation and climate resilient farming will help to checkmate the ecological hazards.

Economically, out of a total of 89.35 million farmer households, 43.42 million are indebted (National Sample Survey organisation, May 2005). Farmer indebtedness is particularly high in Andhra Pradesh (82.0 per cent), Punjab (65.4 per cent) and Tamil Nadu (74.5 per cent). This is why farmers have little bargaining power in the market. The monsoon and the market are two of the major determinants of farmers' well being. Synergy among scientific skill, political will and farmers' enthusiasm gave birth to the green revolution of the sixties. We need a similar combination today, if the desired second or ever-green revolution is to be realized.

Water, energy and food security are these essential components of national well being and progress and required integrated attention. That is why the current 4th IDSAsr International seminar organized by Guru Arjan Dev Institute of Development studies, Amritsar assumes importance from the point of view of developing sustainable food, water and energy security systems for our country. I wish the seminar great success.

(Prof M S Swaminathan)

AGRICULTURAL SCIENTISTS RECRUITMENT BOARD
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
Krishi Anusandhan Bhavan-I, Pusa, New Delhi 110012

Dr Gurbachan Singh
Chairman

MESSAGE

Global food demand is predicted to be almost doubled by 2050. However, over exploitation of natural resources and production environment during last three decades has resulted in their degradation both in terms of quantity and quality. Achieving food and nutritional security in light of this scenario in near future is a big challenge. The emerging issues of climate change, diversion of agricultural land for non-agricultural use, declining land holding size and increased cost of cultivation etc. are bound to add to food crisis in the future. As per IAASTD, 2009 estimates, nearly 30 per cent global green house gas emissions leading to climate change are attributed to agricultural activities including deforestation. Moreover, anthropogenic emissions of green house gases have also considerably increased during the recent past due to unscientific agricultural practices resulting in climate change and global warming of the planet. Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluoro-carbons (HFCs), perfluoro-carbons (PFCs) and sulphur hexafluoride (SF5) are the six important gases which are responsible for the current global warming. The mean global annual temperatures are reported increased between 0.4 to 0.7^{0}C during the last century. A further increase of 1 to 3^{0}c during 21st century has been modeled. The year 2005 was reported the warmest year so far. Almost all the years in the last decade recorded extreme weather events, and the year 2007 was also declared as one of the warmest years.

Melting of glaciers, sea level rise, sub-mergence of islands/ coastal areas and change in rainfall and temperature pattern over the next century are predicted. This change is bound to affect water availability and biodiversity pattern which will demand a new set of land use pattern including enterprises, commodities, crops and varieties. Global warming related ozone depletion has also been reported which may lead to increased ultra violet radiation with far reaching adverse impact on earth's environment and human as well as livestock populations

including microbial communities. Such effects of climate change have already started impacting agricultural productivity in several agroclimatic regions and sub-regions of India. The country experienced one of the severest droughts of the last century during 2002 and 2009 that lowered food grain production by more than 29 and 17 million tons, respectively. The cold wave of 2002-2003, 2005-2006, and 2007-2008 caused significant damage to winter crops in the states of Punjab, Haryana, Rajasthan and western Uttar Pradesh. Agricultural crops like winter maize, mustard, gram; fruit crops like litchi, papaya, mango; vegetables like potato, tomato, brinjal, peas and flower crops like marigold, chrysanthemum and dahlia were extensively damaged. Five to ten years old multipurpose trees like Prosopis, Juliflora, Cassia siamea, Azadirachta indica, Emblica officinalis, Tamarindus indica etc. were also damaged and defoliated. During 2010-11 winter seasons, most of the pulse crops including gram and pigeonpea were badly damaged in Madhya Pradesh due to frost. The heat waves of March 2004 and 2010 in northern states coincided with the ripening phase(grain filling) of wheat and slowed down the translocation of photosynthetic assimilates from vegetative parts to grain and impaired the production by more than 4 and 2 million tons, respectively. Prolonged cool temperature during 2010 – 11 winter favoured higher wheat productivity but also proved highly conducive for the onset of yellow rust on wheat. The monsoon behavior in 2007 over Kerala was totally different to that of previous years and very heavy rains were observed between June and September leading to severe flooding in low lying areas. Traditionally assured and high rainfall areas like West Bengal, Bihar, Jharkhand and Assam experienced drought like situation during 2009 and 2010. Predicted spatial redistribution of precipitation, droughts, floods, heat waves, cold waves and water balance will change the land use pattern, cropping systems, pests and diseases. To deal with likely scenario of climate change and its management following strategies are suggested:

- *Developing new plant genotypes for drought, heat and cold tolerance adapted to climatic variability and ranges. There is a strong case to screen and document the already existing germplasm of crops, trees, animals and even microbes about their location specific response to such changes. Based upon this screening, location specific crop/variety calendars for application according to changed situation needs to be developed.*

- *Devising agronomic practices which may moderate/negate the impact of predicted climate changes and promotion of conservation agriculture practices such as zero tillage, bed planting, residue management and crop rotation.*

- *There is a need to develop contingency plans to coup-up with weather related aberration such as cold and heat waves and drought. These contingent plans should be such that can be practically implemented on a short notice/warning.*

- *Developing precision and accurate forewarning mechanisms to reduce production risks and for undertaking preventive measures. There is a strong case now to go for*

developing and upgrading medium and long range weather forecasting systems (15-20 days in advance) so that farmers have reasonable time to respond to risks.

- *Identification of genes for tolerance to moisture, heat and cold stresses and developing a canvas of transgenics having tolerances to abiotic stresses. Biotechnological approaches such as pyramiding of genes should be a priority area of future research in climate change.*

- *Reducing green house gas emissions through carbon sequestration in different land use systems with major emphasis on raising horticultural plantations on degraded soils. Research on bio-diesel/petro crops such as Jatropha and Pongamia which have potential to substitute fossil fuels needs strengthening. Since India cannot afford to divert cultivable area from grain crops to ethanol/bio-diesel production, our priority should be to extend cultivation of such plants on degraded lands which constitute an area of about 120 m ha.*

- *Curtailing losses of methane and nitrous oxide from cultivated fields by increasing use efficiency of water, nutrients, energy and other agronomic manipulations.*

- *Manipulation of crop micro climate by means such as use of wind breaks, tunnels or green house to reduce the effects of climate change.*

- *Genetic engineering/biotechnological tools which could covert C_3 plants in C_4 mode of photosynthesis to tap the increased CO_2 in the environment for higher biomass production.*

- *Develop knowledge based decision support systems for translating weather information into operational management practices at district, block and village Panchayal level.*

- *Benchmarking of areas prone to climate change impacts on agriculture, horticulture and livestock and periodic monitoring to initiate timely preventive action.*

- *Establishment of automatic weather stations in all the 127 NARP zones to provide value added agromet advisory service to the farmers. There is also a need to establish climate monitoring towers/climatic control facilities at select places in the country for periodic monitoring of water, energy, gases and salt fluxes. These facilities should be used for designing location specific cropping/farming systems.*

- *Promoting multi-enterprise agriculture to reduce risk and for assured livelihood security in areas prone to weather/climate aberration. Nearly 50 per cent of the farmers in India cultivate less than one ha land. Integrated farming system is a promising proposition for such small holding.*

- *Improved management of livestock populations including poultry through better management of feeding and livestock housing. Animal sector is the major contributor for methane to the environment.*

- *Improving the efficiency of energy use in agriculture by using better designed efficient machinery and implements.*

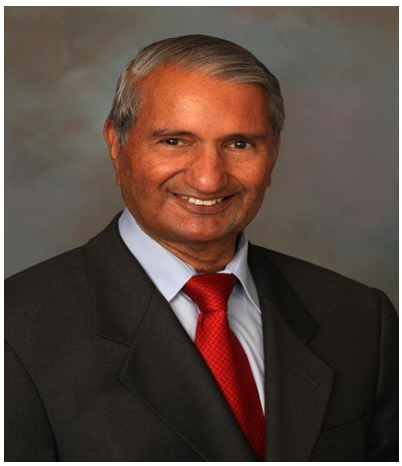
- *There is a need to develop crop insurance and early warning systems to reduce/negate the impact of climate change and achieving stability in production. There is also a need to develop weather-crop-livestock relationships and weather-crop forecasting pest infestations.*

- *There is a need to intensify efforts for increasing climate literacy among all stakeholders of agriculture and allied sectors, students, researchers, policy planners, science managers, industry and farmers.*

(Gurbachan Singh)

Gurdev S. Khush
Adjunct Professor

MESSAGE



I am delighted to learn that Guru Arjan Dev Institute of Development studies is organizing fourth IDSR international seminar on "Water, Energy and Food Security nexus." Right to food is the birthright of every individual on this earth. Therefore, food security is most important agenda of governments and development agencies. Food security depends upon adequate supplies of water for crop production and irrigation, and on energy for running tractors and tube wells. Water is necessary for generating hydroelectric power and for generating nuclear energy. Hence, water, energy and food security issues are intertwined. Concerns about the adverse effects of climate change on water availability are real. Energy sources such as fossil fuels are not finite. Consequently, costs of energy have been rising. Demand for food is rising because of increasing population and changing food habits due to improving living standards.

It is high time these issues are deliberated upon in such seminars. I am sure some of the authorities on these issues will discuss these problems and review policies to overcome them. I send my best wishes for the success of the seminar.

(Gurdev S. Khush)

Prof. Samir K. Brahmachari
Director General, CSIR &
Secretary, Government of India

Department of Scientific and Industrial Research
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH
Anusandhan Bhawan, 2, Rafi Marg, New Delhi- 110001

MESSAGE

It gives me immense pleasure to learn that Guru Arjan Dev Institute of Development Studies (IDSAsr) with support from Ministry of Earth Science, Government of India is organizing 5th national seminar on the theme "Water Energy and Food Security Nexuses" during 8-10 February, 2013 at Guru Nanak Dev University, Amritsar.

Water, energy and food sectors, needless to say, are intricately interconnected and interact in numerous substantial ways. These strong connections between the three resources present a scenario where actions in one area invariably impact the others, thus demanding the maintenance of the delicate equilibrium. The changing industrial climate and increasing demands of the steadily growing global population in the past years have placed tremendous stress on these resources, threatening the existing balance and posing water, energy and food security threats to millions worldwide.

Safe food and water and affordable energy are crucial issues today that requires immediate attention and quick action. Ensuring water, food and energy security requires a deeper insight into the interlinkages between the sectors of water, energy and food and how the changes in one affect the other. Under such circumstances it is imperative that we adopt a nexus approach to understand the interconnectedness of these sectors and to mitigate the negative economic, social and environmental impacts of thoughtless development practices. A nexus approach is needed the need of the hour to meet increasing global demands without compromising sustainability.

In the context, I appreciate Guru Arjan Dev Institute of Development Studies to conduct this national seminar. Needless to say, this will prove to be a wonderful platform for innovative thought sharing and will help in the creation of a platform for giving proper impetus to configure new technologies and policies to ensure water, food and energy security to all.

I wish the organizers and participants of this programme all success and congratulate the organizers on this timely initiative,

03 January2013 ***[Samir K Brahmachari]***

New Delhi

Dr Jyoti Parikh
Executive Director
IRADe

MESSAGE

Water and energy and food security issues are closely tied and getting more critical by each day. Increasing population, urbanization, climate change and poverty are causing stresses that need to be understood and dealt with from multi - disciplinary and multi - stakeholder perspectives.

I am happy that IDSAsr is organizing this event to get deeper into the issues.

Unfortunately I am unable to join you but will look forward to receiving the proceedings.

I wish you all the success in this endeavour.

With best wishes

(Jyoti Parikh)
Executive Director

THE ENERGY AND RESOURCE INSTITUTE

R K Pachauri Ph. D
Director General

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MESSAGE

I am very glad to see that the Guru Arjan Dev Institute of Development Studies is organizing a seminar on the theme of water, energy and food security, focusing on the nexus between these three important subjects.

It is becoming increasingly clear that a segmented approach dealing with anyone of the three issues, water, energy or food, would really not solve the serious problems that the world is facing in this regard. One factor that would affect development in all the three areas is related to the impacts of climate change. For instance, in the case of water, increasing temperature, particularly the increase in frequency and intensity of heat waves would have serious implications for water availability. So also would the increase in extreme precipitation events. In fact, the Intergovernmental Panel on climate change(IPCC) has found that even in areas where there is a decline in average annual precipitation, a much larger proportion will take place in the form of heavy falls. This would have major implications for water availability seasonally during the entire year. Food security would also be affected by climate change because of the impacts on agriculture not only on account of the changing water regime, but also the direct impacts of increased temperature on a number of agriculture crops. In fact the IPCC has found that as early as 2020 some countries in Africa may see a decline of 50 percent in yields of some crops as a result of climate change and climate variability.

All these impacts and changes are taking place against the background population growth and increases in incomes, as a result of which demand for water, energy and food is likely to increase significantly. There are also direct linkages between water, energy and food production and it is important to evaluate the nexus between the three.

To that extent I hope the seminar being organized will address the technical, economic nad institutional challenges in dealing with the triple challenge of water, energy and food security in the country, for which institutions like the Guru Arjan Dev Institute of Development Studies have an important role to play.

(R K Pachauri)

International Center for Agricultural Research in the Dry Areas
Science for better livelihoods in dry areas

Dr Mahmoud Solh
Director General,
International Center for Agricultural Research in the Dry Areas (ICARDA)

MESSAGE

It is my pleasure to be associated with the 4th IDSAsr International Seminar on "Water, Energy and Food Security". ICARDA, the International Center for Agricultural Research in the Dry Areas, shares many of the same objectives as the GAD Institute of Development Studies. Both institutions recognize the importance of these three factors, and the inter-relationships between them. And both institutions are committed to research and partnership-building to develop solutions to ensure food security for future generations without depleting water or energy reserves.

Food security is an issue that concerns almost every developing country, including those with strong economic growth. Climate change, for example, will lead to lower rainfall, extreme, temperatures, greater seasonal variability, drought and floods and higher intensity of other extreme weather events… all contributing to lower agriculture productivity, and higher and more volatile food prices in many developing countries.

Water resources are at the heart of ICARDA's mandate. The Center works in dry areas, where water scarcity is already approaching critical levels– and will further worsen, as a result of climate change. Whether societies achieve their economic and social development goals will depend largely on the availability of water for agriculture, and efficient, sustainable management of this water. Scarcity of agricultural water will be the key constraint to food production, economic development – and even social stability.

Cheap, plentiful energy will be needed to sustain agricultural production growth. Instead, developing countries are likely to face severe energy shortages, because the world has failed to invest more in renewable sources energy or their sustainable use.

All three factors – water, energy, food security – are intertwined. I am glad to note the "nexus" approach taken by this seminar, which will explore these relationships. A better understanding of these relationships will help develop appropriate technologies for developing countries, analyze trade-offs between different policy options, and identify institutional arrangement to implement such policies.

ICARDA and its partners have developed a range of water-efficient technologies that are being scaled out across dry areas in West, Central and South Asia, North Africa and Sub-Saharan Africa. We have also demonstrated the need for – and effectiveness of – integrated, multi-disciplinary approaches to tackle the complex problems faced by small-scale farmers in dryland areas. Many of these innovations can be adapted to local conditions, and scaled out even more widely. ICARDA will be happy to provide technical advice, support and training; and to develop collaborative projects with national research and extension agencies, universities and other partners to achieve food security, improved livelihoods and a healthy environment.

I wish the meeting all success. I am sure the discussions, involving so many eminent professionals, will provide scientists as well as policy makers with new insights on these crucial challenging issues.

(Mahmoud Solh)

PUBLISHER NOTE

It gives us immense pleasure to place before you this publication (eBook) before you based on the various papers received for presentation and discussion at the seminar contributed by the emmienent researchers in the their own field of excellences at the 4th National/International Seminar on the theme ***Water Energy and Food Security****. Some of the papers were also invited for this complitation and revised in the light of discussion at the seminar. We regret it has not been possible to publish in full length a large numbers of papers due to time constraints and hope the contributors whose papers could not publish in full would appreciate our difficulty and bear with us. The publication of this ebook was made possible with the financial support of the society. However the seminar was jointly sponsored by Council of Scientiific and Industrial Research, and Ministry of Earth Science, Government of India, New Delhi.*

Publisher as well as the institute/society is not responsible for any error or omission of the contents/subject matter of the papers. The authors are only responsible for that.Views and comments/suggestions are most welcomed

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INTRODUCTORY REMARKS

Rethinking Nexus: Water Energy and Food Security

The International Energy Agency's (IEA) warning that water demand would outstrip energy demands two-fold highlighted the scale of water-energy nexus. But the reality is more complex. Critically, a global population expansion to 9 billion people by 2050, coupled with increased economic growth, will intensify competition for water, as well as increasing the need for food and energy, creating a trilemma for 21st century society to resolve.

Traditional water-energy nexus thinking highlights the mutual importance of water and conventional energy. Energy is fundamental to collect, transport, distribute and treat water. Water is essential to extract process and refine fossil fuels. The onset of climate change further exacerbates the interconnectivity of the energy-water nexus.

A global water gap of 40 per cent between demand and accessible water by 2030 and that water consumption is set to rise from 4,500 billion cubic metres to 6,900 billion cubic metres with no change to business as usual practices and policies, such as improved 'crop per drop' irrigation and rain-fed measures.

Agriculture accounts for 71 per cent of current total global water withdrawals. A 50 per cent population increase will exponentially increase agricultural output, requiring more water and energy through fertilizers, harvesting and processing. India could double water consumption through to 2030 to 1.5 trillion cubic metres, leaving the country with a 50 per cent water gap. Anticipating any substantially positive impact of genetically modified organisms (GMOs) in developing plants that combine higher energy content with reduced water consumption is difficult.

A call was raised for awareness of the nexus between water, food and energy security, as well as climate change. A serious water crisis ahead has been realized as many groundwater resources are depleted, while demand for food and energy is increasing. By 2030, the world's population and economic growth are expected to lead to a 40 per cent increase in energy and water

demand, and a 50 per cent increase in food demand. Meanwhile, climate change puts additional strain on agriculture.

The increases in food prices in the recent past too have been closely linked to rising energy and oil prices, with serious economic implications. The poor are particularly affected by high food prices as they spend a high proportion of income on food. Worryingly, the triple food, fuel and financial crisis of recent years may be a taste of things to come.

Global agriculture is also highly dependent on energy from fossil fuel-burning for many processes, from on-farm mechanization, to fertilizer production, to food processing and transportation. The price of oil is also closely correlated with the price of fertilizer.Energy is crucial for production and transport of food, from the 'farm to fork'. The food sector currently accounts for around 30 per cent of the world's total energy consumption and over 20 per cent of greenhouse gas emissions. The emerging biofuels market increases interdependencies between food and energy prices, since feed and fodder commodities are being used for biofuels, and also because a higher oil price increases demand for biofuels. The Stockholm Environment Institute (SEI) has found that growing bio-fuels from crops is extremely water-intensive, as well as being a practice which puts pressure on food crops. According to the FAO, it takes 2,500 litres of water to produce one litre of biofuels for transportation. New legislation may be needed to address the impact of biofuels mandates on food and water security.

Energy and water are both absolutely essential for food. This is especially true because irrigation is used for the production of roughly 40 per cent of global food. In this way, agriculture accounts for about 70 per cent of all freshwater withdrawal. Inefficiency in one area can also lead to inefficiency in another. For example, subsidized electricity for irrigation can lead to over-pumping, which contributes to groundwater depletion. Where water is extremely scarce, desalination – which is highly energy-intensive – is used.

As conventional fossil-fuel sources become depleted, we have seen a shift to processes like hydraulic fracturing ("fracking") which are even more water-intensive. Extraction and processing of oil sands uses about 100-1000 litres of water per gigajoule (GJ), compared to 10-100 litres for conventional oil and gas. According to the World Resources Institute (WRI), 79 per cent of new planned power capacity in India will be built in water-stressed areas. Use of Carbon Capture and Storage (CCS) technology also increases water consumption.

Renewable energy has brought new challenges. Hydropower, already the world's dominant source of renewable energy, is a prime example of a technology that must be carefully managed to avoid negative impacts. Dams can affect biodiversity, fish migration and have impacts on downstream food security. We must start to think about the 'water productivity' of energy. Solar power, for example, hardly uses any water.

In the long-term, it will be necessary for our food to be produced using sustainable energy resources and this is likely to require a transformation in agricultural systems. At the moment, we are seeing the opposite occur: food crops such as maize and soy are being used to fuel energy-consuming transport. This issue must be tackled. Otherwise, there is a risk that food prices will continue to sky-rocket.

Research is only just beginning to explore the complex issues in the food-energy-water nexus. What is clear is that better collaboration is needed between different sectors. Policy-makers must ensure that expansion of certain types of energy does not put a strain on other vital resources. Policy-makers often work in silos – for instance, there can be little cooperation between those working on reducing emissions and those on adapting to climate change. This may have led to the controversial issues created by biofuel expansion. It is clear a more holistic outlook is needed in tackling these problems and managing increasing demands for energy, water

This water gap presents the opportunity for water-rich countries, such as Canada, to address how to maximize its freshwater resources to provide 'virtual' water through intensive products and commodities to water scarce countries. Current energy trends exacerbate the trilemma. Average global temperature increases of 3.6°C are likely. The current global energy infrastructure will contribute 80 per cent of the greenhouse gas emissions necessary to reach a 2°C warming, the threshold of serious climate change predicted by the Intergovernmental Panel on Climate Change (IPCC). And the US Third National Climate Assessment suggested extreme scenarios could lead to a temperature increase of more than 5°C by the end of the century, causing cataclysmic climate change by IPCC projections.Moving from this current energy trend is problematic. Fossil fuels are projected to comprise 80 per cent of global energy demand to 2035 with current policies. A shifting of fossil fuel subsidies to renewable energy subsidies could see renewable energy supply over 60 per cent of demand.

From a water perspective, this energy shift could be advantageous. Energy's water dependency accounted for 15 per cent – 583 billion cubic metres – of global water withdrawals in 2010. While only 66 billion cubic metres are not returned to source, energy-related water withdrawals are anticipated to increase by 20 per cent by 2035, with a dramatic 85 per cent increase in consumption. The rate of water not returned to source would almost double to 120 billion cubic metres.

In contrast, the use of renewable energies to 2035 is predicted to increase water consumption by only 4 per cent although some technologies – such as concentrated solar power, which generates steam to drive turbines – would be more water intensive than others. Tackling climate change through measures such as carbon capture storage could also prove to be water intensive.

But energy is vital to humanity and development. Worldwide 1.3 billion people have no access to electricity, while 2.6 billion people use traditional biomass for cooking. Does the world need to rely on fossil-fuels to bridge this energy gap? Wind, water and sunlight can provide all new energy to 2030 and replace pre-existing energy sources by 2050. Society, industry, governments and investors have to wake up to the reality surrounding food, energy and water – and fast. There are alternatives to fossil fuels but there are no alternatives to food, or freshwater.

Nearly one-third of all food produced gets lost or wasted in production and consumption systems, according to the Food and Agricultural Organization. In a world of 7 billion people, set to grow to 9 billion by 2050, wasting food makes no sense – economically, environmentally and ethically. Small but simple actions by consumers and food retailers could dramatically cut the 1.3 bn tonnes of food lost or wasted across the world each year. Requesting smaller portions at restaurants, freezing leftovers and donating to food banks can help make a difference, while retailers and supermarkets should be carrying out audits and working more closely with their suppliers to reduce waste.

Together, we can reverse this unacceptable trend and improve lives. In industrialized regions, almost half of the total food squandered, around 300m tonnes annually, occur because producers, retailers and consumers discard food that is still fit for consumption. This is more than the total net food production of sub-Saharan Africa, and would be sufficient to feed the estimated 870 million people hungry in the world.

According to the FAO, 95 per cent of food waste in developing countries are unintentional losses at early stages of the food supply chain, caused by financial, managerial and technical limitations in harvesting techniques; storage and cooling facilities in difficult climatic conditions; infrastructure; packaging and marketing systems. But in the developed world, the end of the chain is far more significant. At the food manufacturing and retail level, large quantities of food are wasted because of inefficient practices, quality standards that over-emphasize appearance, confusion over date labels and consumers being quick to throw away edible food due to over-buying, inappropriate storage and preparing meals that are too large. Per capita waste by consumers is between 95 kg and 115 kg a year in Europe and North America/Oceania, while consumers in sub-Saharan Africa, south and south-eastern Asia each throw away 6 kg to 11 kg a year.

WATER, FOOD AND ENERGY NEXUS IN SOUTH ASIA: A NEW PATHWAY TO SUSTAINABLE ADAPTATION

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ABSTRACT

Adaptation to climate change has received increased attention in recent years in the academic and development discourse. Effective adaptation to climate change requires the efficient use of land, water, energy, and other vital resources, together with coordinated efforts to minimize trade-offs and maximize synergies. The concept of water, energy, and food nexus is considered to be an effective mechanism for enhancing resource use efficiency, minimizing trade-offs, and maximizing synergies in resource use. However, as in many developing countries, the policy process in the countries of South Asia generally follows a sectoral approach that does not take into account the interconnections and interdependence among the three sectors. In designing effective adaptation strategies, it is critical to understand the linkages between the nexus perspective and adaptation to climate change.

This paper seeks to increase understanding of the interlinkages in the water, energy, and food nexus, explains why it is important to consider this nexus in the context of adaptation responses, and argues that focusing on trade-offs and synergies using a nexus approach could facilitate greater climate change adaptation and help ensure food, water, and energy security by enhancing resource use efficiency and encouraging greater policy coherence. The paper provides a conceptual framework for considering the nexus approach in relation to climate change adaptation, discusses the potential synergies, and finally offers a broader framework and reform measures for making adaptation responses more effective and sustainable.

KEYWORDS: *Water-food-energy nexus; Adaptation to climate change; South Asia; Policy coherence; Trade-offs; Synergies*

WHY IS NEXUS-BASED ADAPTATION IMPORTANT?

Climate change is already threatening both the development process and the basic elements of life, such as access to water, energy, food production, and the environment, around the world and especially in developing countries. With 70 per cent of the expected global population of 9.2 billion people living in cities by 2050, demands for water, energy, and food will increase exponentially. The demand for food is expected to raise by 35 per cent by 2030 and for water and energy by 40 per cent each *(Hoff 2011*). Currently, some1.2 billion people live in regions with

insufficient water to meet human needs, and at least 1.5 billion are without access to modern forms of energy. By 2040, one-third of the world's population will live in areas of water stress (*Hajkowicz et al. 2012*). Competition for land for food and energy is expected to increase. In 2008, about 100 million tons of cereals (4.7 per cent of global cereal production) were used in the production of biofuels. Global energy use has approximately doubled over the last 30 years, and by 2040 the demand is likely to grow by more than half again. Thus, competition for land for biofuels is likely to increase further. There is growing evidence that the atmosphere will continue to warm throughout the twenty-first century, which will affect water availability, food production, and energy use and require effective adaptation. Climate change is both affecting and affected by the nexus. The failure to pursue new adaptation pathways for sustainably managing the water food and energy nexus will exacerbate the future climate change thereby perpetuating the vicious cycle of unsustainability.

The global community is looking for new approaches and solutions to adaptation to climate change, as well as to meeting development challenges, such as ensuring water, energy and food security that are critical for human survival and sustainable well-being. Water, energy, and food are all subject to rapidly growing global demand and all face resource constraints, while billions of people lack sufficient access to them (*Bazilian et al.2011*). The ongoing depletion of these strategic resources as a result of unsustainable consumption and production patterns is constraining future economic growth and social progress and threatening the very basis of human survival, and the situation is likely to worsen in the face of increased demands. The Rio+ 20 Declaration "*The Future We Want*" stresses the need for balanced integration of economic, social, and environmental concerns in economic development and also highlights the urgent need to address food, water and energy security in such a manner so as to reduce the adverse impacts on human and natural systems as one of the greatest challenges facing humanity.

Meeting this challenge has emerged as a top priority on the national and international development agenda. Mitigation and adaptation are complementary components of a response strategy to climate change aimed at reducing the extent as well as increasing the resilience to change. Adaptation is critically important in developing countries, where large numbers of people depend on climate-sensitive sectors such as agriculture, forestry, and fisheries; have limited resources and capacity and live in climate-vulnerable settings such as mountains and coastal areas (*WRI 2011*).

The goal of adaptation is to reduce vulnerability to both climatic and non-climatic changes; thus, it is closely linked with the sustainable use and management of water, energy, and food, all of which are vital for sustainable development. The production and consumption of water, energy and food are closely interlinked, forming a nexus, with changes in any one component likely to have a marked impact on the others. However, they still tend to be treated as separate issues, both in regular development planning and in planning for adaptation. The failure to recognize the close linkages can result in counter productive actions that threaten the success and sustainability of planned interventions, which is particularly problematic in adaptation, where changes are being made to enable survival in a future changed situation for which there is no guiding

experience. At the same time, recognition of the nexus offers possibilities for planning to be made more effective. There are several compelling reasons for pursuing nexus- based adaptation as an effective strategy to meet future challenges.

Promoting Synergy and Co-benefits: Although interest in adaptation to climate change impacts has surged in recent years, the focus has remained sectoral. The role of the water-food-energy nexus in addressing the competing demands of and facilitating, adaptation and development has not yet been fully recognized. Historically, most adaptation plans, including the *National Adaptation Programmes of Action* (NAPAs) have been prepared to meet sectoral goals. They generally focus on sectoral and project-based activities, without adequate consideration, or coordination, of cross-sectoral interactions among key climate-sensitive sectors, such as water, energy and foods, which can be used to minimize trade-offs and promote synergy and co-benefits.

Overcoming Maladaptation Practices: Sectoral adaptation strategies can increase vulnerability or undermine net resilience by decreasing capacity or increasing risks in another place or sector, resulting in maladaptation practices (*Walker et al. 2006; Urwin and Jordan 2008; Barnett and O'Neill 2010*). For example, in China, excessive use of pesticides in food production has had a negative impact on health costing an estimated USD 1.4 billion per year and has adversely affected farm and off-farm biodiversity (*Norse et al. 2001*) which in turn has negatively affected food production. Similarly, subsidies for ground water extraction, provided by many South Asian countries to cope with surface-water shortages and uncertainty in water availability, have led to over exploitation of groundwater, wastage of scarce water resources, and increased demand for energy for pumping, ultimately undermining food and energy security. Baluchistan, an arid region of Pakistan, is now growing apples and other fruit through groundwater irrigation which requires huge amounts of energy, while the country faces crippling shortages of energy for other activities (*Mustafa and Qazi 2007; Khair 2013*). Overcoming these problems is not possible without taking a nexus perspective to develop integrated solutions.

Ensuring Policy Coherence and Coordination: The prevailing approaches see adaptation largely a local issue with a community or ecosystem focus (*Huq and Reid 2004*) and ignore the role of the national, regional, and global policies and institutions which shape adaptation options and choices. Local adaptation approaches often prove unsustainable owing to inadequate institutional support (*Agrawal 2010*). Climate change brings multiple stresses, and adaptation requires comprehensive and integrated approaches with coordination between different sectors and at different scales - local, national, and regional. As water, energy and food are critical for human survival and sustainable well-being, managing these vital resources sustainably requires a nexus perspective.

Addressing Planetary Boundary and Resource Scarcity: On going global climate change, the rapidly increasing population, urbanization, globalization, and aspirations for better living standards are already posing a challenge to planetary sustainability, pushing the planet beyond its carrying capacity. Climate change and anthropogenic pressures have exacerbated the pressure on water, energy, and food (*Rockstrom et al. 2009*). All three sectors are both highly vulnerable to climate change and contribute heavily to that change through their greenhouse gas

emissions (*Howells et al. 2013; Callow et al.2011*). Adaptation is therefore, intrinsically linked to water, energy and food security. The nexus approach provides a framework for addressing competition for resources through enhancing resource use efficiency. Although the likely impacts of climate change on water, energy and food production have raised serious concerns and has been emphasized in the pursuit of appropriate adaptation measures, the links among water, energy and food, and the role of this nexus in sustainable adaptation, have not yet been well researched. Failure to consider the nexus of water, energy and food in resource assessments and policy making has led to contradictory strategies and inefficient use of resources (*Howells et al. 2013).*

Need for Urgent Action

With large populations, limited land resources and growing water stress, South Asian countries face the common challenge of how to grow more food with the same or less land, less water, and increased energy prices. Rice and wheat, the staple foods in the sub region, require huge amounts of water and energy. Efficient and coordinated management of water, energy and food is critical for adaptation and mitigation to climate change in the region (*Rasul 2014*).

Organization of the Study:

Understanding the role of the water, energy and food nexus in adaptation is an essential basis for designing effective adaptation policies and strategies; this study using South Asia as an example, argues that in the developing world, focusing on the trade-offs and synergies of the water, energy and food nexus is a potential strategy for integrated and efficient resource management and for adaptation to address future challenges in a systematic way. Following this introductory section, section on "***Conceptualizing Climate Change Adaptation* and *the Water, Energy and Food Nexus*"** provides an overview of the concepts of climate change adaptation and the water, energy and food nexus; section "***Challenges of Food, Water, and Energy Security and Adaptation to Climate Change in South Asia*"** discusses the inter related challenges of water, energy, and food security in the South Asian region and the implications for adaptation to climate change; section "***Synergies in the Water, Energy, and Food Nexus and Adaptation Strategies***" provides a more detailed discussion of the synergies between water, energy, and food and the way in which the nexus perspective can help in adaptation to climate change; and finally, section "***Towards a Nexus-Based Framework for Sustainable Adaptation***" offers a broader framework and reform measures for making adaptation responses more effective and sustainable. The study relies predominantly on information drawn from secondary sources, including books, reports, and journal articles. Some information has been drawn from the research experience of the International Centre for Integrated Mountain Development (ICIMOD) in the HKH region over the past 30 years, as well as the authors' own research experience in the region.

CONCEPTUALIZING CLIMATE CHANGE ADAPTATION AND THE WATER, ENERGY, AND FOOD NEXUS

Although a growing body of literature is emerging on both adaptation to climate change and the water, energy and food nexus, the linkage between the two is rarely explored or articulated in the

policy- program- action continuum. This section briefly examines these concept and their linkages.

Evolving Approaches to Adaptation to Climate Change:

Adaptation has received increased attention in recent years in the academic and development discourse. Different scholars defined adaptation in different ways based on their professional interests (e.g., *Adger et al. 2005; Doria et al 2009; Smit and Wandel 2006; OECD 2009*). In terms of climate change, adaptation has been defined as the process or adjustments through which people reduce the adverse effects of climate on their health and well-being and take advantage of the opportunities that their climatic environment provides *(IPCC 2007*). Adaptive capacity and vulnerability are thus important concepts for understanding adaptation. While vulnerability can be seen as the context in which adaptation takes place, adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, in order to reduce adverse impacts and take advantage of new opportunities (*World Bank 2010*).

The concept of adaptation continues to evolve, however, and its focus is gradually changing from simply responding to the impacts of climate change to addressing the underlying factors that cause vulnerability. More specifically, approaches to adaptation have evolved from the initial infrastructure-based interventions to a more development-oriented approach based on building broader resilience to climate hazards by addressing the underlying causes of vulnerability rather than simply responding to the symptoms (*Calow et al. 2011; Davies et al.2013*). Transector and transboundary considerations, however, are only just emerging. Table 1 shows how adaptation approaches have evolved over the past two decades in terms of assessment of risks, mainstreaming, focus, and scope. In the 1990s, the focus was on assessment of the climate risks and aimed at reducing climate impacts using a locally specific sectoral approach. In the 2000's, the theory of adaptation, including the notion of mainstreaming gained momentum faster than policy and practice, although the sector-based approach still dominated in mainstreaming. In the current decade, the emphasis has shifted, with adaptation linked more towards sustainable development. There has been a shift away from sectoral approaches and an emerging emphasis on cross-sectoral and transboundary approaches, for example, focusing on river basins.

Broadly, there are two distinct perspectives on how to approach adaptation in developing country contexts. The first focuses on reducing climate change impacts. The second focuses on reducing vulnerability by addressing not only climate change but also other drivers of vulnerability and poverty such as gender and social equity, as well as other structural factors hindering long-term sustainable development.

In practice, most interventions fall somewhere between these two extremes. The development-oriented approach emerged based on the underlying premise that people are vulnerable not only to climate change but also to arrange of other stresses, depending on access to resources and other socio-environmental circumstances shaped by political and economic processes (*Kelly and Adger 2000; O'Brien et al.2004*). Technological measures designed to adapt to specific changes in climate may fail to address the issues local people consider most urgent, such as access to water, food and energy and livelihood security.

TABLE 1: EVOLVING APPROACHES TO ADAPTATION

Feature	***1990s***	***2000s***	***2010s***
Overall Objective	***Reducing Climate Risks and Impacts***	***Reducing Climate Risks and Uncertainties***	***Reducing Climate Risks and Impacts With Socio Economic Improvements Main Streaming Climate Change Adaption and into Development***
Scope	*Sector-based approach, location specific*	*Sector-based approach ,but adaptation main streamed into sectoral planning*	*Trans-sector and transboundary approaches started*
Focus of activities	*Protective: coping strategies, protection of those most vulnerable to climate risks and with low levels of adaptive capacity*	*Preventive: coping strategies, prevention of damaging strategies arising from risks to climate-sensitive livelihoods*	*Transformative: building adaptive capacity, transforming social relations to combat discrimination and underlying social and political vulnerability*
Activities	*Activities seek to address impacts exclusively associated with climate change: provision of social services; social transfers (food/cash), including safety nets*	*Managing Climate Risks: activities seek to incorporate climate-related information into decision-making*	*Building Response Capacities:* *activities seek to build robust system for problem solving* *Addressing the drivers of vulnerability* *activities seek to reduce poverty and other non-climatic stressors that make people vulnerable*

Sources*: Adapted from Davies et al. (2013) and Calow et al. (2011*)

It is increasingly recognized that successful adaptation will require interventions that address the full spectrum of challenges, including underlying causes of vulnerability, in the context of other theories of risk and development. As pointed out by *Schipper (2007*), "*mainstreaming will not be effective if esisting development trajectories are inconsistent with the objectives of adaption*. It is vulnerability reduction that should be integrated into development policy, rather than the creation of explicit adaptation strategies. In this sense, focusing on adaptation before aligning

development processes through the creation of enabling conditions for adaptation is like "***putting the cart before the horse.***"

Concept of Sustainable Adaptation

Debates on climate change adaptation have taken place largely outside the broader discourse on sustainable development (*Bizikova et al. 2013*). Sustainable development has only been included as a theme by the IPCC since the third assessment (*Munasinghe and Swart 2000*), and little attention has been paid to the identifying principles that create synergies between adaptation and sustainable development. Climate change adaptation can be made more relevant to policy by contextualizing it within a sustainable development framework (*Robinson and Herbert 2001*). *Eriksen et al. (2011)* defined: "sustainable adaptation as "a set of actions that contribute to socially and environmentally sustainable development pathways, including social justice and environmental integrity". It considers the wider effects of adaptive responses on other groups, places, and socio-ecological systems, both in the present and in the future." According to *Doria et al. (2009, p.815),* "Successful adaptation is that adaptation that generates net benefits for the adapting party, in both the short- and long-term, without causing net loss of welfare for the wider society." A sustainable adaptation process requires adjustments in policies, institutions, and attitudes to establish enabling conditions for sustainable development through reduction of vulnerability, while at the same time overcoming factors that cause vulnerability to climate change. Considering that note very adaptation intervention reduces poverty and inequality (and some poverty reduction measures may aggravate vulnerability), sustainable adaptation measures need to specifically target the nexus between vulnerability and poverty (*Eriksen and O' Brien 2007; Eriksen et al. 2011*) while emphasizing transitions to low-carbon economies (*Winkler and Marquand 2009).*

Principles of Sustainable Adaptation:

Although as yet there is no framework or set of principles for sustainable adaptation agreed by all stakeholders, certain key principles can be discerned:

- Adaptation is an integral part of sustainable development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs, grow and adapt.
- Adaptation must be addressed in a comprehensive and intersectoral manner, as part of overall development.
- Adaptation of one sector or one community should not lead to a net loss of welfare for the wider society.
- Adaptation responses and mechanisms should be sensitive to the needs of local communities and their resources, knowledge, and culture.

Concept of Food, Water and Energy Nexus:

The discourse on food, water, and energy security is driven by the growing pressure on natural resources. The demand for food, water, and energy is growing steadily, but the resources required to generate them are limited and in many cases dwindling (*Rockström et al.2009 a,b; State of the Planet Declaration 2012*).The interdependencies among water, energy and food are

numerous and multidimensional; this relationship is often called the ***Food, Water and Energy Nexus*** (although the order of the components may vary). Though the discourse on this nexus has been gaining currency (*Marsh and Sharma 2007; Hoff 2011; Hussey and Pittock 2012*) but how the concept can be applied to ensure food, water and energy security is not yet clearly understood. Understanding the different inter faces in the food, water and energy nexus is critical for taking sustainable adaptation action to address food, water and energy security.

Complex Interrelationships

- ***Water for Food and Energy***: Water plays a vital role in food and energy production and in sustaining the ecosystems which support agriculture and other economic activities that are critical for achieving food security (*Molden 2007; Hellegers et al.2008*).
- ***Energy for Food and Water***: Energy is required for food production (especially irrigation) and for water supply, including extraction, purification and distribution of water (*Nonhebel 2005; Bazilian et al.2011*). Nearly 7 per cent of the world's commercial energy production is used for managing the fresh water supply (*Khan and Hanjra 2009*). Agriculture accounted for almost 21 per cent of the total power consumption in India (*Kumar et al.2012*).
- ***Agriculture and Land for Energy and Water***: Agriculture has a dual role as an energy user and as an energy supplier in the form of bioenergy. Sustainable agricultural practices such as actions to avoid land loss or degradation save water by increasing soil water storage and groundwater recharge. They also save energy, for example, by reducing the use of energy-intensive fertilizers. Agriculture and food production have a further impact on the water sector through their effects on land condition, runoff, groundwater discharge, water quality, and availability of water and land for other purposes such as natural habitat (*Alauddin and Quiggin 2008*).

The relationships among food energy and water are dynamic. Actions in one area usually have had impacts on one or both of the others, with profound economic, environmental and social implications. Indeed, the security of one sector often cannot be achieved without undermining security in another sector (*Newell et al 2011*). The environmental footprints associated with increased water and energy use or food production impose external costs to water and ecosystems, thus threatening the sustainability and resilience of global water and food system (*Khan and Hanjra 2009*).

The nexus approach aims to systematize the interconnections and proide tools to acces the use of all resources (Hermann *et al.2012*). It is a system-wise aopproach; it recognizes the inherent interdependence of the food, water and energy sectors for resource use, seeks to optimize the trade – off and synergies and recognizes the social and environmental consequences (*Bazilian et al 2011; Prasad et al 2012).* Understanding the linkages within the food energy and water nexus can provide opportunities to increase resource use efficiency and enhance cooperation and policy coherence among the three sectors. For example sustainable agricultural practices, such as those designed to prevent land degradation, save water and energy by increasing water storage in the soil and groundwater recharge and by reducing the use of energy-intensive fertilizers. The nexus

perpective should help to promote inter disciplinary and mutaually beneficial actions (*Scott et al 2011).* It can contribute to meeting the future needs of the global population, particularly those who do not have accesses to safe drinking water and modern energy *(Marsh 2008).* From this perspective, identification of crucial interactions, conflicting demands, and potential synergies in the water, energy and food nexus can be a powerful entry point for achieving sustaibale adaption.

Key Principles of the Nexus Approach:

The nexus approach is centred on core principles of efficiency, equity and sustainability. Thje fundamentals of the approach can be summarized as follows:

- Understand the interdependence of subsystems within a system across space and time, and focus on system efficiency (using a system-based approach to natural resources policies and regulations rather than the productivity of individual sectors to provide integrated solutions that contribute to water energy and food security and sustainable development.
- Recognize the interdependence between water, energy, and food and promote the wise development and efficient use of these resources in an environmentally responsible manner.
- Identify crucial interactions, conflicting demands, and potential synergies to minimize trade-offs and maximize synergies across sectors, and encourage mutually beneficial responses that enhance the potential for cooperation between and among all sectors.
- Ensure policy coherence and coordination across sectors to build synergies and generate co-benefits to produce more with less, while reducing loss and waste in the spirit of the 3Rs principle– ***Recharge, Retain and Reuse*** – and contributing to long-term sustainability with limited environmental impact.
- Value the natural capital of land, water, energy, and ecosystems to support the transition to sustainability.

Interfaces between Water, Energy and Food Nexus and Adaptation Strategies

The water, energy, and food nexus and adaptation responses are interlinked in numerous ways. Understanding the interlinkages is critically important for policymakers in devising sustainable adaptation strategies. Table 2 shows the links between the adaptation response and nexus approaches, which share many common features, while indicating complementarities and co-benefits from nexus-based adaptation.

CHALLENGES OF FOOD, WATER, AND ENERGY SECURITY AND ADAPTATION TO CLIMATE CHANGE IN SOUTH ASIA

South Asia is one of the most dynamic regions of the world in terms of population growth, economic progress, urbanization, and industrialization. The demographic, economic, and environmental changes in South Asia have increased the demand for resources, including food, water, and energy, and intensified their use, which has serious implications for adaptation strategies to ensure food, water, and energy security in the region.

The population of South Asia almost tripled from 588 million to 1.6 billion in the half century from the late 1950s to2010 and is expected to reach 2.2 billion by 2025. With high population

TABLE 2: COMPLEMENTARITIES AND CO-BENEFITS FROM NEXUS-BASED ADAPTATION

Key Characteristics	***Nexus Approach***	***Climate change adaptation***	***Complementarities and Co-benefits from nexus- based Adaptation***
Goal	*Ensure efficient use of available resources to support transition to sustainability*	*Build resilience and enhance adaptive capacities against climate and other risks*	*Understanding adaptation to climate change is critical for addressing nexus challenges and efficient use of resources is critical for effective adaptation*
Core Principles	*Minimize resource waste and maximize economic efficiency, while accelerating the sustainable supply*	*Reduce vulnerability by managing climate risks and building response capacity*	*Since resource scarcity often increases people's vulnerability, the nexus approach may contribute to facilitating adaptation and vice versa*
Main Focus	*Provide integrated solutions that contribute to sustainable development*	*Minimize shock, risks, and vulnerability and address impacts and risks associated with climate change*	*Cross-sectoral nexus analysis identifies trade-offs and synergies and integrates policy implementation*
Broad Strategies	*Policy integration ,harmonization ,and governance to build synergies and generate cobenefits across sectors in a sustainable way*	*Addressing the drivers of vulnerability to climate change in specific sectors through building adaptive capacity and resilience*	*Diversification increases resilience; the nexus strategy is critical for integration of climate adaptation and mitigation, while broadening the scope to address poverty-vulnerability linkages*

growth and industrial development, cereal demand is projected to rise to 476 million tons by 2025, compared to 241 million tons in 2000 (*FAO 2011*). But this higher agricultural production has to come from the same amount of land and may be even from less land, because of competing uses arising from population growth, urbanization, and industrialization. Per capita food consumption has remained stagnant in many parts of South Asia in recent years, despite impressive growth in per capita income (*Alagh 2010*). Low levels of consumption have contributed to persistent hunger and malnutrition (*Dev and Sharma 2010*) in South Asia.

Increasingly Water-Energy Intensive Food Production in the Face of Water and Energy Scarcity

Agriculture consumes about 90 per cent of the water and 20 per cent of the total energy used in the region. Water, once considered abundant, has become increasingly scarce with declining per capita water availability in Pakistan, India (*Gupta and Deshpande 2004*), and China (*Liu et al.2007*). With about 60 per cent of the population in India and 65per cent in Pakistan relying on groundwater for irrigation (*Qureshi et al. 2010*), they are already extracting ground water 56 per cent and 25 per cent faster than it can be replenished, respectively. The increased extraction of ground water has increased demand for energy and lowered the groundwater table in many parts of the HKH region, especially the north western Himalayas. This has created a serious concern for the entire region, as the shortage of water and energy severely constrains not only agriculture but also the overall economic growth and human well-being. For example, the energy shortage in Pakistan is causing a loss of about US $1 billion and 400,000 jobs per annum (*GoP 2013*). The situation is similar in Bangladesh, India, and Nepal and is challenging overall macroeconomic stability. Despite the complex interdependency of food, water, and energy among competing uses, each Country in the HKH region has put forward a *NAPA* to address the issues /impacts of climate change using a sectoral adaptation approach, with little or no attention being paid to a nexus-based system-wise adaptation approach to deal with the vulnerability to climatic and non-climatic changes. Considering that water, energy, and food are the vital resources for poverty and vulnerability reduction, it is critically important to prioritize and devise an integrated adaptation option based on a nexus assessment that reduces vulnerability to both climate and non-climate changes.The key features and challenges of food, water, and energy security and their interlinkages are summarized in Table 3.

SYNERGIES IN THE WATER, ENERGY AND FOOD NEXUS AND ADAPTATION STRATEGIES

Sustainable adaptation options reduce vulnerability to both climate and non-climate changes and Address vulnerability-poverty linkages. As water, energy, and food are vital resources for poverty and vulnerability reduction, understanding the linkages among them is critical for adaptation planning. This section attempts to explore potential areas of trade-offs and synergies or comple- mentarities in the water, energy, and food nexus as a new tool to support development of integrated adaptation strategies. Given the complex inter play of water, energy, and food demand and supply, numerous challenges and opportunities exist to minimize trade-offs and promote synergies to formulate sustainable adaptation options.

TABLE 3: KEY FEATURES AND CHALLENGES OF FOOD, WATER, AND ENERGY SECURITY IN SOUTH ASIA

Key Characteristics	Adaptation Challenges	Food, Water, and Energy Resources and Adaptation to Climate Change
Food Security	**Food Security**	**Food Security**
Huge chronically undernourished population. About half of the world's poor (46 per cent) and 35 per cent of the world's undernourished live in South Asia *About 25per cent of the world's population (projected to reach 2.3 billion by 2050) live in just 3 per cent of the world 's land area* *Declining crop land: Per capita arable land continually declining due to population growth, urbanization, and increasing biofuels cultivation to meet the energy demand* *Intensive food production: Food production becoming Increasingly water and energy intensive* *Changing food preferences toward meat:* *The meat production process requires more energy and water* *Sensitivity to climate change: Food*	*Provision of food, water, and energy to a large malnourished population without degrading the natural resource base and environment* *Burgeoning human population: To feed the growing population, agricultural production will have to increase by 70 per cent, energy by 40 per cent, and water by 57 per cent* *Limited options for growing more foodgrains by expanding crop area* *Adapting to the declining groundwater table* *About 7 kg of grain equivalent energy is required to produce 1 kg of meat* *Uncertainty in water availability due to rapid glacier melt and changes in monsoon pattern in the Himalayas*	*To meet the nutritional needs of all, food production needs to double in the next 25 years* *Increased pressure on land, water, and energy to meet the increased demand* *Competing demand for land for food* *Agricultural growth is constrained due to shortage of energy and water* *Increased pressure on water to meet the food requirement* *Climate change is likely to be a critical factor in increasing water and energy demand for food production and land demand for biofuels production*

production is highly vulnerable to climate change due to rising temperatures, accelerated glacial melting, increased evapotranspiration and erratic rainfall,		
Water Security	***Water Security***	***Water Security***
Growing water stress: Growing water demand for agriculture, energy, industry, and human and livestock use; annual water demand is predicted to increase by 55 per cent by 2030 compared to 2005 *Upstream- downstream dependence on water high dependence of downstream communities on the upstream for water to grow food and generate hydropower* *Increased dependence on groundwater for food production* *About 70 to 80 per cent of agricultural production depends on groundwater irrigation*	*Providing access to safe drinking water in face of an increasing variability in water supply* *Need for enhanced upstream-downstream coordination and cooperation for sustainable development of HKH water resources* *Adapting to declining water tables*	*Water-intensive adaptation practices leading to increased water pollution and water borne diseases, high child mortality and poor human health* *Rivers originating in the mountains area life line for dry-season water for irrigation, hydropower, and major economic activities* *Ground water pumping for irrigation requires excessive energy which further increases electricity demand* *Food water and energy resources and adaption to climate change*
Energy Security	***Energy Security***	***Energy Security***
High energy poverty *About 63 per cent of the population without access to electricity; 65 per cent use biomass for cooking* *Underutilized potential for hydro power and clean energy*	*Providing adequate and reliable energy to a large population without increasing population* *Adaptation options are restricted*	*Growing demand for water and land for energy production* *Energy diversification to meet the growing demands of food, water, and economic growth*

Source: Rasul,G, Sharma, B.(2015)

While some adaptation measures such as water use efficiency, renewable energy, and growing biofuels on waste land might have positive implications for water, energy, and food resources, other measures for adaptation and mitigation such as extensive groundwater pumping, desalination plants, and interbasin transfers of water to deal with water scarcity, and growing biofuels to deal with fuel scarcity, may increase nexus challenges (*Bazilian et al. 2011*). Clearly, any policy designed to reduce vulnerability to climate impacts in one sector will affect and be affected by water, energy, and food linkages.

Promises of a Nexus-Oriented Approach for Sustainable Adaptation: Potential for Synergy

Some sector-specific adaptation measures have the potential to provide synergistic "win-win" opportunities to enhance climate mitigation or adaptation objectives across one or more of the other sectors in the nexus, while other measures may have negative impacts on mitigation or adaptation potential in other sectors (Table 4). For example, increasing the efficiency of freshwater use as an adaptation measure has the potential for synergy across sectors, as it increases the availability of water for energy and agriculture, while reducing emissions per capita. But at the same time, it has potentially negative implications because resiliency gains from water use reductions may be lost if conserved water is used to expand planted acreage. Similarly, mere provision of irrigation water does not guarantee productivity because salinization induced by irrigation reduces productivity. Electricity production in China and India also has water use and carbon emission impacts, 78 per cent and 52 per cent of total electricity, respectively, and is generated using fossil fuels (coal).

Electricity generation from wind or photovoltaic is typically much less water intensive than generation from fossil fuels. Water smart technologies can save both water and energy while improving food security. For example, micro-irrigation technologies, such as drip and sprinkler irrigation methods, have been proven to be highly efficient in increasing crop productivity while using less water, thereby saving both water and electricity, which is widely use for pumping groundwater (*Narayanamoorthy 2007*). Experience has shown how increasing water use efficiency could be a win-win option for nexus-based adaptation (*UNESCO 2009*). In planning and policy, full consideration of such cross-sectoral interactions is critical to devising adaptation options for enhancing synergies and reducing risks.

There are also strong links between energy, food security, and adaptation. Universal access to adequate, affordable, and reliable renewable energy is both an adaptation and a mitigation response to climate change and also enhances other options and choices for adaptation. Growing biofuels on waste land can enhance the energy supply and thus reduce dependence on fossil fuels. However, diverting cultivable land for biofuels can threaten food security. Holistic adaptation to climate change can also support achieving nexus security by reducing vulnerability and minimizing the risk of disasters. Understanding the potential synergies in the water, energy, food, and adaptation nexus is critical for effective adaptation and sustainable development.

TABLE 4: SYNERGIES BETWEEN CLIMATE CHANGE ADAPTATION AND NEXUS APPROACHES

Sector	Sector-Specific Adaptation Measures	Positive Implications for the Sector	Potential for Synergies Across the Nexus
Water	*Increasing water use efficiency* *Switching from use of fresh water to waste water* *Switching from wet to dry cooling at thermo electric power plants Desalinization* *New storage and conveyance of water to serve new demands*	*Reduces water use per capita* *Reduces fresh water use per capita* *Reduces water use and associated thermal pollution* *Increase in brackish and fresh water supplies* *Increased water supplies to meet demand*	*Increased availability of water for energy and agriculture* *Increased availability of fresh water for food energy, and other uses* *Increased availability of fresh water and overall water supply for energy, agriculture, and other uses* *Increased water supply for energy and other uses, improved water quality, reduction in flood potential*
Land	*Switching to drought-tolerant crops* *Using waste or marginal land for biofuels energy*	*Reduce vulnerability by managing climate risks and building response capacity*	*Reduced water demand* *Reduced pressure on non renewable energy as some fossils fuels are replaced with biofuels*
Energy	*Increasing transmission capacity* *Increasing renewable energy e.g., solar, wind, biogas*	*Reduced economic and social impacts* *Increased clean energy and reduced pressure on energy*	*Potential for reduced emissions if new transmission and wind/ solar power supplied to the grid* *Reduced green house gas emissions, reduced water demand for cooling, thermal power*

Source: Skaggs et al. (2012)

Nexus-based adaptation offers a pathway to a nexus-smart green economy. For such a transition, efforts to attain food security need to be water, land, and energy smart; efforts to achieve energy and climate protection goals need to be water and land smart; and efforts to reach water goals need to be energy and climate smart. As an example, the so-called *Jyotigram* scheme for improved access to energy for both households and irrigation (water pumping) in Gujarat, India, is a promising integrated approach which has significantly reduced groundwater overexploitation and increased energy and food security, while raising Gujarat's GDP growth above that of the rest of India (*Shah et al. 2009*). Another example of a nexus-smart green economy is the Mongolia capital, Ulan Bator, the world's second most polluted city, where a 50-MW wind farm was built that will save 18,000 tons of carbon dioxide and 1.6 million tons of water each year. It has led to an abundant potential for a green environment that can help poverty eradication and provide jobs and sustainable development (*Slezak 2013*).

There are a number of ongoing approaches that can contribute to development of a nexus-smart green economy that supports adaptation. For example, REDD+ intervention (reducing emissions from deforestation and forest degradation) is a promising adaptation measure to conserve or enhance biodiversity and forest ecosystem services (*Danielsen et al.2011*). REDD+ contributes to mitigation, by increasing carbon sequestration, and canals obeused as an entry point to support more efficient fuel use. At the same time, measures to improve water use and energy efficiency can also support the sustainability of REDD+ interventions and ensure the permanence of carbon stocks by preventing activity displacement and induced deforestation and by limiting or avoiding damage to the ecosystem from extreme weather events. Similarly, payment for ecosystem service (PES) approaches have a potential to contribute to adaptation by enhancing the provision of ecosystem services, enhancing adaptive capacity, and providing incentive mechanisms to encourage communities to adopt specific measures for adaptation to climate change (*vande Sand 2012*). Costa Rica's PES program demonstrates ways to conserve and regenerate ecosystems and thus improve long- Term adaptive capacity (*Sánchez-Azofeifa et al.2007*)

TOWARD A NEXUS-BASED FRAMEWORK FOR SUSTAINABLE ADAPTATION

South Asia faces a difficult challenge in meeting the growing demands of the burgeoning population for food, water, and energy, and the problem of ensuring food, water, and energy security is further compounded by climate change. The goal of adaptation to climate change is to reduce vulnerabilities to both climatic and non-climatic changes; thus, it is closely linked with the sustainable use and management of water, energy, and food, which are also vital for sustainable development.

Understanding the role of the water, energy and food nexus in adaptation is a key to designing effective adaptation policies and strategies. The nexus approach is a system-wise approach that recognizes the inherent interdependencies of the food, water, and energy sectors for resource use and seeks to optimize the trade-offs and synergies, thus enabling adaptation responses to be made more effective and sustainable. The nexus outlook can also help to stimulate critical

thinking on aligning the sustainable development goals (SDGs) with planetary boundaries in the post-2015 development agenda.

The nexus perspective is critical to ending a common solution for all three sectors, by determining and resolving trade-offs and exploiting potentials for synergy to meet the increasing demand without compromising sustainability. Strategies to facilitate adaptation to climate change need to incorporate the dynamics among water, energy, and food and develop mechanisms for progressive and transformational change that moves from sectoral to trans-sectoral adaptation. The nexus approach requires a major shift in the decision making process towards taking a holistic view and developing institutional mechanisms to coordinate the actions of diverse actors and strengthen complementarities and synergies among the three sectors (*Rasul, 2015*). The complex interplay of food, energy, and water demand and supply requires a holistic approach to address the twin challenges of poverty and vulnerability for sustainable adaptation. A framework is required in order to move from a sectoral to a holistic approach. Development of a detailed framework is beyond the scope of this paper; however, abroad approach and some key elements of the framework are suggested below for pursuing a nexus based pathway for sustainable adaptation.

First and foremost enabling condition for such adaptation pathway is the need to take a system-wise, integrated adaptation perspective in determining the trade-offs and synergies associated with the complex interplay of food, energy, and water demand and supply to ensure the security of all three sectors. This calls for ensuring policy coherence and cross-sectoral coordination, harmonizing priorities and nexus smart investment and technologies.

These enabling conditions relate to targeting outcomes of nexus smart policy interventions that underpin the three sustainability dimensions: economic (increasing resource efficiency), social (accelerating access for all), and environmental (investing to sustain ecosystem services). Finally there is a need to target the vulnerability-poverty linkages (over lap between poverty eradication and vulnerability reduction) to reduce poverty and vulnerability concurrently, rather than treating them separately, in order to ensure that adaptation solutions are sustainable.

The framework illustrates the need to understand how the context of vulnerability to both climate and non-climate change influences the development of poverty and how people adjust their adaptation strategies, before devising a nexus-based response strategy. It also shows why adaptation should be an integral part of sustainable development, with climate change implications factored into all development planning, decision-making, and implementation (*Leal 2011)*. In this sense, the framework underscores the importance of identifying the potential synergies and trade-offs between adaptation and mitigation measures and of integrating them in a two-pronged approach to managing the short-and long-term disturbances to the climate in the pursuit of sustainable development. The following are some broad recommendations:

- ***Tap New Water and Energy Sources to Alleviate Competition across Sectors*****:** New sources of water and energy should be exploited through investment in renewable energy, rain and storm water harvesting, widely distributed water storage activities, and reuse of water to alleviate competition across sectors for water and energy.

- ***Deepen the Nexus Knowledge Base*:** Develop analytical frameworks to better understand challenges and to find opportunities for potential synergies in the water, energy, and food nexus and sustainable adaptation. There is a dearth of knowledge and universal metrics about interconnections between water, food, and energy in terms of resource use intensity and the possible areas of trade-offs and synergies, including benefit and cost dynamics and their distributive implications. Existing nexus metrics which define an output per unit input are limited to two sectors only.
- ***Promote a System-Wise Adaptation Approach for Win-Win Solutions*:** Move from a sectoral to a trans-sectoral approach so that different adaptation responses and measures support each other, synergy is enhanced, and trade-offs are minimized and efficiencies are enhanced.
- ***Strengthen Policy Integration and Policy Coherence*:** Strengthen policy integration and policy coherence, while strengthening institutional capacity for coordinating/managing the water, energy, and food nexus and adaptation together in a holistic way, through stronger integration and governance mechanisms across sectors and among the major actors (public-private-civil society partnerships).
- ***Protect Essential Natural and Environmental Resources*:** Protect essential natural and environ-mental resources and design mechanisms to include externalities into decision-making by introducing appropriate incentives and regulations.
- ***Place Nexus-Smart Policy for Adaptation at the Center of National Development Strategies*:** Operationalizing the nexus perspective as a tool for adaptation requires appropriate nexus smart policies and institutional capacities to manage coordination across sectors. Such a perspective offers a powerful policy tool for moving form dual nexus for two set of resource (e.g., water-food, food-energy, water-energy) to triple nexus approach to address adaptation challenge and modify development trajectories and outcomes, so salient in achieving the sustainable development goals.

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FOOD INSECURITY AND MANAGEMENT OF RISKS

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Food insecurity is a state where:

- food is not systemically available at all times;
- food that is available is not culturally acceptable[2], where culture is broadly defined to include religious beliefs, customs, usage and practices;
- people do not have economic access to food;
- people do not have physical access to food;
- people do not have social access to food;
- food that people do not consume has the requisite nutritional value[3] for a healthy life; and
- people do not have access to potable water, for absorption of food by the body.

Granted that, food insecurity exists when one or more of these conditions exist. Clearly, not only is it important to ensure availability of food (obviating condition (i) above) but also to guarantee that people have adequate physical, social, cultural and economic access[4] to food to meet their dietary needs and food preferences for an active and healthy life[5]. Thus increased food

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[2] *The phrase "**culturally acceptable**" food is to be widely interpreted to also mean, amongst other things, food that meets religious edicts, including Halal Food, Kosher Food, Vegetarian Food and Jain Food. It is important to bear in mind that food that is "culturally acceptable" and food that is preferred ("food preference") connote different concepts. The former is exogenous while the latter in endogenous. One may prefer to a particular food (say eat fish) but he may not do so as there may be a religious injunction against eating fish.*

[3] *This implies that food is safe. Unsafe food is not considered as nutritious food.*

[4] *The lack of access, of all forms, could be temporary, due to natural disasters, economic collapse, or conflict, or permanent, due to persistent poverty and lack of economic development.*

[5] *At the household level, the food insecurity status of each household lies somewhere along a continuum ranging from highly food insecurity freedom to very low food insecurity freedom and can be divided into four kinds. **High degree of freedom from food insecurity:** Households have no problems, or anxiety, about consistently accessing adequate food. **Marginal level of freedom from food insecurity**: Households have problems or anxiety at times about, accessing adequate food, but the quality, variety, and quantity of their food intake are not substantially reduced. **Low level of freedom from food insecurity**: Households*

production, to circumvent condition (i) above and elimination of poverty, to tackle condition (iii) above, are important, "but much else also needs to be done", including amongst other things:

- enhancement of general economic growth,
- expansion of employment and decent rewards for work,
- diversification of production,
- enhancement of medical and health care,
- arrangement of special access to food on the part of vulnerable people (including deprived mothers and small children),
- spread of basic education and literacy,
- strengthening of democracy and the news media, and
- reduction of gender based inequalities.

These different requirements call for an adequately broad analysis alive of the diversity of causal antecedents that lie behind the many sided nature of food insecurity[6] in the contemporary world (Sen 1997).

MEASUREMENT OF FOOD INSECURITY

While defining food insecurity is relatively easy, measuring it is somewhat more difficult. Food insecurity in many ways is a severe form of poverty. Though poverty and food insecurity are closely related, they are not direct measures of each other. Shifts and trends in poverty may foretell similar changes in food insecurity, but not necessarily so. Because people must eat to survive, they will often sacrifice many other basic needs, such as clothing, shelter and transportation, before they decide to suffer food insecurity. Thus a person may be able to avert food insecurity but in the process may lapse into other forms of poverty.

Amongst the widely accepted measure of food insecurity is the percentage of the population, especially of children, who are undernourished, which reflects both the average amount of food available per person as well as the extent to which people can access food in a country. Stunting, wasting and under-weight children can also be taken as proxy measures of food insecurity. (See Table 1 below for definitions of some of these terms). According to the MDGs hunger can be measured with the two indicators suggested, namely, (i) prevalence of underweight children fewer than 5 years of age and (ii) proportion of population below minimum level of dietary energy consumption.

SHOCKS AND RISKS AS CAUSES OF FOOD INSECURITY

Amongst the causes that lead to food insecurity risks and shocks faced by poor people are the foremost. Risks, in the context of food insecurity, denote an uncertain outcome of events that can damage the well being of the people, by pushing them into food insecurity or deepening the same

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reduce the quality, variety, and desirability of their diets, but the quantity of food intake and normal eating patterns are not substantially disrupted. ***Very low level of freedom from food insecurity****: At times during the year, eating patterns of one or more members of the household are disrupted and food intake reduced because the household lacked money and other resources for, and faced conditions not conducive to, accessing food.*

[6] *Sen, Amartya (1997): "Hunger in the Contemporary World", Discussion paper DEDPS/8 (London, STICERD, London School of Economics) November*

and shock means an adverse realization of a stochastic variable. Risk is thus an ***ex-ante*** concept and shock is an ***ex-post*** one.

TABLE 1: SOME FOOD SECURITY RELATED CONCEPTS

Undernourishment *describes the status of people whose food intake does not include enough calories (energy) to meet minimum physiological needs.*

Malnutrition/Under-nutrition *is defined as a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain natural bodily capacities such as growth, pregnancy, lactation, learning abilities, physical work and resisting and recovering from disease. The term covers a range of problems from being dangerously thin (*underweight*) or too short (see* Stunting*) for one's age to being deficient in vitamins and minerals or being too fat (obese).*

Stunting *reflects shortness-for-age; an indicator of chronic malnutrition and calculated by comparing the height-for-age of a child with a reference population of well nourished and healthy children*

Wasting *reflects a recent and severe process that has led to substantial weight loss, usually associated with starvation and/or disease, calculated by comparing weight-for-height of a child with a reference population of well nourished and healthy children. It is often used to assess the severity of emergencies because it is strongly related to mortality.*

Underweight *is measured by comparing the weight-for-age of a child with a reference population of well nourished and healthy children.*

Source*: Bread for the World (2004), Mukherjee (2004*)

Knowing that a crisis may descend anytime, not knowing whether one will be able to cope with it, are all parts of poor men's landscape of life. Poor people are exposed to a wide array of risks and shocks. This has generated a forbidding amount of literature on the various aspects of risks and shocks in developing countries including their sources and kinds, their effects on poor households as also on individual, household and community responses to managing these.

There are various ways in which risks and shocks can be classified. For example risks and shocks can be classified as political, environmental, economic and social risks (Holmes and Jones, 2009). Risks and shocks can be classified as macro, meso and micro risks. Risks and shocks can also be broadly categorized into: *idiosyncratic* and *covariate* risks and shocks (Bhattamishra and Barrett, 2007). All classifications have their own advantages and disadvantages. There can also be various combinations and permutations of these risks and shocks. For example, economic risks and shocks can be either idiosyncratic or covariate.

Similarly idiosyncratic and covariate risks and shocks can be at the macro, meso or micro level. Table 2 below presents the various combinations of risks and shocks. In this paper we discuss the issue of food insecurity and risks in terms of idiosyncratic and covariate risks as it helps both to keep the discussion uncomplicated and formulate policy options without much complexity.

WHAT DO WE MEAN BY IDIOSYNCRATIC AND COVARIATE RISKS AND SHOCKS?

Idiosyncratic risks and shocks are those risks and shocks where the experience of one household in this regards is typically unrelated to the experience of neighbouring households' experiences. Covariate risks and shocks are those risks and shocks which many households in the same locality suffer. For ease of understanding we shall discuss the link between food insecurity and shocks only, given their *ex post* character.

TABLE 2: MAIN SOURCES OF IDIOSYNCRATIC AND COVARIANT RISK

Idiosyncratic	*Covariant*		
Risks affecting an Household (micro)	*Risks affecting individual or communities (meso)*	*Risks affecting groups of households nations (macro)*	*regions or*
Type of risk	←	→	
Natural		*Rainfall,*	*Earthquake*
Landslide,	*Flood,*		
Volcanic eruption	*Drought*		
High winds			
Health	*Health Emergencies*	*Epidemic*	
Injury			
Disability			
Old age			
Death and funerals			
Debt			
Displacement			
Social	*Crime,*	*Terrorism*	*Civil strife,*
Domestic violence,	*Gang activity*	*Wars,*	
Lack of intra-household	*Voicelessness*	*Social upheaval,*	
Power,	*Absence of social capital*		*Social Exclusion,*
Time Poverty,			*Discrimination,*
Life Cycle Status			*Poor implementation of laws,*
Economic	*Job loss*	*Unemployment*	*Changes in food prices,*

Wage cut *Loss of crop production* *Business Failure* *or currency crisis,* *Fall in financial resources,* *Technology shock,* *Terms of trade shock,* *Transition costs of* *economic reforms etc,* *Fall in Aid flow,*	*Displacement* *Harvest failure* *Fuel or financial,*	*Growth collapse,* *Hyperinflation,*
Lack of regulatory framework, *Lack of enabling environment*		
Political *Political default on* *social programs,* *Coup d'etat*		*Riots*
Environmental *Deforestation* *Nuclear disaster*		*Pollution*

Source: World Bank, 2001 *and* ***Holmes and Jones, 2009.***

Idiosyncratic shocks commonly arises due to chronic illness or sudden illness (usually not the infectious diseases), crop yield shocks associated with microclimatic variations, localized wildlife damage, loss of draught power due to death or maiming of animals used in cultivation/transportation, pest infestation, and one-off events such as property loss due to fire, theft or vandalism, sudden death or loss of limbs of the breadwinner or even a temporary job loss where employment is largely in the informal sector and domestic violence. On the other hand ***covariate shocks*** occur due to natural disasters like the Indian Ocean Tsunami that led to 400,901 people big displaced in Indonesia alone (OCHA, 2005), clearly swelling the ranks of hungry; war (like the war in Afghanistan), civil strife like the one in Sri Lanka which has created 3,00,000 internally displaced persons who face food insecurity of different degrees; food price instability such as the one seen in 2008 that had added nearly 41 million people to those who were hungry (FAO 2008); financial crises such as the one that grips the world now that had thrown out of job 24.8 million workers jeopardizing their economic access to food[7] etc., where everyone in a community is vulnerable.

[7] *Especially when less than 20 per cent of the population is covered by unemployment benefits*

Generally, there are insurance available against idiosyncratic risks such as life insurance, health insurance and draft animal insurance, but they are very expensive for those who are most likely to suffer them, namely, the poor. Insurance against covariate risks are not generally available as the risks are too large, barring a few publicly funded ones like crop insurance in India and where available they are prohibitively expensive.

It may be underscored that though the distinction between *idiosyncratic* and *covariate* shocks is critical for policy making, traces of idiosyncratic shocks can be found even in largely covariate shocks, because there are discernible differences between households in their exposure and capacity to respond to shocks. Additionally the extent to which a risk is covariant or idiosyncratic is a function of the underlying causes. For example, job loss can be an idiosyncratic risk for a casual mason due to heavy rain, or job loss can be covariate risk for a whole community of casual workers if it is the outcome of macroeconomic turbulence as seen in 2008. Similarly, the risk of becoming affected by HIV/AIDS can be an idiosyncratic risk germane to causing food insecurity or it can be a covariate risk if it becomes a pandemic, contributing to food insecurity in a community or even a nation like in some African countries. However, the bottom line is that a growing body of empirical evidence suggests that idiosyncratic risks dominate over covariate risks in Asia like in Africa (Deaton, 1997) and hence idiosyncratic shocks are the dominant causes of food insecurity in this region. The main sources of idiosyncratic and covariant risks are also shown in Table-2 above.

There are basically five main clusters of idiosyncratic risks: (i) sickness, injury and disablement; (ii) natural disasters (iii) aging; (iv) crime and domestic violence and (v) unemployment and other labor market risks**.** We shall briefly discuss them here

(I) Sickness, Injury* and *Disablement: Poor people often live and work in environments that expose them to greater risk of illness or injury, and they have less access to health care (Prasad, Belli and Das Gupta 1999). Their health risks are strongly connected to the availability of food, which is affected by almost all the risks the poor face (natural disasters, wars, harvest failures, and food price volatility). Communicable diseases like SARS, Bird Flu and H1N1 Virus that have afflicted Asia since 2003 are concentrated among the poor. Respiratory infections are considered by some experts as the leading cause of illness and even death (Gwatkin, Guillot, and Heuveline 2000). In India, for instance, it has been found that the poor are 4.5 times as likely to contract tuberculosis as the rich and twice as likely to lose a child before the age of two (World Bank 1998).

Illness and injury in the household have both direct costs (for promotive health; preventive health care and curative health care) and opportunity costs like lost income or schooling while ill. Direct costs eat into the economic power of the poor to access food while the opportunity costs affect both the short term loss of economic access to food for the poor and long term loss in economic access in term of higher capability poverty. The timing, duration, and frequency of illness also affect its impact on the food security of the people. Poor households can compensate for an illness during the slack agricultural season, but illness during the peak season leads to heavy loss of income, especially on small farms, leading to diminution of economic access to

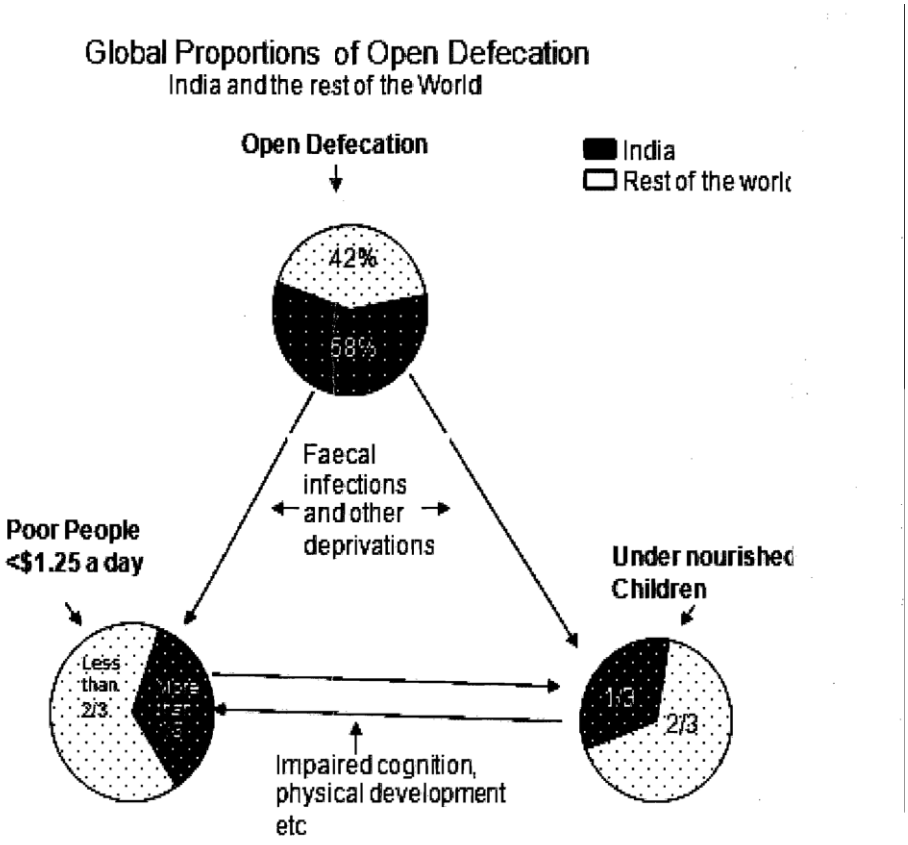
food, usually necessitating taking out loans at usury rates of interest making further inroads into the economic access to food, something that triggered the global phenomenon called the "Grameen Bank of Bangladesh.

In the Indian context Open Defecation is a major cause of food insecurity. It is not widely recognized that most of the child malnutrition (which is a major form of food Insecurity) is caused by open defecation. And India is the home to over 58 per cent of world's open defecation. Open defecation leads to Faecal Infections and other deprivations that causes undernourishment in Children, leading to impaired cognition, physical deprivation and the like, which agitated the mind of even the Prime Minister of India who had reportedly said that "child malnutrition is a curse we must remove. Thus India has about one third of the entire world's people who live on less than 1.25 $ a day.

Indeed there is a syndrome of open defecation, Faecal Infections, poverty and undernourishment. Among the Faecal Infections, diarrhea is dramatic, measureable and often visible. Hence it attracts a lot of attention and remedies have been found. But combinations of other infections which do not have such dramatic symptoms may, taken one with the others, be more devastating in their impact on child health and nutrition. They include but is not restricted to, hookworm causing anemia (200 million cases in India); enteropathy (damage to the wall of the gut, reducing absorption of nutrition, and energy used in fighting infections which get into the blood stream); ascaris, tapeworms and other intestinal parasites that 'steal' food from children; live fluke, dysentery, hepatitis, typhoid and other infections (trachoma, polio etc). One medical authority considers that enteropathy alone is more harmful to child nutrition than diarrheas. These can all be cut off through sanitation and hygiene. (See Diagram)

***(ii) Natural disasters*:** Natural disasters cause food insecurity to millions of people. Just take two examples. The December 26, 2004 Asian tsunami tragedy demonstrates the destructive capacity of natural disasters, and their impact upon food security. According to early impact assessments, agricultural and fishery losses due to the tsunami were severe. For example, in Tamil Nadu state of India, 59 000 fishing vessels have been destroyed, affecting the livelihood of nearly 700 000 fisher-folk and their families. In Aceh province of Indonesia, income losses in agriculture and fisheries make up more than one-third of total losses due to the disaster, while in the worst-affected districts of Sri Lanka, 80 percent of fishing vessels have been destroyed or seriously damaged, throwing hundred and thousands of people into the throes of food insecurity.

More recently on 3 May 2008, a cyclone (Nargis) devastated Myanmar's low-lying Irrawaddy delta region leaving more than 1 million people homeless. An estimated 80,000 people died in the delta's Labutta district alone. Myanmar had been expected to export 600,000 tons of rice in 2008, including to Sri Lanka and Bangladesh but it could not live upto the expectation as the cyclone flooded 5,000 square kilometers (1,930 square miles) of farmland in the country's main rice-growing area, worsening a food crisis even outside of Myanmar. Additionally since an 80 per cent loss in the December 2008 harvest was recorded (CARE, 2009) it means food distribution must continue in Myanmar itself to prevent food insecurity and starvation.



***(iii) Aging*:** Many risks are associated with aging: illness, social isolation, inability to continue working, inability to cook and uncertainty about transfers (usually from sons and daughters) being able to provide an adequate means of livelihood and so on. The incidence of poverty among the elderly varies significantly. In many countries in Central Asia, like Georgia and Armenia, the incidence of poverty is above average among the elderly, particularly among people 75 and older. There is also a gender dimension to the problem of poverty associated with old age. Women, because of their higher life expectancy at birth, constitute the majority of the elderly, and they tend to be more prone to food insecurity in old age than men (World Bank 2000). With better health care facilities and rising income in many of the Asian Countries, the number of elderly people in the developing countries in Asia and the Pacific, will increase significantly in the foreseeable future adding to the number of food insecure.

(iii) Crime and Domestic Violence: Crime and domestic violence reduce earnings, take away income and destroy assets, which entrenches food insecurity. Unlike the rich, the poor have few, if at all, means to protect their life, property, assets and income, against crime, all of

which help fight food insecurity. Crime also hurts children of poor people: children exposed to violence may perform worse in school thereby reducing their income earning capabilities which may, in the long run, be germane to lower purchasing power and hence, lower economic access to food. A study of urban communities in the Philippines, amongst other countries, showed that difficult economic conditions destroys social capital as involvement in community organizations declines, informal ties among residents weaken, and gang violence, vandalism, and crime increase (Moser 1998). Violence and crime may thus deprive poor people of two of their best means of reducing vulnerability to food insecurity, human and social capital, which act as "informal" insurance against transitory food insecurity. Rich and poor women alike are victims of domestic violence, but the incidence is often higher in poor households

***(iv) Unemployment and other Labour Market Risks*:** Labour market risks include unemployment, falling wages, and taking up hazardous and low-quality jobs in the informal sector as a result of macroeconomic crises or policy reforms. The first workers to be laid off during cutbacks in public sector jobs are usually those with low skills, who then are exposed to food insecurity, amongst other things and are forced to migrate to urban areas adding to the already staggering numbers of urban poor, a pattern observed in many countries during the structural adjustment reforms of the 1980s and early 1990s. Economic crises such as the East Asian crisis in 1999 and the ones in 2007-200, also had significant effects on labour markets, with real wages and non-agricultural employment falling in all affected countries.

Fluctuations in demand for labour often disproportionately affect women and young workers who are therefore at greater risk of facing food insecurity. Most public sector retrenchment programs have affected women's employment more than men's (World Bank 2000), and women are more likely than men to work for small firms, which tend to be more elastic to demand fluctuations and pay lower wages, both of which have a strong bearing on women's purchasing power and economic access to food. As incomes fall, poor households try to respond by cutting consumption of food, pulling out children from school and pruning health care, especially for women and girl children.

Liberalization of markets often boosts the price of staples which could benefit small farmers if they are net sellers of food but in many cases they are net buyers of food. Thus, the urban poor, rural landless, poor people, artisans, herdsmen, fisher folks and farmers are confronted with seasonality, selling food immediately after the harvest when food is plentiful and prices are low and buying food when it is scarce and prices are high. All these categories of poor are exposed to different degrees of food insecurity. Traders in food can step in and equalize prices over the year through arbitrage, but rural areas lack transport facilities and related infrastructure to facilitate the process, apart form the question of incentives.

For the rural poor, crop diversification and income diversification into nonfarm activities can help reduce food price and harvest risks, and eliminate food insecurity due to successive harvest failures, for various natural causes. For example, because of insufficient monsoons in India in 2009 indebtedness in 80 per cent of households in 160 districts declared drought affected will increase. According to the latest count, as many as 246 districts spread across 10 states, or 40per

cent of the total number of districts, have been declared drought-hit. Even if the weather gods relent in the coming days, the rains may be too little, too late to undo the damage to the kharif (roughly June-October) harvest which is reckoned at 20 million tonnes for paddy alone. The situation is tailor-made to stoke inflationary fires, deepen rural distress and cause food insecurity especially when according to the latest *Economic Survey*; the per capita consumption expenditure of 71.9 per cent of the rural population was less than Rs 20 per day in 2004-05. (Gangadharan, 2009).

D. AGENDA FOR PUBLIC ACTION

(i) Increase and Diversification of Production Especially in Agriculture.

Mr. Sharad Pawar was somewhat right, when he mentioned that we must raise agricultural output before enacting food law. "Solution is that unless and until we increase production, we will not be able to implement this (food security bill)". (***Times of India***, 30 January 2012, p. 13). For this to happen, perhaps the most striking feature of agricultural innovations will have to be a shift away from the high external input-intensive model of the Green Revolution of the sixties to a New Green. The first Green Revolution of the last century achieved significant yield increases through promotion of high external inputs agriculture, of irrigated water, chemical fertilizer, pesticide and insecticides and fossil fuel. In contrast, the Second Green Revolution must increase yields, by moving agriculture from high external input-intensive agriculture to "*High Tacit-and-Explicit Knowledge-Intensive Food Production*" in both *induced food production* and *autonomous food production* systems (read food from common property resources). The Second Green Revolution must integrate traditional knowledge and technology with advances in modern-day science and agricultural engineering (including plant genetics, plant pathology and information technology) and encompass the ecologically integrated approaches, like intergraded pest and soil fertility management, minimum tillage and drip irrigation. Additionally the *Knowledge-Intensive Food Production* system must focus more on the entire systems of crop production rather than on individual crops. Such an approach can help to deliver resilience and sustainability to food production, and at once, score high on the equity front, ultimately distributing power and autonomy to individual farmers.

POLICIES PERTAINING TO ACCESS

(ii) Enhancement of general economic growth that generates employment and guaranteeing decent rewards for work.

And the economy needs to grow fast, so that employment is created, giving people economic access to food. As Joseph Stiglitz argued in Kolkata, on 12 January 2012, that "hunger is not caused by an absolute shortage of grain but by the lack of income of those in poverty to get access to it" (***The Hindu***, 13th January 2012, p. 13). Since much is said and written about it, we need not labour the details here except to say that an enabling environment for investment should be created (not like allowing FDI in multi brand retail trade and then keeping it in abeyance) and the choice of technology must be pro-employment. Additionally the legal architecture has to ensure a decent reward for work, that minimum wages are inviolable and that exploitative intermediation is ruled out. Growth also

means that the governments have more resources to share the cake and make investments necessary for food security.

(iii) ***Protection of the poorer sections of society from both idiosyncratic and covariate shocks that impinge on food security***. *M*ost food insecure people are vulnerable to two kinds of shocks, *idiosyncratic* shocks (affecting individual households such as sudden loss in employment, loss of limbs and unexpected illness) and *co-variate* shocks (that affect large sections of society such as earthquakes, floods, droughts and epidemiological catastrophes). In case of co-variate shocks, the governments, aid agencies, non-state actors and you name it, all get on an overdrive to provide relief and rehabilitation. But in case of idiosyncratic shocks the affected households are largely left to fend for themselves, depending in many cases on informal systems of insurance. A lot needs to be done here on a range of measures. Promotion of micro-insurance, community- based insurance and self-insurance, income guarantees (like the National Rural Employment Guarantee Scheme) and right to access common property resources for non-timber forest produce should be on top of the agenda for tackling idiosyncratic shocks.

The various ways in which the State (read Government), individuals, households and communities can deal with the different kinds of shocks are tabulated in Table -3.

(iv) ***Diversify the delivery system***. Despite every effort and the food security bill, there will be significant sections of society which will not be able to secure food for themselves for a variety of reasons, including physical incapacity and psychological barriers. The State need to provide food (not just grain) for these sections of people and in the delivery of food, the mode of delivery as also the institutional mechanisms for such delivery of food have to be as varied as possible: Ration Shops constitute one critical element in this scenario. The delivery of food can take other forms such as food stamps, direct cash transfers, free kitchen for cooked foods run by non-state actors and the like. And the focus should be on "reach" and "depth" as much as on the range. And the institutional mechanism for delivery of food can include ration shops, non-sate actors like NGOs and private companies, charities, Gram and traditional Panchayats.

(v) ***Eliminate gender based inequalities that lead to eight kinds of food insecurities faced by women***. Women face several inequalities, notable amongst which are natality based inequality (where sex-selective abortion does not succeed or is not possible for whatever reason, the girl child starts from the womb with familial and parental environments that are hostile to her existence), inequality in access to food (even mothers are all too eager the son gets to eat first and better food), to education, to health care, employment opportunities and role in certain jobs. These inequalities invade the capability of women to achieve food security. Inequality in ownership and inheritance of assets hinder food security of women. Critical assets such as homes and land are very asymmetrically owned, impairing women's capability to access food. There is no gainsaying the fact that such inequalities must be removed through institutional and structural changes if we dream of a food secure India. The war against food insecurity will be lost or won in the war against gender discrimination.

(vi) ***Health and Education Securities for food security***. A package of *health security*, especially access to reproductive health, sanitation and potable drinking water, and education *security* has to be made available to every citizen. Healthcare is available to only 10 per cent of the people at the top of the pyramid, which has to be reversed. Over 55000 women die in child birth every year and thirteen lakh children who die before they reach their first birthday (*Times of India*, 16 January 2012, p. 11), which are both a direct function of the failure of health infrastructure. This has to be stopped. With total fertility rate at 2.6 per cent per woman on a population base of over 1.1 billion people, trying to achieve food security will be as futile as trying reach a mirage. Only when we have health security can we achieve rapid fertility decline, vital for food security. Health security is even necessary for economic security (Ela Bhatt: "When Health is Security" *Times of India*, p. 18), which in turn has a direct bearing on economic access to food. For example, the recent study by *Naadi Foundation* (*The HUNGAMA Survey Report*, 2012), found the prevalence of malnutrition is significantly higher among children from low-income families, although rates of child malnutrition are significant among middle and high income families. Children from households identified as Muslim or belonging to Scheduled Castes or Schedule Tribes generally are worse off.

Similarly education security is critical for food security in several ways. For example, in the 100 Focus Districts studied by in the aforesaid Naadi Foundation Report, found that 66 per cent mothers did not attend school; rates of child underweight and stunting are significantly higher among mothers with low levels of education; the prevalence of child underweight among mothers who cannot read is 45 per cent while that among mothers with 10 or more years of education is 27 per cent. The corresponding figures for child stunting are 63 and 43 per cent respectively. It was also found that 92 per cent mothers had never heard the word "malnutrition". Though Right to Education is a constitutional right, it is a matter of public history that the quality of education has still to be raised to desired level ("Brick in the Wall", in *Times of India*, 18th January 2012, p. 20). We must also leap frog in renewable energy sources such as solar, wind, biomass and bi-gas and invest in transmission and distribution like in battery and other storage technologies and in micro-grids, as aids to delivery of proper social services, essential for food security.

CONCLUDING REMARKS

Thus the one-line answer to solving our problems of malnutrition, food insecurity and starvation in India is: ***get back to basics***. Focus on investments in technology for increasing agricultural productivity, on growth and employment, on primary health care and basic education, on gender equality, on provision for sanitation and potable water and strengthening the elements that make for a robust democracy. This is no rocket science. Just that the powers that be must have the political will to work for the voiceless majority. This is not only good economics but is also good politics: the voiceless majority constitutes the most energetic voters.

TABLE 3: MECHANISMS FOR MANAGING SHOCKS

	Informal mechanisms		***Formal mechanisms***	
Objective	***Individual and household***	***Group based***	***Market based***	***Government provided***
Reducing the impact of shocks	Preventive health practices Migration More secure income sources	Collective action for infrastructure, dikes, terraces Common property resource management		Sound macroeconomic policy Environmental policy Education and training policy Public health policy Infrastructure (dams, roads) Active labor market policies
***Mitigating the effects of shocks*:** Diversification	Crop and plot diversification Income source diversification Investment in physical and human capital.	Occupational associations Rotating savings and credit associations.	Savings accounts in financial institutions Microfinance	Agricultural extension Liberalized trade Protection of property rights. Access to common property resources
Insurance	Marriage and extended family Sharecropper tenancy Buffer stocks	Investment in social capital (networks, associations, rituals, reciprocal gift giving) Community Based Insurance	Old age annuities Accident, disability, and other insurance	Pension systems Mandated insurance for unemployment, illness, disability, and other risks
Coping with shocks[a]	Sale of assets Loans from money-lenders Child labor Reduced food consumption Seasonal or temporary migration	Transfers from networks of mutual support	Sale of financial assets Loans from financial institutions	Social assistance Workfare Subsidies Social funds Cash transfers

Note: The white shaded area shows household and community responses through informal mechanisms to improve risk mitigation and coping. The dark shaded area shows the publicly provided mechanisms for insuring against risk and coping with shocks—the social safety net.

[a] Publicly provided coping mechanisms can also serve risk mitigating purposes if they are in place on a permanent basis.

Source: Adapted from Holzmann and Jorgensen (2000) and World Bank (2001).

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NATIONAL FOOD SECURITY BILL: CHALLENGES AND OPTIONS

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India has been doing quite well in ensuring ample availability of food to its country-men, be it basic staples like rice and wheat or other food products like edible oils, pulses, fruits and vegetables, milk and milk products, eggs, meat and fish, etc. Most of these are produced domestically to meet the consumption demand, with some surplus being exported (of rice and wheat), and in others dependence is on imports (like edible oils and pulses). Though an important one, making food available is only one aspect of food security. The others are economic access to food and its absorption by people for better nourishment. It is in the areas of economic access and its absorption where India faces big challenges. In spite of buoyant economic growth in recent years, around one-third of India's population still lives below the poverty line (in 2010, as per World Bank's definition of US $1.25/day). In 2011 as per the multi-dimensional poverty index (MPI) of UNDP, India ranks at 75th position among 109 countries. It is much worse than the other BRIC countries indicating the extent of deprivation in terms of living standards, health, and education. The HUNGaMA (Hunger and Malnutrition) Survey conducted by Nandi Foundation in 112 rural districts of India in the year of 2011 shows that 42 percent of children under the age of five are underweight and 59 percent are stunted. All these estimates point to the existence of food insecurity at the micro-level in terms of either lack of economic access to food or lack of absorption of food for a healthy life.

FAO (2002) defines food security as: "*Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life*". As per USDA, food-insecure people are defined as those consuming less than the nutritional target of roughly 2,100 calories per day per person. India leads the chart with 246 million food-insecure people and accounts for nearly 30per cent of the total food insecure people of the developing countries. Growth factor, though essential, may not be sufficient, at least in the short run, to ensure food security for the poor and vulnerable, which spend almost 60 per cent of their expenditure on food. These people need a safety net targeting economic access to food and its absorption.

The recently introduced *National Food Security Bill*, 2011 (NFSB), aims to address this formidable challenge. The proposed legislation marks a paradigm shift in addressing the

problem of food security from the current ***welfare approach*** to a ***rights based approach***. Besides expanding the coverage of the Targeted Public Distribution System (TPDS), the proposed legislation would confer legal rights on eligible beneficiaries to receive entitled quantities of foodgrains at highly subsidized prices. It will also confer legal rights on women and children and other Special Groups such as destitute, homeless, disaster and emergency affected persons and persons living in starvation, to receive meals free of charge or at an affordable price. But the central pivot of the Bill is large-scale subsidized grain distribution to almost two-thirds of the country's population of 1.2 billion. This would perhaps be the biggest ever experiment in the world to distribute subsidized grain to achieve food and nutritional security. It implies a massive procurement of food grains and a very large distribution network entailing huge financial expenditure.

The current Bill creates a statutory entitlement for the included population and its obverse namely a legal obligation for the government. Therefore, it is important to ensure adequate availability of grain with the public authorities to fulfill the underlying obligation. Given the current trends in rates of growth in food grain production and yields, and the growing pressures on land and water in the wake of climate change, there is a possibility that food grain availability on sustainable basis becomes a constraint. With 60 percent of India's farmland dependent on monsoon rains, drought years can slash production and force the country to import large quantities. The government already procures one-third of the cereals production and any increase in procurement will have enormous ramifications on the cereal economy/markets and would crowd out private sector operations with a consequent effect on open market prices.

The food subsidy in coming years will balloon due to the lower central issue price of grain, a significant rise in the number of entitled beneficiaries and the need to keep raising the Minimum Support Price (MSP) to cover the rising costs of production and to incentivize farmers to increase production. The existing food security complex of procurement, stocking and distribution would further increase the operational expenditure of the Scheme given its creaking infrastructure, leakages and inefficient governance. This raises the issue of sustainability of the financial obligations entailed in NFSB.

The issues raised above require careful scrutiny and assessment of the various provisions and operational guidelines of NFSB. This paper delves into most of these issues and their implications. The provisions of NFSB are carefully studied and some of the weak links in the Bill have been brought out with a view to find an appropriate solution to those. An attempt is also made to assess the operational and financial challenges thrown up by the Bill and its macroeconomic impact on the agricultural economy. The paper then suggests various options and instruments, which could be gradually dovetailed to make this Bill much more effective and efficient.

NATIONAL FOOD SECURITY BILL (NFSB)

NFSB has a laudable objective of eradicating hunger and malnutrition from India in the shortest possible time. The proposed legislation marks a paradigm shift in addressing the problem of food security—from the current welfare approach to a rights based approach. It is therefore

important to get it right, not just in terms of making it a legal entitlement under the "rights approach" but making it a success on the ground.

Rationale

The rationale for the Bill is best summarized by the following excerpts from the Bill: "Article 47 of the Constitution, inter alia, provides that the State shall regard raising the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties. Eradicating extreme poverty and hunger is one of the goals under the Millennium Development Goals of the United Nations." and "in pursuance of the constitutional obligations and obligations under the international conventions, providing food security has been focus of the Government's planning and policy. Food security means availability of sufficient food grains to meet the domestic demand as well as access, at the individual level, to adequate quantities of food at affordable prices".

Salient Features

The objective of the Bill is "to provide for food and nutritional security in human life cycle approach, by ensuring access to adequate quantity of quality food at affordable prices to people to live a life with dignity". In line with the stated objective, the Bill provides a legal entitlement to receive foodgrains at subsidized prices by persons belonging to priority households and general households under TPDS. The entitlement shall be provided up to 75per cent of the rural population and up to 50per cent of the urban population (Table 1). Further, in order to improve the nutritional security, the NFSB brings various other ongoing welfare schemes of the government under one umbrella (Table 2).

Table 1: Right to Receive Foodgrains at Subsidized Prices

	Priority	***General***
Foodgrains Entitlement	*7 kg per person per month*	*3 kg per person per month*
Price	*Not exceeding Rs. 3 per kg for rice, Rs. 2 per kg for wheat and Rs. 1 per kg for coarse grains*	*Not exceeding 50per cent of the MSP for wheat and coarse grains; not exceeding 50per cent of derived MSP for rice.*
Coverage ***Rural population*** *- Up to 75per cent* ***Urban population*** *- Up to 50per cent*	 *At least 46per cent of rural population* *At least 28per cent of urban population*	 *Up to 29 per cent of rural population* *Up to 22 per cent of urban population*

Apart from this, the Bill also proposes the following steps for the Revitalization of Agriculture: increase in investments in agriculture, including in research and development, ensuring remunerative prices, credit to farmers, crop insurance, etc; Procurement, storage and movement

Table 2: Provisions for Nutritional Security and Entitlements to Special Groups

Target Group	***Entitlement***
Pregnant woman/ Lactating Mother	*Meal, free of charge, during pregnancy and six months after child birth* *Maternity benefit of Rs 1000 per month for a period of six months*
Children (6 months-6 yrs)	*Age appropriate meal, free of charge, through the local anganwadi*
Children (6 years-14 yrs)	*One mid-day meal, free of charge, everyday, except on school holidays, in all schools run by local bodies, Government and Government aided schools, up* *to class VIII, so as to meet the nutritional standards*
Children suffering from Malnutrition	*Meals through the local anganwadi, free of charge*
Destitute persons	*At least one meal every day, free of charge*
Homeless persons	*Affordable meals at community kitchens*
Emergency and disaster affected persons.	*Two meals, free of charge, for a period up to 3 months from date of disaster*
Persons living in starvation	*Free Meals, two times a day, for 6 months from date of identification;*

related interventions: incentivizing decentralized procurement including procurement of coarse grains, augmentation of adequate decentralized modern and scientific storage etc; Reforms in TPDS: application of information and communication technology tools to improve PDS system, leveraging 'Aadhaar' for unique identification of beneficiaries for proper targeting of benefits under this Act etc, ensure transparency Others: Provision of safe and adequate drinking water and sanitation, nutritional health and education support to adolescent girls, senior citizens, persons with disability and single women.

Proposed Mode of Operation

To operate the bill, the Central Government would procure foodgrains for the central pool through its own agencies, the State Governments and their agencies; allocate foodgrains to the States as per the defined entitlements and at prices specified; provide for transportation of foodgrains to the designated depots in each State; and create and maintain required modern and

scientific storage facilities at various levels. Under TPDS, it shall be the duty of the State Government to take delivery of food grains from the designated depots of the Central Government in the state at the prices specified in Schedule I, organize intra state allocations for delivery of such food grains through their authorized agencies at the door step of each fair price shop (FPS) and ensure actual delivery of food grains to the entitled persons at the prices specified in Schedule I. The local authorities shall be made responsible for proper implementation of the proposed legislation in their respective areas, to conduct periodic social audits on the functioning of fair price shops, TPDS and other welfare schemes, and publicize its findings and take necessary action.

For the efficient operation of TPDS, every State Government shall create and maintain: scientific storage facilities at the state, district and block levels being sufficient to accommodate food grains required under the targeted PDS, and other food based welfare schemes; (ii) suitably strengthen capacities of their food and civil supplies corporations and other designated agencies; and (iii) establish institutionalized arrangements for fair price shops within the state in accordance with the provisions of the PDS (Public Distribution System (Control) Order, 2001). Provisions have also been made in the Bill for transparency and accountability including disclosure of records relating to PDS, and social audits and setting up of Vigilance Committees besides an elaborate grievance redressal mechanism to ensure that the benefits reach the rightful persons, failing which they can approach grievance redressal bodies that are proposed to be set up for this purpose.

In the event the Central Government is not able to provide the foodgrains to the State Government from the central pool due to any shortfall in the central pool, the Central Government would provide funds to the State Government to the extent of the shortfall, as may be prescribed by the Central Government itself. The State Governments are responsible for implementation and monitoring of schemes of the Central Government as well as their own schemes for ensuring food security to the targeted beneficiaries of their states.

CONCEPTUAL ISSUES:

It is worth noting here that NFSB, in its current form, throws major challenges as in:

1. Food Supplies in the Times of Crisis

The Bill provides for a Force Majeure clause (Clause 52) that "the Central Government, or the State Governments, shall not be liable for any claim by persons belonging to the priority households or general households or other groups entitled under this Act for loss/damage/compensation, arising out of failure of supply of foodgrains or meals when such failure of supply is due to conditions such as, war, flood, drought, fire, cyclone, earthquake or any act of God."

This clause provides immunity to the central and state governments for loss, damage, or compensation arising out of failure of supply of food grains or meals in force majeure conditions, which have been defined widely, including droughts and floods, which are likely to increase in intensity and frequency due to climate change effects. This is an exemption for both Central and State Government for failure to supply food grains when such failure is either "directly or

indirectly" on account of force majeure. *If pictured these conditions especially call for the food requirement and only the governing bodies/ government can supply to the needy in these times of crisis, but the clause gives the opportunity to the governments to run off. While there may be circumstances where this clause can apply but the number of such conditions must be a few and condition of draught should be eliminated from the clause. This clause needs redrafting.*

2. Centralized Model

The draft bill in the current shape gives a legal sanction to a highly centralized procurement and distribution model. All guidelines, rules etc will be prescribed by the Centre including criteria for priority households, exclusion criteria, reforms in TPDS, price at which the State Government is required to sell the food grains to the entitled persons - are just a few of them, to count. It leaves no room for experimentation/ customization for the States suited to their specific choices, institutional strengths and weakness.

Once the Act comes into effect the existing schemes pursued by the states will suffer considerably. Currently, State Governments can adopt their own PDS structures as the PDS System is governed by PDS (Control) Order, 2001 under the Essential Commodities Act (ECA), 1955. ECA empowers the State Governments to issue orders for their respective states. The NFSB however creates a new statutory framework governing the PDS. The PDS systems of States will have to first comply with the NFSB. In the event of a conflict between NFSB and ECA, the provisions, rules, regulations and orders issued under the NFSB will override the ECA provisions.

Though Section 40 of the NFSB allows State Governments to design their own schemes but these would be rendered practically ineffective. The Bill imposes an obligation on the State Governments to procure food grains only from FCI for TPDS. States will have to procure for its own system separately on its own- for which literally there would be not much grain left. It would additionally impose a financial burden on the states as they will have to procure the entire requirement of food-grains at their own cost and pay through the state treasury. *Independence for the customization and experimentation should be given to the state governments to adopt the bill according to the needs and structure of the respective states.*

3. Centralized Procurement: An Unsustainable Model

NFSB mandates Central Government to procure for the Central Pool. State Governments are responsible for further distribution. In 1997-98 Decentralized Procurement System (DCP) was introduced in view of the practical difficulties faced by the Central Government/FCI to procure on its own. Under DCP, States were invited to assist in the procurement and distribution of foodgrains under the TPDS. This experiment has been quite successful in Madhya Pradesh and Chhattisgarh as far as augmenting the level of procurement is concerned. Both these states have taken initiative to open large number of procurement centers and dramatically increased the procurement of paddy in Chhattisgarh and wheat in Madhya Pradesh, almost leading to state monopsony in procurement of these crops. NFSB seems to be suggesting a retrogressive step of going back to centralized procurement model which was found unsustainable in the first place.

Thus the proven successful models should be kept and centralized model be adapted in only those states where DCP has not been successful.

4. Adoption of Ineffective Food Security Complex

NFSB gives the existing PDS and procurement system a new lease of life in an "as is where is" condition despite its established ineffectiveness and leakages. For fulfilling its goal of food security, it heavily relies on the current institutions which already have had a history of failure. The estimated leakages from the TPDS go as high as 40 percent. The existing system of TPDS needs to be reformed for efficient delivery of food grains but the norms and types of reforms are to be decided by the Central Government. This would bring the ongoing PDS reforms in States like Chhattisgarh and Haryana to a halt. Thus the states should be left with the some say to deal with the inefficiency of the system.

5. Distribution of Responsibilities between Centre and States

The Central government has limited its responsibility only to the procurement for the central pool and delivery to the State government for distribution through the TPDS. The State Government is made responsible for collection of foodgrains from FCI depots and to further ensures that the legal entitlements are enforced. NFSB directs cost sharing in overheads, survey costs and for welfare schemes. *If the Central Government is unable to provide foodgrains from its Central Pool, it has to provide funds to the extent of short supply of food grains from its central pool to the State Government that also as determined by itself. But if the State Government is unable to provide the entitled grains, then it has to pay a "Food Security allowance" to the excluded beneficiaries. How will the state governments distribute that cash to ultimate beneficiaries without having developed a proper financial structure for that remains unclear.*

6. Food Security Allowance (FSA): Ambiguity Prevails

Section 13 of NFSB stipulates that in case of non-supply of the entitled quantities of food grains or meals to entitled persons under the bill, such persons shall be entitled to receive such food security allowance from the concerned State Government in such time and manner as stipulated by the Central Government. This entails that the State would have to provide the entire administrative back up for the food security allowance/decentralized procurement triggered in case of failure by the Central Government and distribution, which would then cost the State additionally. This would have large financial implications for the State Governments.

The amount payable would depend entirely on the rules framed in respect of the same. The statute does not mandate that the allowance has to be suitable to enable the relevant entitled persons to obtain the food grains from the market. Since the entitlement is essentially to obtain the identified food grains at the subsidized prices specified in Schedule–I, if FSA is according to these prices (much lower than market prices), then this monetary support during distress conditions would be grossly insufficient to buy foodgrains from the market. Whether this FSA would be triggered in case of Force Majeure is also unclear.

7. Non Clarity of Benefits to "General Households" The entitlements of persons belonging to "general households" have been linked to such reforms in the PDS, and from such date as prescribed by the Central Government.

8. Cereal-Centric Approach

Though cereals are central to the issue of food security, diversifying demand patterns to protein rich items also needs to be appreciated. NFSB deals only with supply of cereals ignoring the demand side of food consumption. In this context, it is worth noting that the latest consumption data of NSSO shows that in each deciles expenditure group, the per capita consumption of cereals has been falling. Thus, while NFSB will try to make the production basket cereal-centric, diversifying demand will throw pressures on non-cereal segment, creating an imbalance in demand and supply of food items. This will lead to higher inflationary pressures and imports of non-cereal foods, especially edible oils, pulses, fruits and vegetables, protein foods, etc.

9. Physical Approach

Global experience on social safety net programmes show that food coupons/vouchers, CCTs are better alternatives than transfer of food. Globally, countries have moved away from physical handling of grains and used such alternatives based on income approach for improving economic access to food. NFSB could have inbuilt flexibility in it for States to experiment with such an approach. Some of these issues should be taken care of in the rules framed under the Act.

OPERATIONAL CHALLENGES

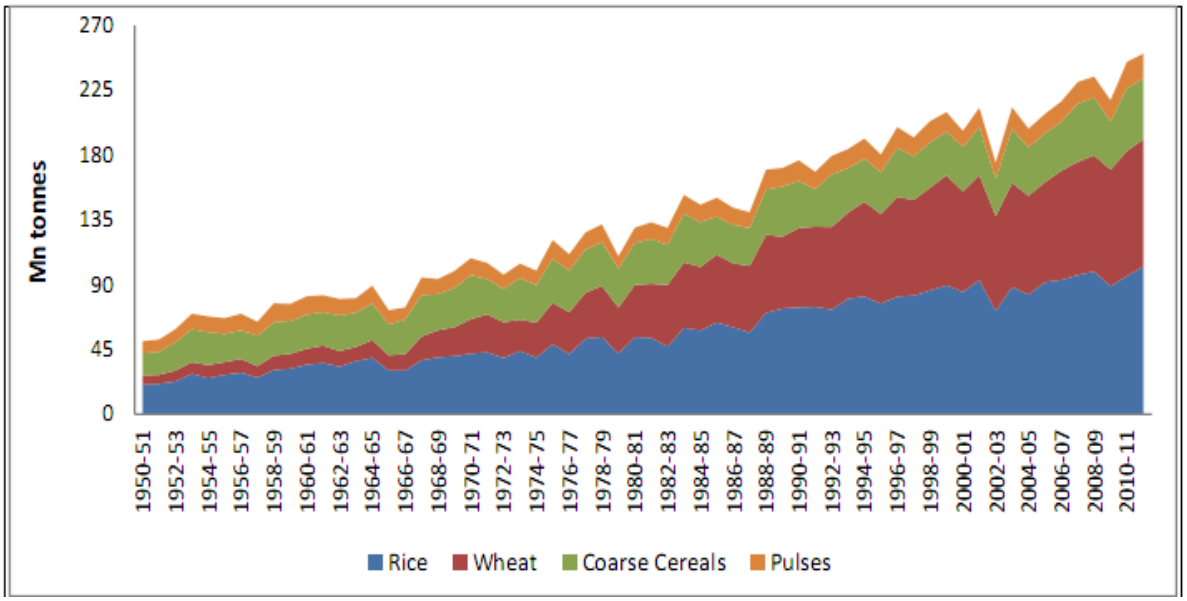
The existing system of foodgrain management is characterized by the dominant presence of the government in all the basic aspects of marketing viz., procurement, storage, transport and distribution, with all these operations being bundled and carried out by the FCI. Currently, FCI's operations are intended to build buffer stocks to meet any exigency, open market purchase/sales to stabilize domestic prices and provide food security requirements through sale of subsidized grain. It procures; mainly wheat and rice, for the Central Pool at the MSP announced by the Government and distributes it through the State managed PDS. In addition, several states procure directly for decentralized procurement and distribution. Over the years inefficiencies have been evident in the operations of FCI through concentration of procurement operations to a handful of States, an ever increasing central pool of stocks and growing diseconomies of scale. The following sections elaborate the mammoth operational challenge thrown up by NFSB as it would entail a huge procurement/distribution infrastructure.

PRODUCTION

Since the NFSB creates a statutory entitlement for the included population and its obverse namely a legal obligation for the government, it is important to ensure adequate availability of grain with the public authorities. Attainment of self-sufficiency in food grains at the macro level has been one of the country's major achievements in the post-independence period. The production of food grains increased from 51 million tonnes in 1950-51 to 108.4 million tonnes in 1970-71 and has touched 257 million tonnes in 2011-12 (Figure 1). Production of rice has increased by almost five times since independence from 20.6 million tonnes in 1950-51 to 104.3 million tonnes in 2011-12. Production of wheat has increased manifold since independence from

6.5 million tonnes in 1950-51 to 93.9 million tonnes in 2011-12. India has also been a net exporter of cereals for most years since 1990. The per capita availability of foodgrains has increased from 394.9 gms per day in 1951 to 438.6 grams per day in 2010. It should be noted here that as economic growth picks up, it is common to observe a change in dietary patterns wherein people substitute cereals with high-value food.

Figure 1: Foodgrains Production in India (1950-51 to 2011-12)

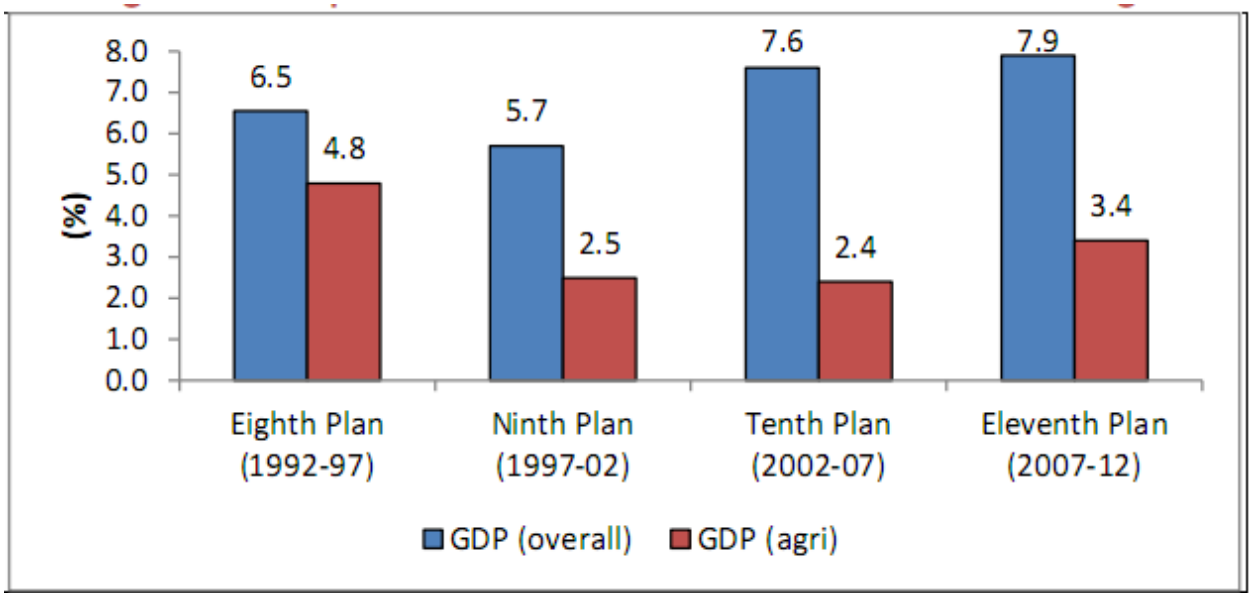


Agriculture has been growing at a trend rate of growth of 2.9per cent during 1991-92 to 2011-12- much lower than the targeted 4per cent in the Five Year Plans. The increasing divergence between the growth trends of the total economy and that of agriculture and allied sectors during the Plan periods suggests underperformance by agriculture (Figure 2). The average growth rate of foodgrain output has declined from 2.2 percent in 1990s to 1.8 percent in 2000s. Similarly, growth rate of yield of foodgrains has declined from 2.4 per cent in 1990s to only 1.3 percent in 2000s (Table 3).

Table 3: Average Annual Growth rates during 1990s and 2000s

Crop	***Area***		***Production***		***Yield***	
	1990s	*2000s*	*1990s*	*2000s*	*1990s*	*2000s*
Foodgrains	*-0.3*	*0.3*	*2.2*	*1.8*	*2.4*	*1.3*
Total Cereals	*-0.1*	*-0.2*	*2.3*	*1.7*	*2.4*	*1.6*
Rice	*0.7*	*-0.5*	*2.1*	*1.3*	*1.4*	*1.5*
Wheat	*1.6*	*0.6*	*4.5*	*1.3*	*2.9*	*0.6*
Coarse Cereals	*-2.4*	*-0.4*	*-0.1*	*4.6*	*2.0*	*4.6*

Figure 2: Comparative Performance of Growth of GDP and Agri-GDP



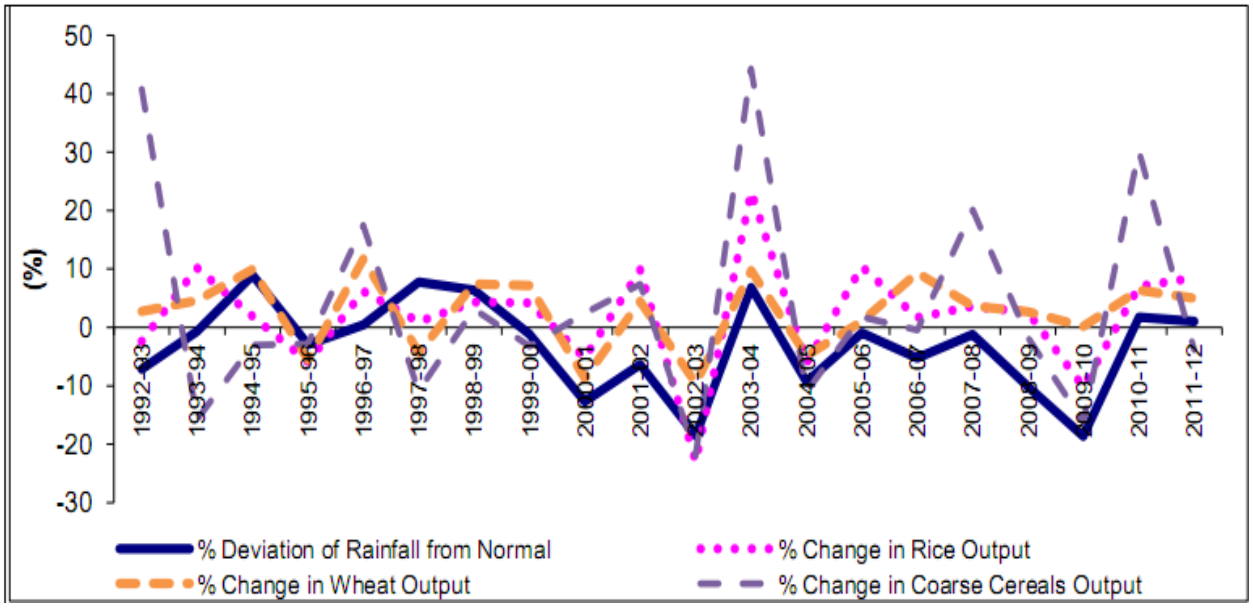
Indian agriculture has not witnessed any major breakthrough since the Green Revolution which focused on the two cereals (wheat and rice) and concentrated on north-western India. Punjab and Haryana are the two states that contribute the largest to foodgrains production but this is at the cost of annual negative balance in the ground water reserves for these states. According to the latest assessment of ground water situation in India (CGWB 2009-10), 75per cent blocks in Punjab are overexploited, only 18per cent are considered safe. As a step towards demand management of water, a gradual shift of these water guzzling crops from North-Western India to Eastern States is required. Under 'Bringing Green Revolution to Eastern India' (BGREI), eastern States like Bihar, Madhya Pradesh and West Bengal are emerging as large producers but gross lack of marketing and procurement infrastructure has caused distress to farmers despite record production. This raises doubts on the sustainability of production without commensurate investments in agri-infrastructure, especially marketing.

VOLATILITY IN PRODUCTION

Volatility in food systems due to exogenous shocks from weather related events or instability in international markets compromises national food security. While India has achieved much in augmenting food grain production, especially of rice and wheat, curbing volatility in year-to-year production remains a critical challenge. The volatility in coarse cereals is much higher than that of rice and wheat, intensifying the pressure on rice and wheat in drought years. Indian agriculture is still highly dependent on rainfall and drought years cause production and stock declines which can take a couple of years to be made up. A case in point is the drought year 2002-03 where the production of wheat and rice fell by 28.5 million tonnes over the previous year (overall foodgrain production dropped by 38 million tonnes). It took 3 years to make up and

it was only in 2006-07 that the production exceeded the 2001-02 level. With the gross irrigated area as a percent of gross cropped area having increased from 34per cent in 1990-91 to 45.3per cent in 2008-2009, agriculture now has better capacity to bear the brunt of deficit rainfall. However, more than 50 per cent area under cultivation is still at the mercy of monsoons. Further, the sustainability of irrigation is also significantly dependent on rainfall. Increasing resilience of Indian agriculture against drought and managing water resources sustainably remains a formidable challenge.

Figure 3: Change in Output of Cereals & Coarse Cereals and Deviation of Rainfall from Normal



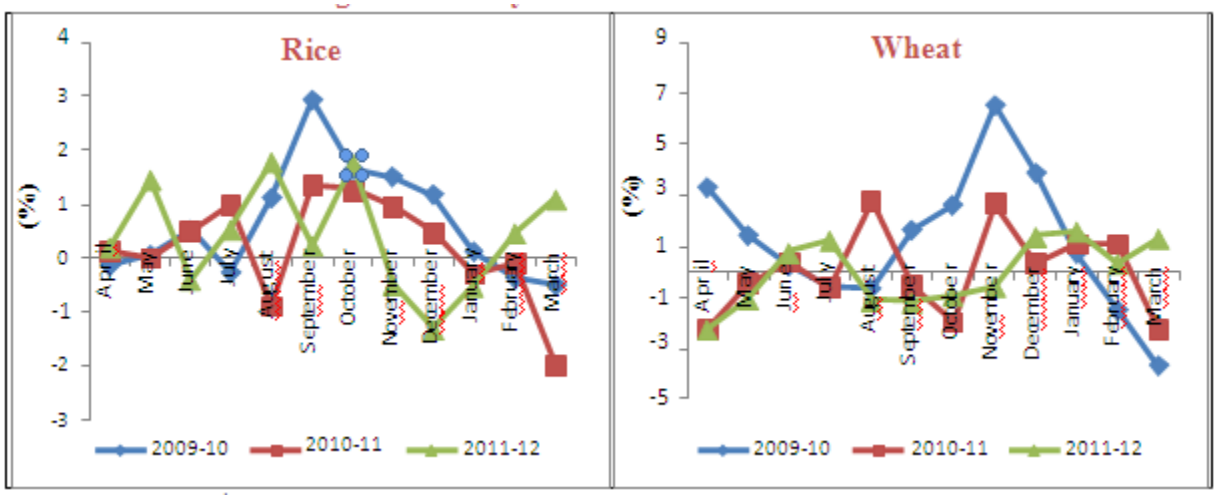
YIELD

India is currently the second largest producer of both wheat and paddy but its productivity levels are still lower than the world average and that of major producing countries, as shown in Table 4. The challenge before India is to raise the productivity of its basic staples like rice and wheat with increasing pressure of urbanization and industrialization on land and water availability (currently more than 60 per cent of cropped area is under grains and more than 80 per cent of water resources is used for irrigation in agriculture). Increase in foodgrain production will have to come from investment in productivity enhancing technologies in irrigation, power, fertilizers, seeds and post harvest technology to reduce losses.

VOLATILITY IN PRICES

Because of the low price elasticity of demand for food staples and the thinness of markets, problems in food availability translate into large spikes in domestic prices and reductions in real incomes of poor consumers. Rice and wheat experience wide fluctuations in wholesale prices during a year which can be seen in Figure 4. As 2009-10 was a drought year, the figure clearly shows the wide fluctuations in monthly prices of wheat and rice. This volatility in prices creates uncertainty in the 'economic access' pillar of food security.

Figure 4: Intra-year Inflation in Rice & Wheat



PROCUREMENT

NFSB would require procurement for Central Pool and would depend upon the existing system particularly FCI. Currently, FCI procures mainly paddy and wheat (primarily through state agencies) from farmers (at MSP) and in the form of rice from rice millers (at levy price). It is essentially a system of open-ended procurement under which FCI is obligated to buy all the grains that farmers offer to sell at the prescribed procurement price (MSP plus Bonus) as long as the grains meet a certain quality standard. The high cost of operations has been evident and well documented.

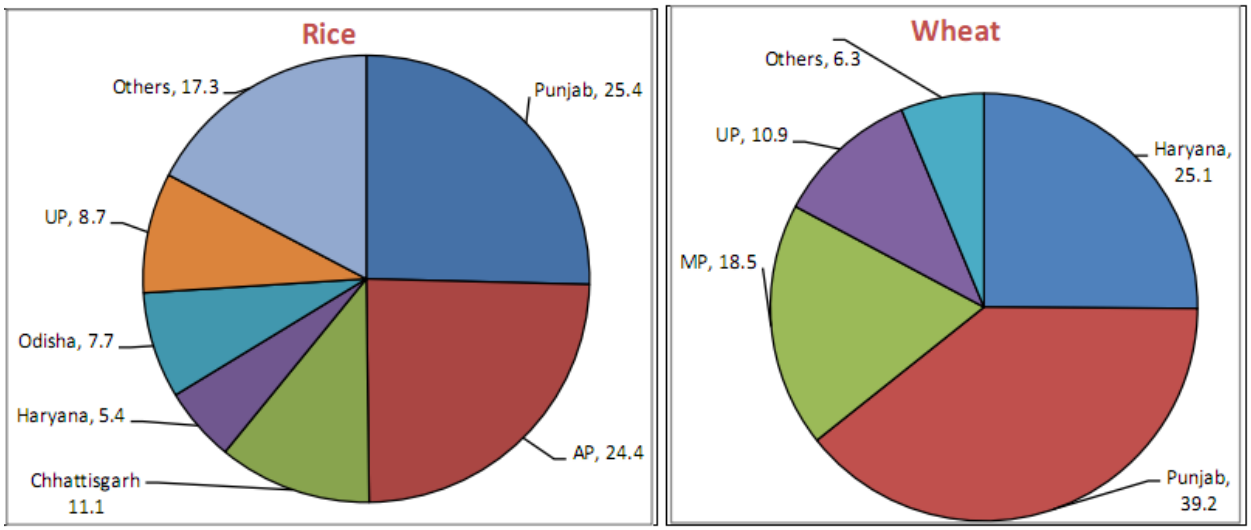
CONCENTRATED PROCUREMENT

Although, in principle the system is applicable to the country as a whole, effectively the system operates primarily in a few surplus states such as Punjab, Haryana, Western UP and Andhra Pradesh. Figure 5 show that 70 per cent of rice procurement is done from Punjab, AP, Chhattisgarh and UP while 80per cent of wheat procurement is done from Punjab, Haryana and MP alone. It is a known fact that the states of Punjab and Haryana have a very high incidence of taxes and such large scale procurement from these two states increases the procurement costs. Around Rs 7000 crores (10 percent of the food subsidy in 2011-12) have been collected in 2011-12 from FCI through levies in states like Punjab, Haryana, AP and MP.

Further, from a logistics point of view it could be cheaper to procure foodgrains from states like MP, Bihar, Gujarat etc and deliver the foodgrains to neighboring deficit states in central, eastern and western India rather than procure from a handful of surplus states in North and South and distribute foodgrains across the deficit states in India. But such a system would need ramping up of procurement efforts in emerging surplus or self-sufficient states in cereals, such as Uttar Pradesh, Bihar, West Bengal, Assam, and Orissa. It is often lack of effective price support operations, especially when cereal markets are controlled by restricting exports, or imposing restrictions on their free movement across the country or putting stocking limits on private trade,

etc., that open market prices go below MSP. This inability of farmers to get even MSP in these states does not allow farmers to augment their incomes by increasing production of rice and wheat.

Figure 5: Concentrated procurement of Rice and Wheat (2009-10 to 2011-12)



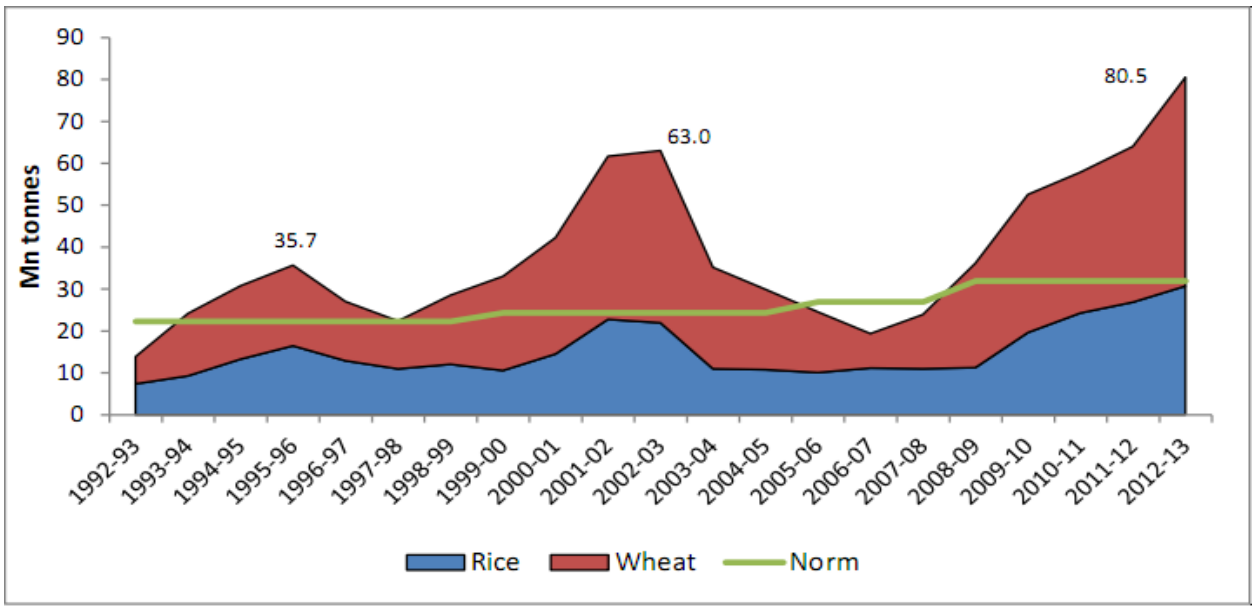
Agricultural marketing infrastructure is inadequate across states in India barring a few. Unlike in Punjab and Haryana, which have a well-laid out network of mandis and procurement centers, other major producing states of UP, Bihar, West Bengal, Assam and Orissa present a somewhat dismal picture. Lack of adequately equipped mandis/procurement centers and storage poses a major challenge for procurement from other states. Even in states like Chhattisgarh and Madhya Pradesh, which have recently ramped up procurement of paddy and wheat, respectively, infrastructure for proper procurement and storage is woefully inadequate. This leads to large wastages of grain.

STOCKS

As against the buffer stock norm of 31.9 million tonnes of Rice and wheat (as on 1st July of each year), total Central Pool stocks were more than double at 80.5 million tonnes on 1st July, 2012 Fig 6). Periodic overstocking by the public sector has huge implications on the fiscal side, apart from distorting the free functioning of food grain market. Higher level of buffer stock carry the risk of higher wastage of food grains along with higher cost of maintaining the buffer. Currently, FCI is facing an acute storage crisis with covered capacity estimated at around 45.0 million tons and Covered and Plinth (CAP) storage of 17.2 million tonnes against the stocks crossing 80 million tonnes. Periodic overstocking by the public sector has huge implications on costs, apart from distorting the food grain market. The additional procurement as a result of the proposed NFSB will put enormous pressure on the existing infrastructure which is inadequate to handle the current procurement norms. Even though modern silo storage and bulk handling is required for preservation of quality and efficiencies there are several impediments to the same such as non-

availability of rail heads at all FCI storages, limited locations with FCI for the same, non-availability of bulk wagons with Indian railways.

Figure 6: Central Pool Stocks with FCI



ECONOMIC COST OF FCI

The economic cost of procurement to Food Corporation of India (FCI) has been increasing over time with rising procurement levels - demonstrating that it suffers from diseconomies of scale with increasing levels of procurement. Currently, the economic cost of FCI for acquiring, storing and distributing foodgrains is about 40 per cent more than the procurement price. To illustrate the costs involved, in terms of storage and interest cost alone, the cost of carrying wheat for a year with government agencies is about Rs 2400/tonne –as on 1st November, 2012, the wheat stocks in the central pool are 40.5 million tonnes-almost three times the buffer norm (for 1st October).

For the quarter ending March, 2012, FCI employed 1.55 lakh workers out of which 1 lakh are contract workers, 19441 are departmental labour, 30112 are Direct Payment system (DPS) workers and rest were under the 'no work no pay' system. The average handling cost per metric tonne for FCI for 2010-11 for contract labour was Rs 41.4 while for departmental labour, it was Rs 311.1 (7.5 times the cost of contract labour) and for workers under the DPS it was Rs 136.9 (3.3 times the contract labour). This indicates contractual labour of FCI were the least expensive. However, the Ministry of Labour and Employment, has prohibited employment of contract labour in the depots of FCI. In years to come, it is quite possible that DPS and contract workers would become part of departmental labour which would raise the costs of labour by 3-7 times.

IMPORTS

In case of deficit production, countries tend to resort to imports from global markets. While this is a feasible policy option, especially in emergency situations, price volatility and availability of

preferred quality in global markets becomes relevant especially with the experiences of 2007-2008 global food and fuel crisis. Rice is a very thinly traded commodity with only about 7 per cent of world production being traded and five countries cornering three- fourths of the rice exports. The thinness and concentration of world rice markets imply that changes in production or consumption in major rice-trading countries have an amplified effect on world prices. While India figures in the top ten wheat producing countries/regions in the world along with five countries of the European Union, China, USA and Russia, it does not have a prominent presence in the international trade in wheat.

While smaller imports can meet small deficits in domestic production to bridge the supply gap, if quantities demanded are too large, they can send the global markets into a tizzy. Sometimes, an impending food price rise (as happened in 2007-08) can invoke knee jerk policy decisions that restrict flow of food to net importing countries. This is especially true in the case of rice, as global markets are much smaller. India's entry into the international market as a large buyer could exert significant upward pressure on prices. Given that NFSB commits for legal entitlements of food (especially rice and wheat), India will have to carry a much larger stock of these to avoid any eventuality of large scale imports of rice and wheat in the event of domestic shortfall (as happened in 2002-03 when grain production fell by 38 million tonnes). If this is not done, India will risk high cost of cereal imports in times of need, especially drought years. Although foreign exchange reserves do provide the cushion to India to enter the global food markets for its needs, yet the large country impact on global prices (especially for rice) cannot be ruled out.

DISTRIBUTION: TPDS

PDS with a network of 4.78 Lakh FPS is perhaps the largest retail system of its type in the world. However, the PDS has virtually collapsed in several states in India due to weak governance and lack of accountability. There are, however, exceptions like Kerala and Tamil Nadu. Table 5 shows the performance of this scheme in 2004-05 and 2009-10, the two years for which NSS data on consumption from PDS are available. In 2004-05, compared to an off take of 29.4 million tonnes of rice and wheat by States, only 13.2 tonnes were actually lifted by households for consumption – suggesting a leakage of 54.1 per cent. In 2009-10, 25.3 million tonnes was received by the people under PDS while the off take by states was 42.4 million tonnes- indicating a leakage of 40.4 per cent.

TABLE 5: ESTIMATES OF LEAKAGE FROM TPDS

	Units	2004-05	2009-10
Offtake under TPDS (Rice + Wheat)	Mn Tonnes	29.4	42.4
PDS Food consumed by the population, NSSO	Mn Tonnes	13.2	25.3
per cent Leakage of Food		54.1per cent	40.4per cent

REFORMS IN TPDS

The problem of fake ration cards has been addressed by a number of states by computerization of databases and using hologram-enabled technologies to eliminate the duplicate cards. A key reform being proposed involves using Aadhaar number based application for improving delivery of food grains through PDS. The task force report recommends setting up of Public Distribution System Network (PDSN) with the aim of providing support in the areas of development, operations and maintenance of technology, supply chain management, transparency and electronic payments. The solution aims to tackle the primary issue of identifying eligible beneficiaries, removal of bogus ration cards and provide choice of FPS to the beneficiary to procure food grains. With respect to private sector participation in PDS reforms, Madhya Pradesh has taken a significant step and used private sector to put in place a system to computerize the PDS and register beneficiaries with their Aadhaar number and provide the food coupons to the beneficiaries.

FINANCIAL CHALLENGES

The large-scale subsidized grain distribution to almost two-thirds of the country's population of 1.2 billion implies massive procurement of food grains and a very large distribution network entailing a huge financial burden on the already burdened fiscal system. The stated expenditure of Rs 1, 20,000 crores annually in NFSB is merely the tip of the iceberg. To support the system and the welfare schemes, additional expenditure is needed for the envisaged administrative set up, scaling up of operations, enhancement of production, investments for storage, movement, processing and market infrastructure etc. The existing Food Security Complex of Procurement, Stocking and Distribution- which NFSB perpetuates- would increase the operational expenditure of the Scheme given its creaking infrastructure, leakages and inefficient governance.

Over and above that, the yearly food subsidy bill itself is likely to gallop. The estimate of food subsidy would depend upon economic cost, central issue price of food grains, number of beneficiaries covered and quantities of food grains allocated and lifted. The food subsidy in the coming years will balloon due to the lower central issue price of grain, a significant rise in the number of entitled beneficiaries and the need to keep raising the MSP to cover the rising costs of production and to incentivize farmers to increase production. These issues raise doubts on the sustainability of the financial obligations entailed in NFSB.

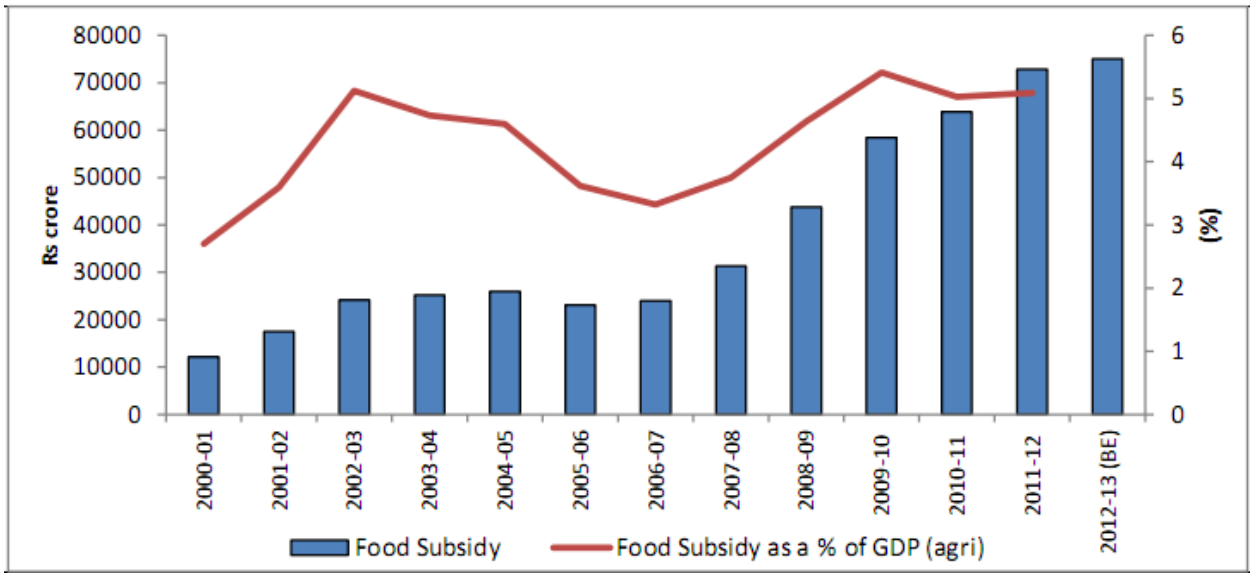
FINANCIAL OBLIGATIONS UNDER NFSB

The financial obligations of states and Centre would be enormous because to support NFSB, the government would need to enhance production, storage and marketing infrastructure, its own procurement and distribution set up, the entire envisaged paraphernalia of National and State Commissions. There will be a requirement of providing additional manpower at various levels for effective implementation of the Act, social audits and evaluation studies, training and capacity building etc. It also has to beef up operations in relation to the multitude of welfare schemes that have been envisaged particularly for midday meals, feeding the poor etc.

a) Food Subsidy

Food subsidy bill represents the basic direct cost incurred by the central government on procurement, stocking and supplying to various food based safety nets such as PDS. During the last ten years, food subsidy has more than quadrupled from Rs 17,494 crore in 2001-02 to Rs 72,823 crore in 2011-12(RE) at current prices. As a ratio of GDP-Agri, it has increased from 3.6 per cent to 5.1 per cent in the same period (Fig 7). Increasing economic costs of handling foodgrains, record procurements in recent years and widening difference between the economic cost of foodgrains and the central issue price have been the major factors leading to the ballooning food subsidy.

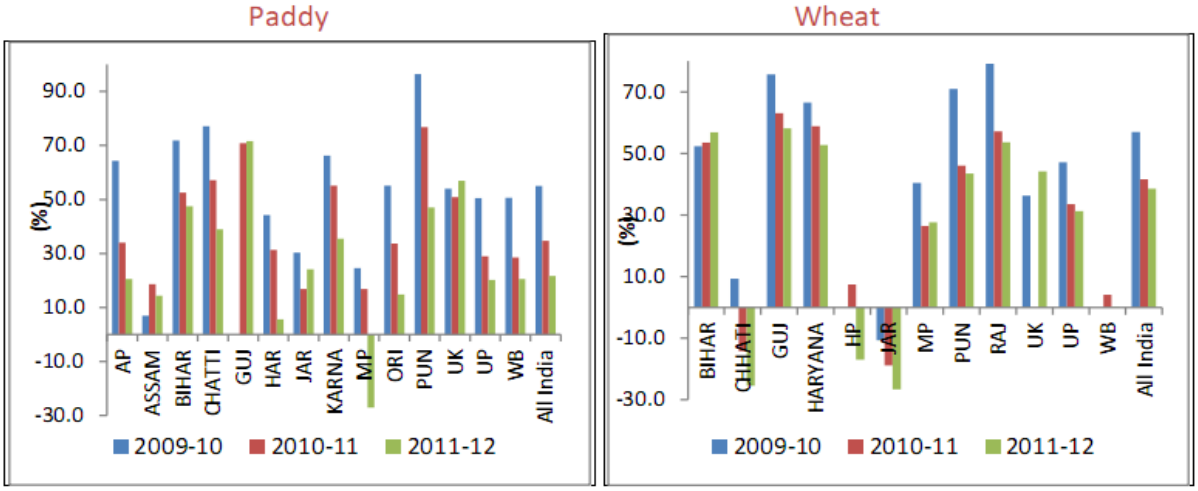
FIGURE 7: FOOD SUBSIDY - TOTAL AND AS PER CENTAGE OF GDP-AGRI (CURRENT PRICES)



Pooled cost of grain (MSP and bonus) accounts for two-thirds of economic cost of wheat and rice. MSP for paddy and wheat have increased at a compound annual growth rate of 10.9 per cent and 8.6 per cent over the last five years (2007-08 to 2012-13 marketing seasons). The cost of production of rice and wheat has gone up by more than 45per cent during last three years (2010-11 to 2012-13 marketing seasons), i.e., on an average, by about 15per cent per year (according to cost projections made by CACP based on Comprehensive survey done by DES). This is primarily due to sharply rising labour and energy costs, including fertilizers. There is an acute shortage of labour in agriculture that has suddenly cropped up in these three years. In some states, labour costs have gone up by more than 100 per cent over the same period. Due to these rising costs, the margins of production for farmers have been declining both for paddy and wheat (Fig 8). Therefore, the government may have to raise procurement prices for rice and wheat to encourage farmers to increase production of these staples. As the cost of production of crops is

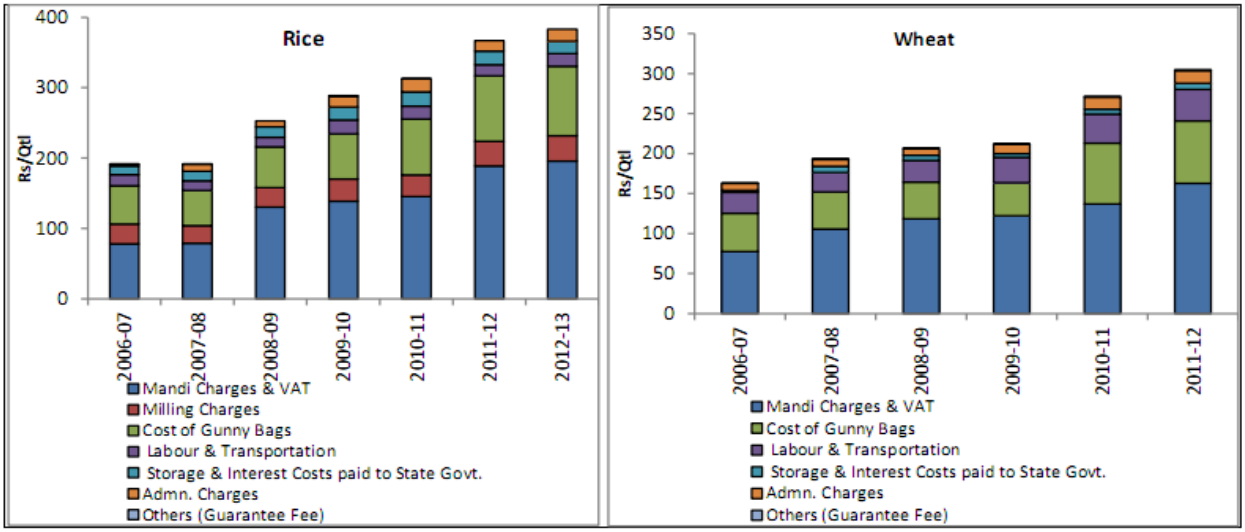
rising, MSP can't be kept frozen. The increase in the food subsidy bill will primarily depend on the rate at which the MSP for wheat and rice increases and the economic cost of handling grains (their procurement, stocking and distribution to the targeted households).

FIGURE 8: STATE –WISE MARGINS IN PADDY AND WHEAT CULTIVATION AS A PER CENT OF C2 COSTS

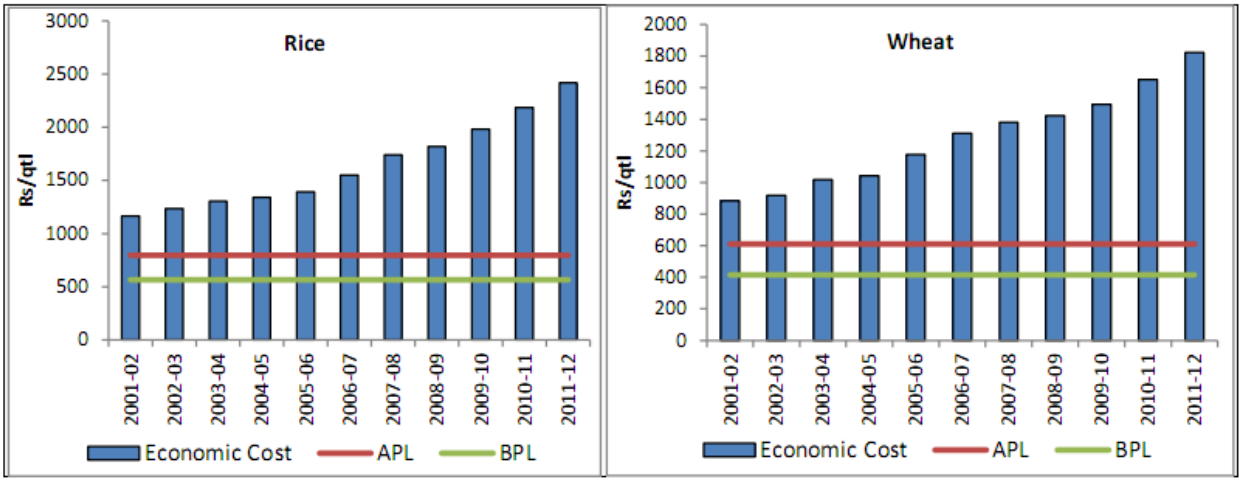


The procurement incidentals (which include market fees, development cess, arhatia commission, cost of gunny bags, charges to State governments for storage and interest etc.) contribute to around one-sixth of the economic cost for both rice and wheat. A major contribution to the increasing procurement incidentals is from the high rates of statutory levies imposed on the market by states like Haryana (11.5 per cent) and Punjab (14.5 per cent) (Fig 9). These add to the costs of procurement for FCI which ultimately add to the food subsidy bill. The concentration of procurement by FCI in a few states leads to increased distribution costs for the PDS where the grains are sent to states like UP, MP and Rajasthan.

Figure 9: Rising Procurement Incidentals of FCI



The difference between the economic cost and issue price is the consumer subsidy, which is reimbursed by the Central Government to FCI. This segment has been increasing during the last ten years as despite increasing economic cost, the issue prices have remained unchanged since July 2000 for BPL families, December 2000 for AAY households and July 2002 for APL families (Fig 10). In real terms, the current issue prices are around 55 per cent of the original CIPs implying that rice and wheat are available at almost half the price through the PDS.



B. Investments Required for Enhancement of Agriculture Productivity

One of the objectives in Schedule III relates to the revitalization of agriculture. The production of wheat and rice need to be enhanced by 25 million tonnes. India has reaped a bumper harvest in 2011-12 and has procured a record 34.9 million tonnes of rice in KMS 2011-12 and 38.1 million tonnes of wheat in RMS 2012-13. But to sustain these levels of procurement, additional agricultural investment to increase production would be required.

C. Increased Requirement of Marketing and Processing Infrastructure

Almost 100per cent market arrivals of wheat and common paddy are already procured by government in Punjab and Haryana. So growth will have to happen in newer territories especially from Eastern states. Many of these states have a very scanty level of market infrastructure with lower market surpluses and handling per market. The states would then have to heavily invest in the market infrastructure to facilitate procurement. Presuming that the market and processing infrastructure will be required for an additional handling of 18 million tonnes, the additional investments in mandis will be to the tune of Rs 5000 crore for 3 years and in the processing infrastructure to the tune of Rs. 5000 crore for 3 years.

D. Increased Requirement of Storage/Warehouse Capacity

The increased level of procurement and distribution of the food grains as result of the Bill will require higher storage and warehousing capacities. The implementation of the Bill will require

storage capacity addition between 22- 32 million tonnes (current covered storage capacity is 45 million tonnes). Some rough estimates show that the additional cost of storage infrastructure would be Rs. 2,500 to 8,500 crore depending upon whether the government invests in silos or traditional storage. Indian Railways too would have to invest in procurement of rolling stock.

Total Expenditure over Next Three Years

As per the calculations made within the Government set up, the food subsidy alone will cost the Exchequer about Rs 95,000 crores to start with. If one counts the other parts of the Bill, and associated set up etc. to get this moving through the existing channel of Public Distribution System, the Bill may touch an expenditure of anywhere between Rs 125,000 to 150,000 crores. And if one adds to it the money needed to produce extra foodgrains on sustainable basis–(The Ministry of Agriculture (DAC) indicated in its submission that an expenditure of Rs 1, 10,600 crores would be needed over a five year period, if one is to ensure ample grain supplies on sustainable basis under the NFSB. For the success of the Bill in its current form, this expenditure will have to be front loaded in the first three years, lest a severe drought upsets the entire calculations about legal commitments.

While calculating the expenditure the facts like rate of statutory levies (taxes, commissions, cess, etc.) on top of the MSP for any procurement of any grain by state like Punjab may raise in future, which will result in higher procurement prices. While calculating the expenditure the facts like rate of statutory levies (taxes, commissions, cess, etc.) on top of the MSP for any procurement of any grain by state like Punjab may raise in future, which will result in higher procurement prices. The possible increase in labor costs in FCI must be taken into consideration. Any increase would add further to the cost, and so would be the cost of setting up extra logistics, from railways to storage.

TABLE 8: CALCULATION OF COST TO EXCHEQUER

All Figures in Rs crores	Year I	Year 2	Year 3	Total
Economic Cost(EC)				
Rice	98658	108524	119376	
Wheat	56154	61769	67946	
Total EC- Grain	**154812**	**170293**	**187323**	**512428**
Sale of grain				
Rice-Priority @ Rs 3 per Kg	7127	7127	7127	
Rice-General @ 50per cent of MSP	6408	6311	6942	
Wheat – Priority @ Rs 2 per kg	3441	3441	3441	
Wheat – General @ 50per cent of MSP	3138	3592	3951	
Total Sale of Grain	**20114**	**20470**	**21460**	
Subsidy (A-B-C)	**134698**	**149823**	**165862**	**450383**

Other Expenditure				
Agriculture Production Enhancement Costs	66000	33000	11000	
Infrastructure and logistics cost	10000	10000	10000	
National and State Food Commission per annum	146	155	164	
District Grievance Redressal per annum	320	339	360	
New Scheme for special groups	8920	8920	8920	
Maternity Benefit per annum-cash scheme	14512	14512	14512	
Misc Costs (PDS reforms, Addl. Staff and office etc)	6667	6667	6667	
Total Other Expenditure	**106565**	**73593**	**51622**	**231780**
Total outflow from Govt (D+E)	**241263**	**223416**	**217485**	**682163**

MACROECONOMIC ASPECTS AND NFSB

Increase in Subsidies

As already delineated in the paper in earlier section, NFSB would require huge funds and thereby huge subsidies by the Central Government. The source for these subsidies could be increasing fiscal deficit (fuelling inflation), additional revenue generation or shift of funds from investment to subsidies. Green Revolution was not an outcome of subsidies but rather of enhanced investments in Technology, Institutions (R andD), communication and physical infrastructure. Public investment in agriculture as a percentage of agri-GDP has increased from 1.8 per cent in 2000-01 to 3.4 per cent in 2010-11. But input subsidies, as a per centage of agri-GDP, have increased at a faster pace than public investment, from 8.9 per cent in 2000-01 to 17.2 per cent in 2009-10. Together, only food and fertilizer subsidies, as a ratio of GDP (agri),accounted for 12.4 per cent in 2010-11- up from 6.0 per cent in 2000-01. In comparison, public investment in agriculture is only around one-fourth of this which is reflective of the imbalance between use of subsidies and investments as policy instruments for agricultural growth. It may be worth noting here that during the last three Five Year Plans, agricultural sector has failed to achieve the modest targeted growth of 4 per cent.

Given fiscal constraints, there is always a trade-off between allocating money through subsidies and increasing investments. Ample research shows that investment option is always preferable to subsidies to sustain long-term growth in agricultural production and also to reduce poverty faster. So the focus of public expenditure for agriculture needs to shift towards investments to boost productivity rather than subsidies. In contrast, NFSB is likely to shift the nature of resource allocation more towards subsidies rather than investments. This will be retrogressive from long term agri-growth and sustainable food security point of view

Forcible Low-Level Equilibrium Trap for Indian Agriculture

The structural composition of agriculture has been evolving over the years. Within the value of total output of agriculture and allied sector, the share of cereals has declined from 27.3per cent in TE 1990-91 to 21.0per cent in TE 2010-11 while the share of livestock has increased from 23.7

per cent to 29 per cent in the same period. Currently, cereals constitute only about one fifths of the total value of output from agriculture and allied sector which is less than the contribution from the livestock sector and almost equal to the fruits and vegetables. The share of fruits and vegetables and livestock have shown an increasing trend in recent years implying that they have been growing at a much faster rate than the traditional crops sector. Given the rising share of high value commodities in the total value of agricultural output and their growth potential, this segment is likely to drive agricultural growth in the years to come. Being highly perishable in nature, this segment requires faster and better linkages between farms and firms in the logistics, processing and organized retailing.

Faster growth in per capita incomes and urbanization are triggering shift towards high value commodities like fruits, vegetables, fats and oils, and animal products such as dairy, poultry and eggs. Share of expenditure on cereals in total food expenditure has declined from 41per cent in 1987-88 to 29.1 per cent in 2009-10 in rural areas and from 26.5per cent in 1987-88 to 22.4 per cent in 2009-10 in urban areas. The Bill's focus on rice and wheat goes against the trend for many Indians who are gradually diversifying their diet to protein-rich foods such as dairy, eggs and poultry, as well as fruit and vegetables. There is a need for a more nuanced food security strategy which is not obsessed with macro-level foodgrains availability. But at the policy level, the Government is still focused on foodgrains and with NFSB is clearly reversing the movement of Indian agriculture from high value items to foodgrains. This will trap the Indian agricultural sector in a low level equilibrium trap as returns are generally higher in high value agriculture. But a faster movement towards high value agriculture needs large investments in infrastructure and risk mitigating strategies. The NFSB is likely to slow down this natural process, and at places even reverse this trend.

Restricted Private Initiative in Agriculture

In pursuit of the food sufficiency regime a regulatory framework has been created with massive government intervention in terms of policing powers under the APMC Act and Essential Commodities Act, interstate movement restrictions, regular but unpredictable export bans on foodgrains, banning of forwards trading on commodity exchanges etc. This will be even further tightened to enable government to carry out its procurement functions now. A combination of the quantum of public procurement and a stringent regulatory framework would drive the private sector out of the food grains sector.

Let us illustrate this with an example of Punjab. Punjab experienced an increasing rate of growth for about 25 years, but from 1997-98, Punjab has experienced a deceleration in its rate of growth. Cultivation of high-yielding varieties of paddy, particularly under assured tube well irrigation has resulted in an alarming depletion of the underground water table, decline in soil fertility, an increased incidence of insect pests, weeds, and increased resistance towards use of chemical inputs, and decelerating rates of growth in yields. Further, almost complete takeover by state of the foodgrain markets caused much of the private sector to withdraw and there was not much modernization and scaling up of its agro processing (mills etc) and storage infrastructure. Punjab rice and wheat may not be even globally competitive without large subsidies through free

power and water. It is surviving basically on government support and without much value addition. As a result Punjab's agri-GDP growth during the decade of 2000 remained pitiably low at less than 2 per cent. Gujarat, in contrast, has focused on commercial crops and diversified into non-farm activities like milk, along with a strong focus on investments in value adding infrastructure. This holds the key to the stupendous growth in agriculture of more than 9per cent per annum witnessed during the decade of 2000. Gujarat remained almost free from any large scale government intervention and regulation, and leveraged its private entrepreneurs to drive growth. Through incentives to attract private sector by providing a favorable investment climate, several non-farm income generating employment opportunities have been created in rural areas supplementing rural income.

State Takeover of Food Grain Economy Would Cripple Competition

Since 2006-07, the procurement levels for rice and wheat have increased manifold with more than one-third of the total production being procured for Central Pool. This will be even more pronounced if procurement is taken as a share of marketed surplus -more than 40 per cent for rice and more than 50 per cent for wheat. Currently, piling stocks of wheat with FCI has led to an artificial shortage of wheat in the market in the face of a bumper crop. Wheat prices have gone up in domestic markets by almost 20 per cent in the last three months alone, because of these huge stocks with the government that has left very little surplus in markets. Apart from imposing a huge additional cost to procure, store, transport and distribute grain, increasing public procurement strangulates the domestic grain market.

Inflationary Pressures on Food Prices

India has recently been experiencing high food inflation in the face of record production of food grains, robust buffer stocks and growing resilience of agriculture to monsoon uncertainties. A distinct feature of recent food price inflation has been the sustained price pressure in protein rich items (pulses, milk, fish, meat and eggs). According to RBI, the inflationary impact of NFSB will depend on the extent to which it will raise demand for food grains relative to the normal increase in supply. This will create demand pressures, which will inevitably spillover to market prices of food grains. Furthermore, the higher food subsidy burden on the budget will raise the fiscal deficit, exacerbating macro level inflationary pressures. Additionally, the need to procure large amounts would need a consistent rise in MSP of the foodgrains to incentivize their production further fuelling the inflationary pressures. This will create further macroeconomic imbalances.

NFSB focus on cereals is likely to induce severe imbalance in the production of oilseeds and pulses, resulting in substantial imports in the coming years. India imported a whopping US$ 9.7 billion (Rs 46,242 crore) worth of edible oils in 2011-12 – a 47.5 per cent jump from last year and pulses worth US$ 1.8 billion (Rs 8767 crore) during 2011-12- an increase of 16.4 per cent as compared to last year. Assured procurement gives an incentive for farmers to produce cereals rather than diversify the production-basket. Import intensity will intensify at higher prices creating inflationary pressures. Vegetable production too may be affected - pushing food inflation further.

Impact on 'Absorption' Pillar of Food Security

NFSB also aims at improving the nutritional status of the population especially of women and children. But studies have shown that the challenge of improving absorption lies in linking nutrition with health, education and agriculture interventions. Access to sanitation
Facilities and women's literacy in particular are found to be strong factors affecting malnutrition. The Indian government has recognized malnutrition as a serious problem in every plan document. However, a pressing issue is the absence of a comprehensive and functioning National Nutrition Strategy. Direct nutrition intervention through the Special Nutrition Programme under the Integrated Child Development Scheme (ICDS; now called the Supplementary Nutrition Programme) and the MidDay Meals Scheme (MDMS) are currently in force to address the nutritional needs of children and women and would continue to be the channels through NFSB. Though no deeper analysis of these schemes has been done for the purpose of this paper, yet it needs to be recognized that malnutrition is a multi-dimensional problem and needs a multi-pronged strategy Women's education access to clean drinking water, availability of hygienic sanitation facilities are the prime prerequisites for improved nutrition. If we include the costs to create such rural and urban infrastructure, enormous financial expenditures and effective strategies are required.

Legal Aspect

The last but not the least the legal aspect of the act needs to be strengthened further. The current provision of penalty for errant official is only five thousand rupees which should be rationalized along with other punitive actions, depending upon the magnitude and severity of complain. The act must have time bound provisions to dispose the claims and grievances of the intended beneficiaries as some of them may have urgent need to access of food and delay in disposal of grievances could be a matter of life or death. The proposed citizen's charter will be good supplementary legislation to realize the objective of "Right to Food Act" along with 'Right to Information Act'. The provision of social audit as seen in case of MGNREGA will also help to maintain transparency in selection of the beneficiaries and distribution of food gains. Involvement of local governments and voluntary organizations in the implementation of the scheme as proposed under the bill are welcome provisions to safeguard the interest of the poor.

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ADDRESSING THE NEXUS BETWEEN WATER, ENERGY AND FOOD SECURITY: TOWARDS INTEGRATED SOLUTIONS

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The nexus between water, energy and food security means that the three sectors - water security, energy security and food security - are intricately linked, and that measures and actions in one area more often than not have impacts in one or both of the others. These connections have always been present, but as the world population plunges towards eight billion with increasing demands for basic services and growing desires for higher living standards, the need for the vital resources necessary to achieve those services and desires has become more obvious.

Water security as defined in the Millennium Development Goals (MDGs) as access to safe drinking water and sanitation, both of which have recently become a human right. While not part of most water security definitions yet, availability of and access to water for other human and ecosystem uses is also very important from a nexus perspective; energy security has been defined as access to clean, reliable and affordable energy services for heating, communications and productive uses, at an affordable price, while respecting environment concerns; and food security is defined as availability and access to sufficient, safe and healthy food for an active and healthy life. The importance on access in these definitions also implies that security is not so much about average availability of resources, but has to include variability and extreme situations such as droughts and the pliability of the poor.

Linkages among the Water, Energy and Food Security Sectors

Improved water, energy and food security on a global level can be achieved through a nexus approach – an approach that integrates management and governance across sectors and scales. A nexus approach also helps in the transition to a Green Economy, which intends, at resource use efficiency and greater policy consistency. Given the increasing interconnectedness across these three areas, a reduction of negative economic, social and environmental externalities can increase overall resource use efficiency, provide additional benefits and secure the human rights to water and food. Thus, a nexus perspective increases the understanding of the interdependencies across the water, energy and food sectors and influences policies in other areas of climate concerns. The nexus perspective helps to rule out interdisciplinary solutions, thus increasing opportunities for mutually beneficial responses between and among all sectors. A deep understanding of the nexus

approach will thus provide the informed framework that is required to meet increasing global demands without compromising sustainability. The nexus approach will also consent to decision-makers to develop suitable policies, strategies, and to identify and alleviate trade-offs among the development goals related to water, energy and food security. Active participation by and among government agencies, the private sector and civil society is significant to keep away from unplanned undesirable consequences. A true nexus approach can only be accomplished through secure partnership of all actors from all sectors.

There are substantial linkages among water, energy and food are. Water is used for extraction, mining, processing, as well as for growing feedstock for biofuels and for generating electricity. Water intensity varies in the energy sector, with oil and gas production requiring much less water than oil from tar sands or biofuels. Identifying biofuels for energy production should requires prioritizing carefully, since water that has been used to grow feedstock for biofuels could also have been used to grow food.

Many forms of energy production through fossil fuels are highly polluting in addition to being water intensive. Further, return flows from power plants to rivers are warmer than the water that was taken in and/or are highly polluted and can consequently compromise other downstream usage, including ecosystems. Conversely, energy is needed for extracting, distribution and treatment of water. Food production is by far the largest consumer of global fresh water supplies. Globally, agriculture is responsible for an average of 70 per cent of fresh water consumption by humans; in some countries that figure ranges between 80-90 per cent. Agriculture is therefore also responsible for much of fresh water over-exploitation. Food production further impacts the water sector through land degradation, changes in runoff water, groundwater discharge, water quality and availability of water and land for other needs. The increased yields that have resulted from mechanization and other modern measures have come at a high energy price, as the complete food and supply chain accounts for approximately 30 per cent of total global energy demand. Energy fuels land preparation, fertilizer production, irrigation and the sowing, and harvesting of crops. The links between food and energy have become quite obvious in recent years as increases in the price of oil lead very quickly to increases in the price of food. The energy sector can have other negative impacts on the food sector when mining for fossil fuels and deforestation for biofuels reduce land for agriculture, and ecosystems.

While the prospects provided by the nexus perspective and the consequent social, environmental and economic benefits are factual, implementation necessitates the right policies and institutions that are up to the mission, as well as frameworks that support empowerment, knowledge and research. Water and energy are closely entangled throughout the food chain. Irrigation implies escalating energy bills and energy is also powerfully used to make water of good enough quality for agriculture. Energy production is linked with significant water consumption, for instance, biofuels that can consume 20-30 tonnes of water per litre bio-fuel produces. Additionally, water can be used for hydropower generation in many parts of the world. The interconnections between water, food, and energy also concerns cost factor. Energy is a key input to agriculture, thus higher energy costs obstructs agricultural production, irrigation, and as a result food prices thus

hampering food security. Increasing energy prices also provide an incentive for replacement of food crops with growing fuel crops. The instability of energy prices is hence conveyed to the food price contributing to increased food security risks.

Environmental Impact of Virtual Water Trade

Virtual water among the countries and continents and within the nation is largely due to the trade of agricultural commodity, the country which export maximum of their agricultural product has definitely been reducing their ground level water. Trade is a source of foreign exchange and therefore, every nation wants to increase its per capita income by exporting maximum of their commodity in the international market. This has totally changed the overall production pattern of the country as land resources are scarce and it needs greater inputs like chemical fertilisers, pesticides, etc. so the soil profile is losing its quality with every passing day. The intensive use of pesticides is not only affecting the soil health but also on human health like mental retardation, brain haemorrhage.

According to Kampman (2007), the states like Haryana and Punjab are always with overproduction of their agricultural products, thereby reducing their ground water level. Hence this affects their blue and green water balance. On the other hand, Bihar, Jharkhand, Odisha import virtual water from northern states even though they have surplus ground water. This creates greater imbalance between states. One of the visual observation at village of Haryana, revealed that the farmers are unable to grow crops round the year. They could only grow the crop in the rainy season because water table was low and so difficult to pump out the ground water for irrigation purpose and even for drinking. This situation has created only the impact of maximum exploitation of ground water for growing water intensive crops.

Indian Food Security and Agricultural Scenario

Agriculture is the basis of economy and sustenance of life of the people of India. Sustainable agriculture may be regarded as the successful management of resources for agriculture to satisfy the changing human needs while maintaining or enhancing the quality of environment and conserving natural resources. Sustainable agriculture integrates three main goals: environmental health, economic profitability, and social equity. Success in promoting sustainable agriculture can be achieved on seven fronts, namely, crop diversification, genetic diversity, integrated nutrient management, integrated pest management, sustainable water management, post harvest technology and sound extension programmes (FAO, 1991).

It is generally believed that India has maintained a satisfactory level of food production in the 1980s**.** Food grain production in India has witnessed a steady increasing growth rate during the 1970s and 1980s from the rate of the previous decades, but the 1990s has witnessed a sharp fall in the growth rate. In fact, the growth rate of foodgrain production during the 1990s has been close to the annual population growth rate, which implies a stagnant per capita production level (Rao, 1997; Sawant, 1997). A comprehensive analysis of agricultural performance and productivity of Indian agriculture by Kumar (2001) has revealed that the changes in cropping pattern have been taking place as a result of substitution of low productivity crops by those which have shown impressive performance in productivity growth. Some of these crops are

paddy, wheat, maize, groundnut, rapeseed and mustard and sugarcane. Coarse cereal and pulses have shown a steady decline in their area. Changes in the cropping pattern had contributed to output growth considerably. Future source of food supply would be the enhancement of yield through technological change (Kumar, 2001).

However, sustaining a steady growth rate of yield would require efficient and optimal resource use of land, surface and ground water, and genetic resources, greater attention to cropping systems than individual crops, revamping the research and extension systems towards varietal improvement for dryland crops, strengthening adaptive local research, emphasis on bio-diversity and ecological balances, improving rural infrastructure including processing, marketing and storage, education and access to mass media, and development of rural financial markets (Vaidyanathan, 1994).

Indices for economic and social status are composite indicators of the economic and social well-being at the community, state and national levels. These social indicators are used to monitor the social system and help in the identification of problem areas that need policy planning and require intervention to alter the course of social change.

If the existing trends in high population growth, low agricultural development, wide disparities in income, huge environmental degradation, and high incidence poverty continues, India's food, agriculture, environment, and quality of human life will be seriously threatened in the coming years. Poverty and malnutrition are likely to remain as major problems. Pressure to produce more food from less land, use of more natural resources, enormous growth in the population and unequal distribution of income will harm the environment in the years to come.

Agriculture sector reforms should be initiated on a war-footing, to bring together all the best that is available and make agriculture an organised unit to give farmers the maximum benefits. Turning agriculture into an organised business with the farmer as the entrepreneur should be the key to second green revolution and for the much desired evergreen revolution in India. Farming should be taken up with the motive of profit making rather than just making a subsistence living. With huge diversity in the number and variety of crops that we produce, variations in agro-climatic conditions, soil type, and prevailing inequalities in the state growth levels, it is most essential to implement the development plans through micro level initiatives and proper coordination between all the stakeholders. These issues need to be considered to meet the targets laid out in the 11^{th} Plan strategy to raise agricultural output. Therefore, the prevailing policy instruments need to be re-looked at, re-defined and efficiently implemented to enhance agriculture productivity and especially dryland farming. There is an urgent need to reduce the regional disparity through appropriate policy planning for a balanced development of the country. There is a need to motivate more private investment into the agriculture sector and incentives like tax concessions or benefits can be proposed to them. There is also a strong need for public-private partnership, not only to start new projects but also to support and maintain the existing public structure.

The following are suggested for not only improving productivity but also for ensuring food security.

1. ***Integrated Nutrient Management***: Attention should be given to balanced use of nutrients. Phosphorus deficiency is the most widespread soil fertility problem in both irrigated and un-irrigated areas. To improve the efficiency of fertiliser- use, what is really needed is enhanced location-specific research on efficient fertiliser practices, improvement in soil testing services, development of improved fertiliser supply and distribution systems and development of physical and institutional infrastructure (Kumar and Desai, 1995).

2. ***Water for Sustainable Food Security***: India, being crop based, needs to produce more and more from less and less of land and water resources. Alarming rates of ground water depletions and increasing environmental and social problems pose acute threats to humankind. Improved management of irrigation water is essential in enhancing production and productivity, food security, poverty alleviation. In India, water availability per capita was over 5000 cubic metres per annum in 1950. It now stands at around 2000 cubic metres and is projected to decline to 1500 cubic metres by 2005. Further, the quality of available water is deteriorating faster (Kumar, 2001). Agriculture is the biggest user of water accounting for about 80 per cent of the water withdrawals. There are pressures for diverting water from agriculture to other sectors. It is has been projected that availability of water for agriculture use in India may be reduced by 21 per cent by 2020, resulting in drop of yields of irrigated crops, especially rice, leading to price rise and threat to food security of the poor. The needs of other sectors for water cannot be ignored. As a result, it is necessary that an integrated water use policy is formulated and judiciously implemented.

3. ***Enhancing Yield of Major Commodities***: The yield of major crops and livestock commodities must be increased. There is a need to strengthen adaptive research and technology, assessment and refinement capabilities of the country so that the existing gaps in technology can be bridged. For this, an appropriate network of extension service will have to be created to stimulate and encourage both top-down and bottom-up flow of information among farmers, extension workers and researchers. The agronomic and soil research need to be intensified to deal with the location-specific problems as decelerating productivity growth in the major production systems. Research on coarse grains, pulses and oil seeds must achieve a production breakthrough. Hybrid rice, single cross hybrids of maize and pigeon pea hybrids offer new opportunities. Soybean, sunflower and oil palm will help in meeting the future oil demands successfully. Forest cover must be preserved to keep off climatic disturbances and provide adequate fuel and fodder. Milk meat and draught capacity of our animals need to be improved through management practices.

4. ***Increase in Productivity*:** It is imperative for India to maintain a steady growth rate in productivity. As productivity increases, the cost of production decreases and the prices also decrease and stabilises. Both producer and consumer share the benefits. The fall in food prices will benefit the urban and rural poor more than upper income groups, because the former spends a much larger proportion of their income on cereals than the latter. All the efforts need to be concentrated on accelerating growth in productivity, whilst conserving natural resources and promoting ecological integrity of agricultural system. More than half of the required growth in

yield to meet the target of demand must be met from research efforts by developing location-specific and low input use technologies with emphasis on the regions where the current yields are below the national average yield.

5. ***Making Dry Areas As Green***: Resource poor farmers in the rainfed ecosystems practise less intensive agriculture; they depend on local agriculture for their livelihood and benefit little from increased food production in the irrigated areas. To help them, efforts must be increased to disseminate the available dryland technologies and to generate new ones. Farming system research to develop location-specific technologies must be intensified in the rainfed areas. (Singh et al, 2002). The Government of India has already extended high priority to watershed development programmes in rainfed areas.

6. ***Watershed Development***: Watershed development and water saving techniques will have far reaching implications in increasing agricultural production in rainfed areas. Livestock sector should be given high priority with multiple objectives of diversifying agriculture, raising income and meeting the nutritional security of the poor farm households.

India and most of the countries in South Asia have concentrated on enhanced production of a few food commodities like rice and wheat, which could quickly contribute to their total food agricultural production. The rice-wheat based cropping system, spread in the most fertile areas, is the backbone of food security in South Asia. All the efforts in the future have to be concentrated on breaking the yield plateau by conserving natural resources and promoting ecological integrity of the agricultural system. Producing more with less of inputs will be the major challenge in the next two decades. Research problems in the rainfed unfavourable ecosystems and breaking of the current irrigated yield ceilings are more complex and challenging. To make headway in them will require mobilisation of the best of science and the best of scientists in the National Agricultural Research System. This needs higher investment in agricultural research.

CONCLUSION

India is the major producer and consumer of food in South Asian region and possesses huge potential that remains highly under realised. Therefore, India has to play a major role not only to maintain its own self-sufficiency in food production but also to meet the additional requirement of its neighbouring countries. The right research priorities and production strategies will promote future growth in agriculture and ensure sustainable food and nutritional security.

With the growing world population, particularly in urban areas, the water, energy, and food resources will be facing budding challenges. By 2030, water supply could face a 40 per cent shortfall, with the world's food needs growing by as much as 50 per cent. By 2050, energy requirement will be three times greater than it was a mere decade ago. Urban development, infrastructure quality, investments in water and energy, demand and supply management solutions possibly will all have an impact on water resources, food and energy production.

Since an average uses of water less than half the amount of water consumed by an average American, but still India is the world largest exporter of virtual water by using more domestic water resources for export products than any other country. Indis’s per capita water consumption

is 1,089000 litres per year, but trade due to India's net virtual water export is 95,000 million cubic meters.

Agriculture is a backbone of Indian economy, because still today agricultural trade contribute more than 16 per cent in country's GDP. All agricultural products are water intensive such as farm produces i.e. everything from food crops to cash crops. The analysis of global water use also indicates that 90 per cent of India's gross virtual water exports is related to food products.

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CLIMATE CHANGE, WATER AND FOOD SECURITY: ADDRESSING THE CHALLENGES

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ABSTRACT

Water is not only essential for good health, but is also a factor helping in food production. Yet only a small amount of the water on earth is available to meet the competing demands of mankind. Climate change is widely considered to be one of the most difficult challenges facing us, both in terms of the action needed to limit it and the ways in which we will have to adapt to its effects. It is considered as posing the greatest threat to agriculture and food security in the 21st century, especially in many of the poor, agriculture dependent countries. Without some form of water control across the world's river basins, freshwater lakes and associated aquifers, local, regional and global food security would not be possible. The socio-economic and environmental factors will play a dominant role in shaping future water management policies. At the same time, climate change will increase future risk and vulnerability of crop production related to water supply and its availability. The amount of water allocated to agriculture and water management choices will determine, to a large extent, whether societies achieve economic and social development and environmental sustainability. This paper reviews current knowledge about the relationships between climate change, water and food security. Though the availability of food and its utilization are less directly linked to water, income from irrigated cash crops is affected by water availability. The safe utilization of water is interwoven with household hygiene and food preparation which depends upon water supply. Against a background of degraded agricultural land, diminishing water resources and progressively thinner stocks of key food products, the ability to improve agricultural production has become a matter of utmost concern. The rural population is at most risk from anticipated climate change especially those living in semi-arid and arid zones have few options for adapting to water scarcity other than migration. It is suggested that adaptation strategies will be needed in the future to reduce the anticipated impact of climate change on availability of water and food security.

KEY WORDS*: Water, climate, agriculture, degradation, management, policies, development*

INTRODUCTION

Nowhere in the world, in no act of genocide, in no war, are so many people killed per minute, per hour and per day as those who are killed by hunger and poverty on our planet —Fidel Castro, 1998. The developing countries in the tropics are more susceptible to climate change damage than temperate countries. Agriculture in the productive areas of Africa and South Asia will be amongst the worst-affected. According to some estimates, almost 40per cent of the production potential in certain developing countries could be lost. The changes in rainfall patterns and temperature regimes will influence the local water balance and disturb the optimal cultivation

period available for particular crops, thus affecting food and agricultural production. The worst brunt of climate change will be borne by the farmers in the areas where agriculture is dependent upon rains. In South Asia, the biggest blow to food production is expected to come from the loss of multiple cropping zones. The worst affected areas are predicted to be the double and triple cropping zones.

Developing countries face a substantial decrease in cereal production potential. In India, rice production is slated to decrease by almost a tonne/hectare if the temperature goes up by 2^0C. By 2050, about half of India's prime wheat production area could get heat stressed, with the cultivation window becoming smaller, affecting productivity. For each 1^0C rise in mean temperature, wheat yield losses in India are likely to be around 7 million tonnes per year, or around $ 1.5 billion at current prices. Contrary to the 18th century warnings of Thomas Malthus and his modern followers, study after study shows that global food production has consistently outstripped population growth, and that there is more than enough food to feed everyone. According to the United Nations Food and Agriculture Organization, enough food is produced in the world to provide over 2800 calories a day to everyone, substantially more than the minimum required for good health and about 18per cent more calories per person than in the 1960's, despite a significant increase in total population. Despite that, the most commonly proposed solution to world hunger is new technology to increase food production. The Alliance for a Green Revolution in Africa, funded by the Bill and Melinda Gates Foundation and the Rockefeller Foundation, aims to develop 'more productive and resilient varieties of Africa's major food crop to enable Africa's small-scale farmers to produce larger, more diverse and reliable harvests'. Similarly, the Manila based International Rice Research Institute has initiated a public-private partnership 'to increase rice production across Asia via the accelerated development and introduction of hybrid rice technologies.'

Scientific research is vitally important to the development of agriculture, but initiatives that assume in advance that new seeds and chemicals are needed are neither credible nor truly scientific. The fact that there is already enough food to feed the world shows that the food crisis is not a technical problem but it is a social and political problem. Rather than asking how to increase production, our first question should be why, when so much food is available, are over 850 million people hungry and malnourished? Why do 18,000 children die of hunger every day? Why can't the global food industry feed the hungry? To offset most of this loss, an effort must be made to convert today's single-cropping areas into two-crop zones. This can first and foremost be done by efficient water harvesting and equitable management.

Coping with the impact of climate change on agriculture will require careful management of resources like soil, water and biodiversity. Making agriculture sustainable is possible only through production systems that make the most efficient use of environmental goods and services without damaging these assets. If climate change impacts can be incorporated in the design and implementation of development programmes right away, it will help to reduce vulnerability, stabilise food production and secure livelihoods. A large scale climate literacy

programme is necessary to prepare farmers, who are today bewildered by the rapid fluctuations in weather conditions that affect their agriculture.

To cope with the impact of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels.

RECOMMENDATIONS FOR ACTION

Global

India must negotiate hard against the post-Copenhagen 'pledge and review' framework for emissions and try to get global temperature rise capped at 2^0C. If this is not done, the impact on agriculture and food security in developing countries will be devastating. Rising temperatures will be beneficial for agriculture in cold temperate regions since warmer conditions will allow their single crop zones to become two, even three crop zones. Given that agriculture is the lifeline of the developing world and will bear the worst brunt of climate change, India must insist that developed countries reduce their own agriculture emissions while at the same time paying for adaptation, especially in the agriculture sector, consistent with the 'polluter pays' principle.

Regional

Regional cooperation at the SAARC level is necessary to protect the Himalayan ecosystems and minimize melting of glaciers. Negotiations on river waters emanating from the Tibetan plateau are urgent so that flows in our major rivers like the Ganga and Brahmaputra are maintained to support agriculture. Regional strategies for mitigation and adaptation across similar agro-ecologies will help all countries of the region to protect their agriculture and food production.

National

New appropriate policy and budgetary support for mitigation and adaptation actions is needed. Multiple food and livelihood strategies are required in rural areas to minimize risk. Food inflation must be contained at all costs. It will worsen with climate change, as more frequent and unpredictable drought and floods will result in reduction in food production. Just one bad monsoon in 2009 led to a reduction of 15 million tonnes of rice and 4 million tonnes of pulse production, causing escalation in prices. A carefully planned programme for strategic research, along with dedicated funding, is needed to develop solutions to cope with the impact of global warming on crops, livestock, fish, soil, etc.

Local

The pursuit of sustainable agricultural development at the local level is integral to climate change mitigation, and combating the effects of climate change is vital for sustainable agriculture. Location-specific technologies will need to be developed at the level of the agro-ecological unit, to make agriculture sustainable and minimize losses to food and nutrition. The real challenge to the agricultural future of our country, however, will have to be met by rapid and targeted adaptation strategies. Adaptation will require strategies to reduce vulnerabilities, strengthen resilience and build the adaptive capacity of rural and farming communities. Industrial agro ecosystems damage environmental goods and services and so have weak resilience.

The development of sustainability in agriculture production systems rather than seeking to maximise crop, aqua cultural and livestock outputs, will help farming communities cope with the

uncertainties of climate change. The ecosystem approach with crop rotations, bio-organic fertilizers, appropriate control of pests and improvement in water retention will increase fertile top soil, reduce soil erosion and maintain productivity over the long term. Building resilience in agro ecosystems and farming communities, improving adaptive capacity and mitigating greenhouse gas emissions will go a long way in enhancing food availability.

Environmental Quality Management Strategies

Environmentally sustainable development requires a combination of six strategies: economic incentives against polluting, law enforcement, technological interventions such as cleaner technologies, institutional mechanisms, poverty alleviation programs, and people's participation. This section examines how these strategies can be effective.

Law Enforcement and Other Controls

- ***Consolidate Pollution Control Laws***: The environment has to be addressed holistically as different media like air, water and soil are interconnected and pollution once generated, can shift in space and time. That is, pollution can be diluted in more water or air or converted into different forms of pollutants like burning solid waste and causing air pollution or pollution laws must be consolidated to address this issue.
- ***Introduce Full Liability Laws***: Industries and other polluters should be made fully liable for their pollution. After the Bhopal tragedy this should have been obvious, yet the Bhopal victims have not got adequate compensation.
- ***Make Clean Technologies Mandatory In New Industries***: The current industry growth rates are around 7-8per cent. In this light, industries being established now will comprise 50per cent of the market in 9 years (Jayaraman 2001). Cleaner technologies should be made mandatory in such industries so as to reduce pollution in the coming years. Industries are less willing to change their techniques once they are established. Hence, they should be made to take on cleaner technologies right from the start. The technology for small-scale industries can be improved by requiring large-scale capital goods manufacturers to produce less polluting equipment.
- ***Make Functioning Treatment Facilities Mandatory –*** Often, due to mandatory requirements, effluent treatment plants are set up but not operated to save operating costs. Therefore, laws should provide for monitoring operation of these facilities.
- ***Require Environmental Audits For Industry*** – Environmental impact assessments are often made at the start of the project but prescribed environmental management practices are often forgotten once the project is underway. Regular audits would act as self-monitoring and enhance compliance to standards.
- ***Provide Effective Right To Information*** **-** If people have the information about what their neighbouring industry pollutes, they would generate pressures for abatement and treatment. Full liability laws need to be complemented with right to information.

A knowledge-intensive rather than input-intensive approach should be adopted to develop adaptation strategies. Traditional knowledge about the community's coping strategies should be

documented and used in training programmes to help find solutions to address the uncertainties of climate change, build resilience, adapt agriculture, and reduce emissions. The conservation of the genetic diversity of crops and animal breeds, and its associated knowledge, in partnership with local communities, must receive the highest priority. Agricultural credit and insurance systems must be made more comprehensive and responsive to the needs of small farmers. For instance, pigs are not covered by livestock insurance despite their potential for income enhancement of poor households. Decentralised seed production programmes involving local communities, to address the crisis of seed availability. Seeds of the main crops and contingency crops (for a delayed/failed monsoon, or floods) as well as seeds of fodder and green manure plants specific to the agro ecological unit must be produced and stocked. Technical and financial investments must be made in climate adaptation and mitigation research.

THE PATH FORWARD

There will be further efforts to coordinate between departments as we move to the implementation of the updated strategies. This will include efforts related to communication and awareness building amongst our countrymen, science and technology development and staff training. The Government will also move forward on the current priority areas and identify opportunities for additional collaboration. The transition to a more sustainable society in the 21st Century will not be achieved by one department or one level of government alone. Moving toward more sustainable development will require the commitment and attention of decision makers at all levels of society. The Sustainable Development Strategies are an important element of the Government of India's response to this significant challenge. The strategies will identify common goals and actions towards ensuring healthy human and natural environments, supporting emerging governance systems, advancing appropriate use of natural resources, building vibrant communities, and influencing international activities.

It is not possible for the government to monitor pollution and the corresponding acts of all industries and individuals. People must be made stakeholders in the environment through awareness campaigns. Industries are sensitive to public pressure. Experience in the west suggests that firms wish to maintain a green profile when citizens are aware of environmental issues. Through generating awareness, the public could directly affect the environmental practices of industries. India has to move forward technologically in an overall context to avoid pollution at source. Modern technologies already developed in the developed countries such as better power plants and cleaner vehicles should be considered through technology transfer for pollution measurements. Technological innovations allow India to develop rapidly in an environmentally sustainable manner. India cannot afford to neglect the environment, if sustainable development is desired. The pressures on environment have to be curtailed by reducing population pressure, increasing literacy, environmental awareness drives and poverty alleviation programmes. The poor have to be turned into agents for environmental restoration by involving them in say forest management, waste management, recycling and so on in a manner that creates incentives for them to use natural resources in sustainable manner. The economic activities must be conducted using environment conserving and resource saving technologies.

Managing environment through better urban designs, improvement in transportation infrastructures and creative use of information technologies needs to be considered seriously. An effective and prompt judiciary and enforcement machinery have proved to be powerful allies in the movements for environmental protection. The strategy for environmental governance should consist of law enforcement, providing economic incentives, people's participation, institutional reforms and support and technological improvements. With the determination of the government, private sector, NGOs, and people, India can perhaps deal with climate change, water and food security.

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FOOD SECURITY AND HEALTH NEEDS OF ADOLESCENTS

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ABSTRACT

India has a high GDP for the past few years, but that does not erase the factthat under-nutrition still prevails in alarming proportions. In the South Asian region, India and Bangladesh continue to have high rates of malnutrition. The "World Development Report 2012: Gender, Equality and Development" highlights issues on the persistence of malnutrition in South Asia. Pregnant women in South Asia put on less weight during pregnancy than they should: 5kgs on average compared to the worldwide average of close to 10kgs. Too often, new mothers are still children themselves, a staggering 75per cent of them are anaemic, and some one-third of all babies in India are born with low birth-weights. Studies reveal that girls in developed countries and low-income countries bear the consequence of chronic food insecurity on their development and well-being. Also being seen here is the public health system's poor responsiveness to community needs.

Adolescents in developing countries are exposed to adverse environmental conditions including food insecurity. The following study of rural Uttar Pradesh deals with food beliefs and food consumption during pregnancy. The study conducted on 300 women in the reproductive age group, was in-depth and qualitative, with the objective of understanding the food consumption behaviour of pregnant women and access to antenatal care.Menarche marks the development of girls including the timing of sexual maturation, nutritional status, and trajectory of growth during the pre-pubertal periods and wellbeing of girls.Girls were subjected to early marriages and subsequently, early child-bearing. Though many beliefs related to dietary intake were in line with the dietary guidelines, women could not afford to consume them. There was insufficient access to nutrients for normal health, growth and development. These were also related to concerns around food availability at home. Though not genetic, we know that malnutrition is inter-generational, meaning that it takes a few generations for the once malnourished girl to become the grandmother of a well nourished child.

The study suggests that India faces a challenge in addressing the nutritional needs of adolescent girls that cannot be resolved by public health services alone. We need to provide a comprehensive package of subsidized food-grains and nutrition cum health services to reach the real beneficiaries and adolescents. The recently launched "Sabla" Scheme by Ministry of Women and Child Development is a welcome step towards this with a package of health and nutrition services such as health check-ups with referrals, Guidance on Adolescents' Reproductive and Sexual Health, Nutrition, Life skills, Child care skills, Antenatal and Post natal care; but has not spread with momentum in all parts of India. Malnourished adolescents cannot deliver healthy babies. This coupled with women's experience of discrimination and

poverty will impact their status. We therefore need to take on the nutrition challenge and tackle food insecurity in order to build a strong human capital.

INTRODUCTION

India has a high GDP for the past few years, but that does not erase the factthat under-nutrition still prevails in alarming proportions. In 2009, the panel headed by economist Suresh Tendulkar put 37.2 per cent of Indians below the poverty line, and stated that 41.8 per cent of people in rural areas and 25.7 per cent of people in urban areas were below the poverty line.In the South Asian region, India and Bangladesh continue to have high rates of malnutrition. The "World Development Report 2012: Gender, Equality and Development" highlights issues on the persistence of malnutrition in South Asia. Pregnant women in South Asia put on less weight during pregnancy than they should: 5kgs on average compared to the worldwide average of close to 10kgs. Too often, new mothers are still children themselves, a staggering 75 per cent of them are anaemic, and some one-third of all babies in India are born with low birth-weights.

Though health is on state list, the effort on the part of the state government in spending the budget allotted for NRHM is minimal (Dwaraknath 2012). Implementation of the NRHM has resulted in an improvement in many development indicators for women. As per the India Human Development Report, fertility rates have come down and have reached replacement levels in a number of states; Maternal Mortality Ratio (MMR) has come down to 212 per 100,000 live births in 2009 from 301 in 2003. Institutional deliveries have risen from 39 per cent in 2006 to 78 per cent in 2009.For addressing the problem of the health and nutrition among the adolescent girls, Kishori Shakti Yojana was launched in 2000 as part of the Integrated Child Development Services (ICDS). Later in the year 2002-03, it was reinforced with the Nutritional Programme for Adolescent Girls.

Yet, studies reveal that girls in developed countries and low-income countries bear the consequence of chronic food insecurity on their development and well-being. This is coupled with the public health system's poor responsiveness to community needs. Poor nutritional status of women during the reproductive period is responsible for the under-nutrition of the children. Discriminatory feeding practices further nutritionally impoverish girls vis-a-vis boys.Pregnancy and childbirth related complications are the number-one killers of 15-19 year old girls worldwide. UNICEF defines MMR as the death of a mother during pregnancy or after 42 days after pregnancy due to various causes directly and indirectly relating to pregnancy and childbirth. India has recorded a very high MMR of an average of 254/100,000 live births. It is painful to note that close to 3 lakh girls under the age group of 15 years are not only married but have at least one born child (Iyer and Kuriakose 2012). More than 50 per cent of the married women between the age group of 15 and 49 have anaemia caused by iron deficiency which has contributed to 19 per cent maternal deaths.

According to NFHS-3, about 48 per cent of the children under 5 years were stunted, 43 per cent were underweight, 24 per cent were under-nourished and 16 per cent were severely underweight. Adolescents in developing countries are exposed to adverse environmental conditions including

food insecurity. Nutritional anaemia is one of India's major public health problems. Anaemia, especially in adolescent girls is an equally challenging problem. Early marriages of the girl normally results in early pregnancy of adolescent girls leading to the birth of undernourished children. About 16 per cent girls within the age group of 15-19 years had begun childbearing, when the body is not prepared and strong for childbearing. This situation enhances the risk of maternal deaths. Maternal Mortality Rate in 2004-05 was 254 in India which declined to 212 amid 2007-09 registering a fall of 17 per cent. However the target of 109 MMR under Millennium Development Goal (MDG) is still quite far.The prevalence of anaemia ranges from 33 per cent to 89 per cent among pregnant women and is more than 60 per cent among adolescent girls. Data from the NFHS-3 reveals that around 10 per cent of all pregnancies in married adolescents aged 15-19 years result in a spontaneous abortion or still birth. Medical complications of pregnancy, such as anaemia, spontaneous abortion and eclampsia are also significantly higher among adolescent mothers (Bijli and Tewari 2010).

PURPOSE OF THE STUDY

It is well recognized that utilization of maternal health services and beliefs associated with food intake during pregnancies have a very important role to play in the improvement of women's reproductive health. Sometimes, due to taboos and customs imposed by religious beliefs, antenatal care is not sought.

The focus on women in health delivery programmes has mainly been with regard to reproduction with an emphasis on the control of fertility. It is necessary therefore to orient studies towards questions of beliefs that are influenced by culture and socio-economic status, which affect women's reproductive health and their use of health care services.

Beliefs and behaviour regarding food intake during pregnancy are partly the outcome of complex cultural systems. This kind of a study will help correlate pregnancy outcomes with maternal nutrition. Traditional practices, culture based perceptions and beliefs also influence women's decisions in seeking health care, besides 'purdah' practice.

Therefore, this kind of research will help identify underlying factors affecting women's nutritional status and health seeking behaviour. It further highlights the 'invisible' problems of women to better articulate their needs and to utilize available health services more effectively. The findings of this study can help develop an insight into existingprogrammes designed to address women's health needs, in the form of comprehensive reproductive health services and the NRHM.

STUDY SETTING

A review of studies in Uttar Pradesh (Ghosh 2004; and Rao et al., 2001)reveals that it is also one of the most backward states in terms of coverage of health services and women seeking health care in rural areas. The study was therefore conducted in Uttar Pradesh. Aligarh district is located in the fertile Ganga-Yamuna plains in the north-western part of Uttar Pradesh. More population resides in rural areas as compared to urban areas. As per NFHS-3, key reproductive health indicators of Aligarh district are very poor, as they have not crossed even 50 per cent of the critical inputs. The locale for the study comprised of two villages, Naglaqila and DohrraMafi,

situated in Jawan Block, Aligarh district, where the key reproductive health indicators were poor, based on district statistics and local information.

The study was carried out to draw a purposive sample of women who had at least one child or were in a state of pregnancy. The reproductive age group ranged from 15-45 years; a sample of 100 women was drawn (50 from each village). The sample population was interviewed in their homes, and was followed up by the researcher on separate occasions, especially for pregnant women.

METHODS

The study was essentially qualitative in nature. Several depth interviews were conducted with all the women, and with key informants at the village level, - 2 'Dais', and 6 women who were known in the village community, in order to explore lay perceptions and the practices related to reproductive health care, food beliefs and pregnancy in the study setting. Based on these interviews, the researcher decided to utilize predominantly ethnographic techniques to collect data on food belief systems and health seeking behaviour, by interviewing the sample, as well as by tapping information from 'dais', key informants and other experienced women of the community. These interviews also helped the researcher to redefine her vocabulary of specific local terms. Based on these interviews, a comprehensive ethnographic field guide was prepared. This field guide was pre-tested and helped the interviewer how to phrase questions appropriately and prepare herself for the range of possible answers. Most of the women and key informants were interviewed more than once. This enabled the researcher to build a social relationship between herself and the informant.

Focus Group Discussions (FGDs) were held as a form of Participatory Rural Appraisal (PRA) technique. Here a group of eight local persons were gathered together (in the homes of key informants or in a central meeting place). This technique helped the researcher to learn about some aspects of the local culture, food habits and health practices. In total, about four FGDs were held. Observation technique was employed by the researcher in studying the subjects and in seeing phenomena. It helped in understanding living conditions, health and sanitation, food-consumption patterns, signs of anaemia etc.

Limitations of the Study*:* Only 23 were pregnant, of the total sample, out of which 5 respondents went away to their own (parental/ native) villages late in pregnancy for delivery, even though they initially reported that they would not. Also, some of the interviewed women were unwilling to respond during interview sessions or were away in the fields or too busy in household work.

RESULTS

Sample Characteristics

The socio-economic and demographic characteristics of women reveal that 70 per cent of them did not work for paid income, 20 per cent were involved in skilled labour(handicraft-patti work, tailoring), and 10 per cent were involved in agriculture-based activities. They spoke hindi/urdu (local language). Majority (80 per cent) were illiterates, while 8 per cent had attended middle school, and 4 per cent primary school. Remaining 8 per cent could read/write hindi/urdu. Most of them came from nuclear families (54 per cent), while the rest belonged to joint/extended families

(46 per cent). The monthly income of 70 per cent women was Rs.1800 to Rs.2500 per family. The practice of *purdah* was followed by majority (95 per cent) of the women. Majorities (80 per cent) were Muslims and *Purdah* was followed when women ventured into the community, and with senior male members within the family.

Adolescence is a period in which growth spurt occurs. Under-nutrition during childhood period largely contributes to a high prevalence of chronic energy deficiency in adult life. The recent National Nutrition Monitoring Bureau surveys reveal that about 57 per cent of 10-13 year girls and 30 per cent of 14-17 years girls were undernourished (Laxmaiah and Brahmam2009). Studies reveal that an adolescent girl's vulnerability is caused by her young age, lack of formal education, her ignorance on matters related to sexuality and reproductive health and her inability or discouragement in the family to use family planning and health services. Precisely at a time when she is soon going to be subjected to the demands of child bearing, the health of the girl deteriorates. According to the NFHS-3, the prevalence of early marriage is 44.5 per cent in India overall (52.5 per cent in rural areas). Adolescents account for a high proportion of maternal deaths in India.

TABLE 1: AGE PROFILE OF WOMEN

Age categories of Women	**Age group (years)**	**Per centage (per cent)**
Currently pregnant	15 -17	11
	17- 19	8
	19- 21	2
	21- 23	2
Remaining sample with at least one child/more than one child	15- 20	10
	20- 25	10
	25- 30	25
	30- 35	6
	35- 40	20
	40- 45	4
	45- 50	2
Total no. of women		100

Majority of the women who were pregnant at the time of study fell below the age of 23 years and most of them belonged to the age group 15-17 years, 10 per cent of the women who had atleast one child / more than one child fell in the age group 15-20 years. Except for two women, majority stated that they gave birth to their first child between the age group of 15-18 years. They said that they got married within a year or two after menarche i.e. 13-14 years and

delivered their first child within a year of marriage. There was pressure from In-laws in most cases, to start a family.The risk of maternal death is about three times higher in girls aged 15-19 years and five times higher in those younger than 15 years as compared to women in their 20s (Mehra et al, 2004). The babies of adolescent mothers are more likely to have low weight, run a higher risk of being premature and have a higher perinatal mortality. Controlled studies in several sites show that adolescent mothers have a higher incidence of prematurity, complicated labour, low birth weight, and low milk secretion (Delisle et al, 2000); infants of mothers aged younger than 18 years have a 60 per cent greater chance of dying in the first year of life than those of mothers aged 19 years or more (UNICEF 2007).

FOOD HABITS FOLLOWED DURING PREGNANCY

The researcher made direct observations and found that women appeared physically weak and malnourished through visible signs of pallor and anaemia. Most of the families lived in one room houses, mostly *kutcha (*with mud flooring). Only 30 per cent of the families lived in *pucca* houses and some with two rooms. There was no concept of closed drains or a specified garbage dump. There were open potholes and drains everywhere, harbouring flies and mosquitoes.

(i) Components of Household Diet:

The respondents were questioned about the types of foods that comprised the normal household diet. The most commonly cited response was "Jo bhi mil jaaye" (Whatever is available). The regular and occasional components of diet included 'dal, subzi, roti, gosht and murg' (Figure 1).

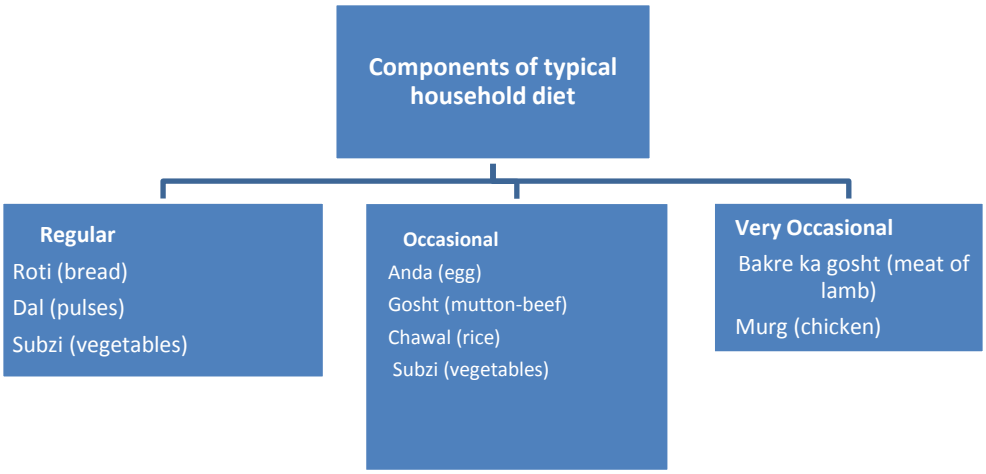


FIGURE 1: COMPONENTS OF TYPICAL HOUSEHOLD DIET

It is evident that the patterns of food intake in the form of- regular, occasional, and very occasional- clearly linked to economic status. But in all the three patterns, *roti* was always included. *Subzi* was recorded in both regular and occasional components, again linking its consumption to family income. Rice was typically cooked for only one or two meals in a week or sometimes only 2-3 times in a month. Eggs, chicken and meat of lamb were rarely consumed and so were fruits. Among beverages, tea was consumed with milk commonly. Women used *gur*

(jaggery) during winter season in tea, the most commonly used beverage, while in summers, sugar was used.

(Ii)Food Consumption and Associated Beliefs in Pregnancy:

Most of the women (52 per cent) said that they did not consume special foods during pregnancy. But many women had beliefs about what food item was preferred, allowed or disallowed during pregnancy. When women were asked as to what was not allowed during pregnancy, it generated responses on prescriptions and proscriptions (avoidances) of food during pregnancy.

The Anganwadi Worker (AWW) and health workers also informed pregnant women in the villages about extra dietary intake when they visited them, mostly due to scientific reasons. But for most women, (even those who had food beliefs in pregnancy), economic constraints made the consumption of these foods an unlikely option.

Following were some responses of women who did not consume special foods in pregnancy

"Koi khasnahin" (Nothing special).

"Kahanmiltahai, khanamushkilpadtahai" (Where do we get food, it's difficult to even get something to eat for subsistence).

"Hum ye sab nahinmaante" (We do not believe in all these).

"Itnakahanhotahaikiapneliyealagaurgharwalonkeliyealagbanaye" (Where can we afford so much in order to be able to prepare separate food for ourselves and separate for rest ofthe family members).

"I have no knowledge about extra diet that is to be consumed during the time of pregnancy."

About 48 per cent of women indicated that they had preferences for specific foods during pregnancy. Table 2 depicts specific food items that were consumed apart from normal diet. Fruits, milk and *ghee* were essential items of dietary intake for all those women who had or were having specific foods in pregnancy, whereas *halwa* (sweet) was consumed by only 10 per cent and *sevaiyan* (vermicelli) by 5 per cent. All the above food items were consumed during all the three stages of pregnancy. *Ghee, halwa* and *sevaiyan*, besides fruits and milk are believed to provide extra strength to the mother and nutrition for the growing foetus, besides normal food, as stated by these women. According to most women, "Ghee khane se lallahoga" (If ghee is consumed, a son will be born). This is clearly indicative of women's preferences for sons.But again due to economic constraints, for most women, (even those who had food beliefs in pregnancy) consumption of these foods became an unlikely option.

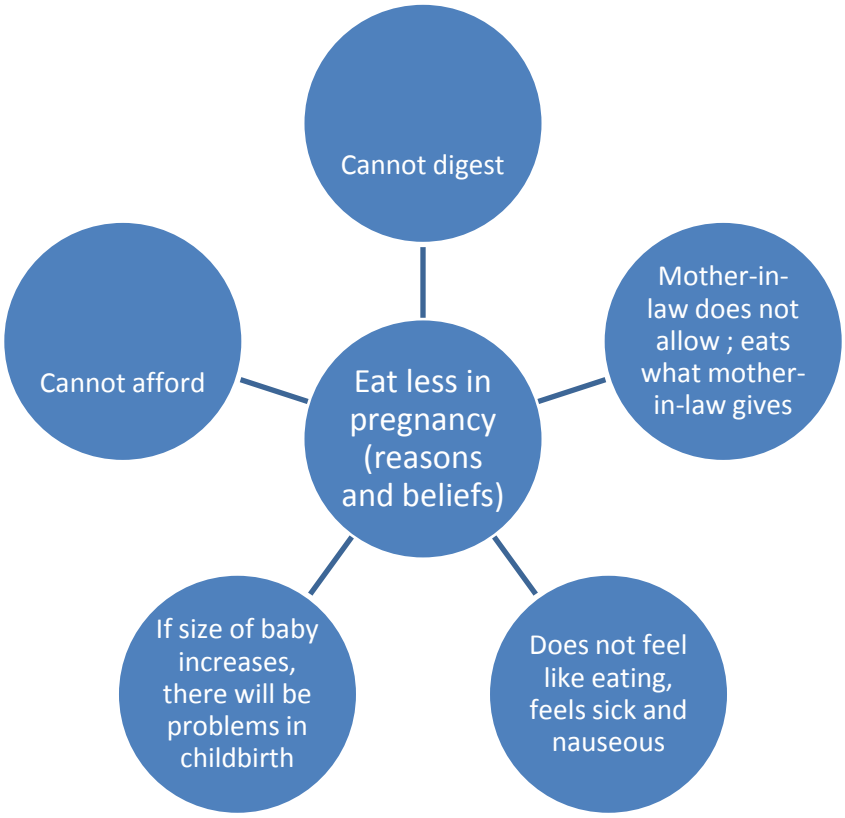
TABLE 2: MEANING OF SPECIAL FOOD ITEMS CONSUMED IN PREGNANCY

Local Term	**English Equivalent**
Ghee	Fat
Doodh	Milk
Bajra	Bajra (Millet)

Mevey	Dry Fruits
Badam	Almond
Gola	Dry Coconut
Chuara	Dry Dates
Gond	Vegetable Gum
BhuneAloo	Fried Potatoes
Seb	Apple
Phal	Fruits
AateKaHalwa	Sweet made in flour and oil
SoojiKaHalwa	Sweet made in Semolina and Oil
Sevaiyan	Vermicelli

The survey indicates that almost half of the total women surveyed eat less than normal diet. According to local *dais* (TBAs) and the ANM, many women ate more than normal diet during the second trimester, as they often felt nauseous during first and third trimesters. About food proscriptions (avoidances) during pregnancy, a variety of reasons were stated, but only by 15 per cent of women. "Curds" was to be avoided as it was considered "thanda"(cold), and "khatta"(sour),. Similarly, non-vegetarian foods such as meats and eggs were to be avoided as these could create "heat" in the body, could cause "miscarriage" (pregnancy breaks down) or "foetus could get spoiled". Similarly the use of *gur* (jaggery) was avoided in pregnancy. Generally, it was considered that heat generating foods are to be avoided such as non-vegetarian foods, foods containing excess oil, chilles or spices. Factors affecting proscriptions of food during pregnancy are depicted in Figure 2

Figure 2: Factors Affecting Proscriptions (Avoidances) of Food during Pregnancy



Quantity of Food Consumed during Pregnancy

A 24 hour-diet recall method was used during the course of interview by the researcher on all the 23 respondents who were pregnant. The concern of the researcher was to record the micronutrient intakes, as estimating quantities consumed of food items known to provide substantial calories such as staple cereal (here wheat), oil, meat etc. for the purpose of the study. For every family, it was found that the per capita energy consumption was in the range of 1200 – 1400 kcal/ day/ adult in the family. This suggests that women eat even less than their normal food intake, (a 24 hour dietary recall done on 10 non-pregnant women was amounting to 1500 – 1600 kcal/ day/ adult). This dietary intake was compared to the recommended dietary intake of ICMR for pregnant women (1900 kcal + additional 350 kcal= 2250 kcal). The results thus show a wide calorie gap between actual intake and recommended levels. The actual calorie consumption contradicted the food beliefs which exist for special food items consumed during pregnancy. The per capita energy consumption within the household was also low.

The beliefs that women had for not consuming extra food items/ supplementary foods, were that if more intake of food is done, it will make the foetus fat, and in turn there will be problems for the baby to come out at the time of delivery. Other women in the family, especially the mother-in-law, also supported this view. Very few women stated that if they did not eat extra dietary supplements during pregnancy because if they ate much they could not digest, felt sick andoften could not afford them. If economic constraints are not considered, then there was apparent consistency between beliefs and stated behaviour with respect to food consumption.

It is thus understood that food beliefs relating to consumption of milk and milk products, oil, and ghee were more widespread, and avoidance of such foods has the potential of creating significantly nutritional deficits.

HEALTH-SEEKING BEHAVIOUR OF WOMEN

(I)Dependence on Traditional Birth Attendants or 'Bhangans':

Women preferred indigenous, local persons (*Bhangans/Dais*) to conduct delivery at homes. The words *Bhangan* or *Jamadar* were used alternately by women, and meant the same, i.e. garbage collector. 'Dai' is the name given to a local woman who is a traditional birth attendant (TBA), and is considered a specialist in deliveries by the communitys. Out of the sample, 82 per cent women consulted *dais* or *bhangans* for deliveries. *Bhangans* were more preferred over *dais* as they charged less. Only 4 per cent women stated that their family members had called the doctor to conduct the delivery at home.

"***Hum ne dai ko bulaya aur hamar isas ne hamar imadad ki". (I called the 'dai' home and my Mother-in-law helped me) - Tahira, 30 years, mother of 03 children, Dohrra Mafi.***

"We had summoned a dai who resides in our village. Two of my children were born with the help of Jamadar and two through the dai. All my children were born at home"- Shabnam, 45 years, mother of 07 children, Nagla qila.

The decision to call the person concerned for delivery was taken by the women themselves or in consultation with the mother-in-law or other women in the community. Economic constraints were cited as a major reason for this.

(II)Health-Seeking Behaviour and Accessibility of Women to Health Facilities:

In this study it was found that while for antenatal and post-natal services, accessibility was a strong factor in women receiving care, availability of these services, and awareness of these services was also a key factor. It was found that an AW (Anganwadi) existed each in Nagla qila and Dohrra Mafi. After visiting these two AWs, it was found that both were functioning, as both, AWW (Anganwadi Worker) and helper, were present at the time of visit. But women did not access them at all, as according to them they were not satisfied with the services there. There was one PHC (Primary Health Centre) which is located about 08 kms away from Naglaqila. Very few women visited it. The women revealed that the ANM from the nearby PHC came once a week or sometimes once in two weeks/ month and administered Tetanus vaccination on expectant mothers and their children, folic acid and iron tablets and assisted doctors from Jawaharlal Nehru Medical College (JNMC), Aligarh Muslim University, to carry out pulse polio campaigns in these areas.

All of the women were aware of an Aanganwadi in their village, but they never visited it. According to them the Anganwadis were non-functional. The women of Dohrra visited 'Jhola Chap' doctors (unregistered local medical practitioners) in their area. There were 5 such doctors in their area. Women of Naglaqila too visited private doctors in their area or called the *Dai*. The *dai* was contacted by 86 per cent of the women for antenatal check-ups at home. For common ailments, the women consulted them. But 80 per cent of women did not consulted anybody most of the times, and expressed that they suffered with health problems such as white discharge, anaemia, gynaecological complications, abortions, miscarriages, fever, cold, and several other ailments, silently, without seeking health care, until and unless it reached a state of severity.

Sometimes the ANM was called for consulting purposes; 95 per cent of the women expressed the need to have a gynaecologist ('lady doctor') to visit their village, as their families did not allow them to visit male doctors due to *purdah*. Even if a lady doctor was to be posted in the village, many women stated that they needed to first seek permission for visiting them from their husbands. When asked about knowledge of iron and folic acids tablets given by the ANM, 30 per cent of the women said that they knew about such tablets, 23.3 per cent said that they had taken these tablets during pregnancy, while 23.3 per cent again said that these medicines were given to them by the ANM and primary health worker. Sometimes women from both the villages visited JNMC, when their conditions got severe, as it was easily accessible for them.

CONCLUSIONS AND SUGGESTIONS

Perceptions of food and beliefs mostly related to local concepts of physiology of the female body and the process of childbirth. Beliefs were there and those who could follow these beliefs followed them. While not genetic, malnutrition is inter-generational, meaning that it takes a few generations for the once malnourished girl to become the grandmother of a well-nourished child. It is therefore suggested that knowledge of these beliefs, through interactions with community women, should be acquired by doctors, ASHAs, AWWs, and other visiting health care personnel as it has implications on appropriate health interventions. It is also important to understand the

strength of these beliefs as weighed by women, as these are vital for programmes which will be designed in seeking behaviour change among women.

Favourable beliefs need to be fostered and encouraged; this is because food intake during pregnancy affects weight gain, pre-pregnant weight of the mother, which is some of the most important factors influencing birth weight of the baby. Food beliefs therefore affect Maternal Mortality, which happens to be a major development indicator.

Malnourished adolescents cannot deliver healthy babies. This coupled with women's experience of discrimination and poverty will impact their status. We therefore need to take on the nutrition challenge and tackle food insecurity in order to build a strong human capital. We need to provide a comprehensive package of subsidized food-grains and nutrition cum health services to reach the real beneficiaries and adolescents. The recently launched "Sabla" Scheme by Ministry of Women and Child Development is a welcome step towards this with a package of health and nutrition services such as health check-ups with referrals, Guidance on Adolescents' Reproductive and Sexual Health, Nutrition, Life skills, Child care skills, Antenatal and Post natal care; but has not spread with momentum in all parts of India.

TBAs or *Dais* were contacted for delivery and other RH ailments. Therefore enhanced training of these TBAs and other lower level health workers has to be promoted by medical officers from district hospital, and JNMC; this does not require much time and effort.The medical officers of JNMC could play an instrumental role in informing the ANM, about the serious problems associated with abortions, unsafe delivery, unhygienic delivery conditions, and inadequate antenatal check-ups, and the ANMs in turn will have to inform and mobilize the women towards seeking proper health check-ups for the same.

Familiarity with a place where a trained health provider is available 24 hours a day, awareness of signs of impending danger, promotion of clean and hygienic delivery practices, information on sources of care, timeliness of seeking care and improved nutritional status through micro-nutrient supplementation (Sloan 1998) will be positive outcomes of the above mentioned contact of women to health care services and these should be encouraged.

Awareness campaigns by local NGOs, academicians, students/researchers of development studies, social work, community medicine and home science, can be organized to empower/equip women and families with more information on hazards associated with malnutrition, early marriages resulting in childbearing,STDs and RTIs, unsafe abortions, dangers of non-immunization practices etc. At other times advocacy and counseling could be practiced through field visits. Knowledge sharing through partnerships and implementation of practices would go a long way in reducing maternal and infant mortality. Take the example of Dr. MahtabBamji, a development practitioner, working towards improving the health and nutritional wellbeing of the poor in Andhra Pradesh. She found that while over 90 per cent of the families had village-level food security for rice, and 80 per cent for millets, over 50 per cent of the households got their pulses and vegetables from outside their village. Dr. Bamji wanted to know how farmers could be motivated to grow more pulses and vegetables for local consumption. She wanted a wide range of perspectives so that she could design an implementable programme.

Solutions Exchange for the Food and Nutrition Security Community (FNS)came to her immediate assistance within a fortnight. This is a knowledge management programme created by the UN Country Team (UNCT) in India to provide a neutral forum to the practitioners in India to share development experiences for mutual benefit. It is a query based moderated mail-group network (www.solutionexchange.net.in).woven around broad MDG themes, which picks up discussion topics from practitioners (UNews 2011).

Recent initiatives by the Government of India like the Food Security Bill, the Right to Health Bill, the National Rural health Mission, *Sabla* for adolescent girls, the revamped ICDS Scheme, and the policy on Early Childhood Care and Development may have significant implications for the survival, development and health of the girl child.

Adolescence is a largely neglected area of research, and few interventions exist to address the special needs of adolescents. Moreover, on the basis of social and demographic trends in India, the battle at the earlier end of the spectrum has to be focused on the pattern of early marriage, whereby society sanctions adolescent sexual activity and adolescent pregnancies that are malefic to mother and child. Sex education for the young, or otherwise ignorant, if pursued in the increasingly fashionable mould of being 'non-judgemental' and 'value-neutral' could provide a one way road to irretrievable disaster (Bijli and Tewari2010).

Literate and more empowered mothers have better nourished children. Recent analyses in Bangladesh reaffirm evidence that when women are involved in household decisions and have control over earnings, their children are better nourished. In general, efforts to improve gender equality will be critical to reducing South-Asia's disadvantage in nutrition. For a healthy and well nourished population, we need to improve access to nutritious and diverse foods, pre-natal services, female education, knowledge and support for appropriate child-care (such as exclusive breast-feeding for the first six months). It is possible. Take Mexico for example. The country took a targeted approach to address malnutrition and achieved remarkable results such as marked reduction in infant mortality, increase in children's height, higher enrolment rates in secondary and high school, reduction in drop-out rates etc (Kocchar 2011).

Food security can be achieved in a better and faster way, if a decentralized approach in the implementation of programme is adopted. Elected local bodies, together with the concerned Departments of Government (health, education, women and child welfare, rural and tribal development, etc.) should prepare micro level action plans.

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FROM FARM TO LANDFILL: WORLD FOOD WASTE

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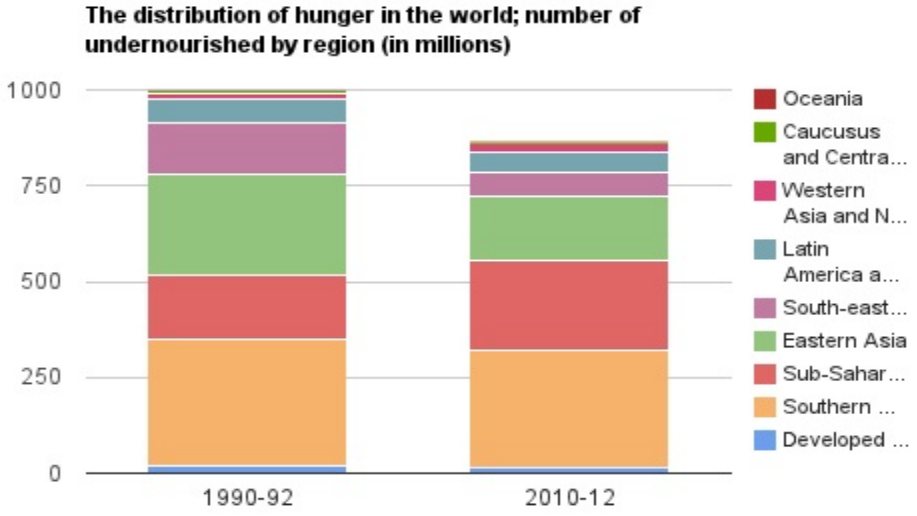
Hunger and food security are emotive issues, but hard to capture with the single "killer" statistic often favoured by high-profile campaigns. The UN, which has long produced estimates of global hunger, has reworked its figures and is backing away from single statistics. In October, the Food and Agriculture Organization (FAO) released a suite of more than 20 indicators, available for most countries, which it said could offer a more rounded picture of the causes and consequences of food insecurity. How much food is available? What are people eating? How much do poor people spend on food compared with other items? How are children affected by food insecurity? These are some of the issues covered. The FAO plans to run a global poll to monitor food insecurity based on peoples' experiences, to better understand the challenges communities face in accessing food. We've pulled out some of the key figures, and you can download the full set below. What can you do with the data? Which indicators do you think are the most revealing?

Global Hunger: The Big Picture:

According to the UN's new hunger figures, the *Millennium Development Goal* (MDG) to halve the prevalence of hunger by 2015 is within reach. The new estimates, which draw on updated



Source: FAO, 2012

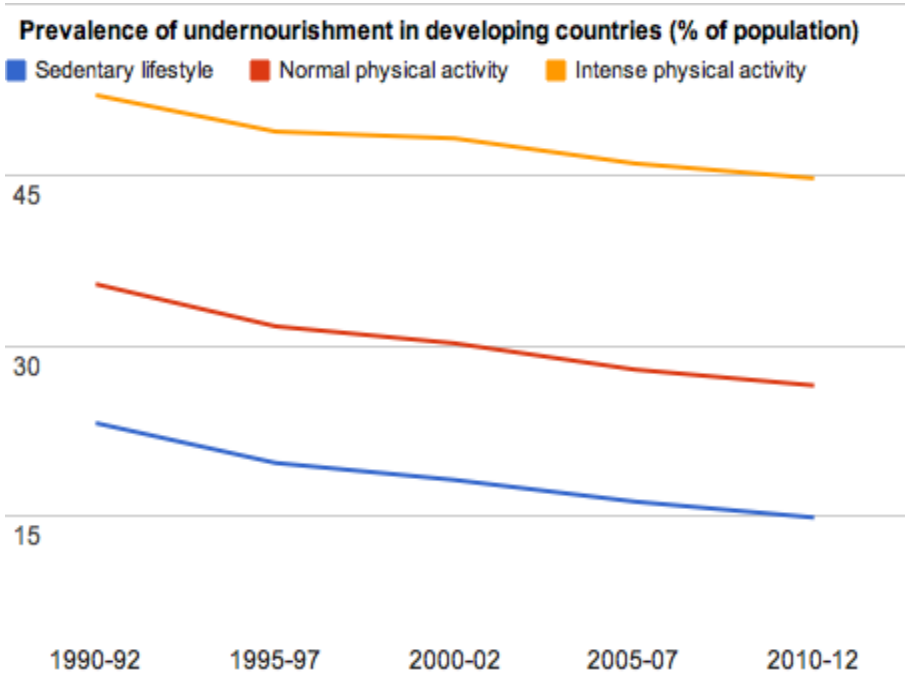
data and a revised methodology, suggest the per centage of hungry people in developing countries has fallen from more than 23 per cent in 1990-92 to less than 15 per cent in 2010-12, or around 850 million people. There are important caveats, however. Progress since 2007 appears significantly slower, and there are stark variations between regions. And there would still be hundreds of millions of hungry people in the world even if the MDG target is met.

Food Prices:

The UN hunger indicator's inability to capture the impact of short-term price spikes and other economic shocks (unless they fundamentally change long-term consumption patterns) is seen by some as a key shortcoming. A local food price index, which estimates affordability and an indicator tracking volatility in domestic prices is seen as a key measure of future food insecurity, are among the statistics released last year. A further indicator looks at how much the poorest 20 per cent of households are spending on food compared with other items. When prices go up, people will often sacrifice other household spending rather than go without food. Using data from household expenditure surveys, this indicator aims to capture the economic consequences of rising food prices.

How Are Peoples Affected By Food Insecurity?

A key criticism of the UN hunger indicator is that it sets the threshold too low, using the minimum calories needed for a "sedentary lifestyle". The number of hungry people today could be as high as 1.5 billion (or more than 25 per cent of the world's total), if the threshold was instead set



Source: FAO, 2012

as the minimum needed for "normal activity", or nearly 2.6 billion (nearly 45 per cent) for "intense activity". The per centage of children under five who are stunted, underweight, or

affected by wasting (measured as low weight for height) are other key indicators of how food insecurity affects long-term human development. The UN's proposed suite of food security indicators also tracks these impacts, along with the percentage of adults who are underweight.

The Double Burden of Undernutrition and Obesity:

As incomes rise, diets are becoming more diverse around the world. This has given rise to a "*double burden*" in some developing countries, where undernourishment co-exists alongside rising levels of obesity. Globally, obesity has more than doubled since 1980, with the number of overweight adults now estimated at 1.4 billion. "The world is increasingly faced with a double burden of malnutrition, whereby undernutrition, especially among children, co-exists with overweight and diet-related chronic diseases and micronutrient malnutrition, according to UN's 2012 State of Food Insecurity in the World report. Being overweight is not necessarily a matter of eating too much food, but eating food that is not nutritious, and poor consumers may have less education and access to information about nutrition. Another part of the explanation may be the rapidly growing supply of previously unavailable products (eg some processed foods, soft drinks and snacks) in the modern retail chains of many developing countries. In many cases, such products replace traditional foods, including street foods in urban areas.

The issue of food losses is of high importance in the efforts to combat hunger, raise income and improve food security in the world's poorest countries. Food losses have an impact on food security for poor people, on food quality and safety, on economic development and on the environment. The exact causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country. In broad terms, food losses will be influenced by crop production choices and patterns, internal infrastructure and capacity, marketing chains and channels for distribution, and consumer purchasing and food use practices. Irrespective of the level of economic development and maturity of systems in a country, food losses should be kept to a minimum.

Food losses represent a waste of resources used in production such as land, water, energy and inputs. Producing food that will not be consumed leads to unnecessary CO_2 emissions in addition to loss of economic value of the food produced.

Economically avoidable food losses have a direct and negative impact on the income of both farmers and consumers. Given that many smallholders live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods. For poor consumers (food insecure or at-risk households), the priority is clearly to have access to food products that are nutritious, safe and affordable. It is important to note that food insecurity is often more a question of access (purchasing power and prices of food) than a supply problem. Improving the efficiency of the food supply chain could help to bring down the cost of food to the consumer and thus increase access. Given the magnitude of food losses, making profitable investments in reducing losses could be one way of reducing the cost of food. But that would, of course, require that financial gains from reduced losses are not outweighed by their costs. How much food is lost and wasted in the world today and how can we prevent food losses? Those are

questions impossible to give precise answers to, and there is not much ongoing research in the area. This is quite surprising as forecasts suggest that food production must increase significantly to meet future global demand. Insufficient attention appears to be paid to current global food supply chain losses, which are probably substantial.

For the international congress Save Food!

at Interpack2011, FAO hired the services of the Swedish Institute for Food and Biotechnology (SIK) to carry out two studies on the extent and effects, as well as causes and prevention of food losses and food waste, one for high/medium-income countries, and one for low-income countries. The two studies highlighted the food losses occurring along food chains, and made assessments of the magnitude of these losses, focusing on quantitative weight losses. They compile, analyze and assemble data and reports produced on the topic of global food loss and waste during recent years. Where information was not available, assessments and assumptions have been made. Results of the two studies are combined in this paper.

What is food loss/waste all about?

Enormous quantities of food are thrown away every day. In developed countries, at retail level, large quantities of food are wasted due to quality standards that over-emphasize appearance. Consumers in rich countries are generally encouraged to buy more food than they need and fail to plan their food purchases properly. In developing countries the problem is essentially due to inadequate harvest techniques, poor post-harvest management, lack of suitable infrastructure, processing and packaging, lack of marketing information. We must know that food waste or losses have an impact on climate change, because we use resources (water, fertilizers, pesticides, seeds, energy, and labour) to produce this food that we will not use. It has an impact on the production of greenhouse gas emissions and consequently on climate change. In developing countries, food losses during harvest and storage reduce the income of small farmers and result in a higher price for poor consumers who can't afford to pay for the food. Reducing food losses can therefore have an impact on improving the livelihoods and food security of small farmers and poor consumers,

Food losses refer to the decrease in edible food mass throughout the *part of the* supply chain that specifically leads to edible food for human consumption. Food losses take place at production, postharvest and processing stages in the food supply chain (Parfitt *et al*., 2010). Food losses occurring at the end of the food chain (retail and final consumption) are rather called "food waste", which relates to retailers' and consumers' behavior. (Parfitt *et al*., 2010).

"Food" waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. Per definition, food losses or waste are the masses of food lost or wasted in *the part of* food chains *leading to* "edible products going to human consumption". Therefore food that was originally meant to human consumption but which fortuity gets out the human food chain is considered as food loss or waste even if it is then directed to a non-food use (feed, bioenergy…). This approach distinguishes "planned" non-food uses to "unplanned" non-food uses, which are hereby accounted under losses.

Technically speaking, food loss and waste refer to the decrease in mass (quantitative) or nutritional value (qualitative) of food - edible parts - throughout the supply chain that was intended for human consumption. Food that was originally meant for human consumption but for various reasons is removed from the human food chain is considered as food loss or waste, even if it is then directed to a non-food use (feed, bio-energy).

- Food Loss refers to food that gets spilled, spoilt or otherwise lost, or incurs reduction of quality and value during its process in the food supply chain before it reaches its final product stage. Food loss typically takes place at production, post-harvest, processing and distribution stages in the food supply chain.
- Food waste refers to food that completes the food supply chain up to a final product, of good quality and fit for consumption, but still doesn't get consumed because it is discarded, whether or not after it is left to spoil. Food waste typically (but not xclusively) takes place at retail and consumption stages in the food supply chain

Types of Food Losses/Waste

Five system boundaries were distinguished in the food supply chains (FSC) of vegetable and animal commodities. Food loss/ waste were estimated for each of these segments of the FSC. The following aspects were considered:

Vegetable Commodities and Products:

- ***Agricultural production*:** losses due to mechanical damage and/or spillage during harvest operation (e.g. threshing or fruit picking), crops sorted out post harvest, etc.
- ***Postharvest handling and storage*:** including losses due to spillage and degradation during handling, storage and transportation between farm and distribution.
- ***Processing:*** including losses due to spillage and degradation during industrial or domestic processing, e.g. juice production, canning and bread baking. Losses may occur when crops are sorted out if not suitable to process or during washing, peeling, slicing and boiling or during process interruptions and accidental spillage.
- ***Distribution*:** including losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.
- ***Consumption*:** including losses and waste during consumption at the household level.

Animal Commodities and Products:

- ***Agricultural production*:** for bovine, pork and poultry meat, losses refer to animal death during breeding. For fish, losses refer to discards during fishing. For milk, losses refer to decreased milk production due to dairy cow sickness (mastitis).
- ***Postharvest handling and storage*:** for bovine, pork and poultry meat, losses refer to death during transport to slaughter and condemnation at slaughterhouse. For fish, losses refer to spillage and degradation during icing, packaging, storage and transportation after landing. For milk, losses refer to spillage and degradation during transportation between farm and distribution.
- ***Processing:*** for bovine, pork and poultry meat, losses refer to trimming spillage during slaughtering and additional industrial processing, e.g. sausage production. For fish, losses

refer to industrial processing such as canning or smoking. For milk, losses refer to spillage during industrial milk treatment (e.g. pasteurization) and milk processing to, e.g., cheese and yoghurt.

- ***Distribution*:** includes losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.
- ***Consumption*:** includes losses and waste at the household level.

What are the Solutions?

In a world of 7 billion people, set to grow to 9 billion by 2050, wasting food makes no sense – economically, environmentally and ethically. Together, we can reverse this unacceptable trend and improve lives. In industrialized regions, almost half of the total food squandered, around 300m tonnes annually, occur because producers, retailers and consumers discard food that is still fit for consumption. This is more than the total net food production of sub-Saharan Africa, and would be sufficient to feed the estimated 870 million people hungry in the world. ***A recent study has revealed that about one third of all food production world-wide gets lost or wasted in the food production and consumption systems. Almost half of this quantity is the result of retailers and consumers in industrialized regions who discard food that is fit for consumption. The total quantity wasted is about 300 million tonnes, which is more than the total net food production of Sub-Saharan Africa. It would be sufficient to feed the estimated 900 million people hungry in the world. (FAO).***

Small but simple actions by consumers and food retailers could dramatically cut the 1.3 bn tonnes of food lost or wasted across the world each year, according to an unprecedented global campaign launched. Requesting smaller portions at restaurants, freezing leftovers and donating to food banks can help make a difference, while retailers and supermarkets should be carrying out audits and working more closely with their suppliers to reduce waste. Because marketing and consumer practices contribute to food waste in rich countries, some nations are making it more of a priority to reduce waste at the consumer level. Some major U.K. supermarkets, including Morrison's, are trying to cut waste by changing their practices. "We don't currently offer buy-one-get-one-free offers on our fruit and vegetables, have relaxed our specifications on this produce to accept more 'wonky' crops and offer clear labeling for customers," according to Morrisons spokesperson.

New Technologies to Avoid Losses

FAO, the Food and Agriculture Organization of the United Nations, has a mandate to raise levels of nutrition, improve agricultural productivity, better the lives of rural populations and contribute to the growth of the world economy. According to a recent report produced by FAO in joint collaboration with the World Bank "***Missing Food: The Case of Post Harvest Grain Losses in Sub Saharan Africa***", investing in post-harvest technologies may reduce food losses and increase the food supply in sub-Saharan Africa where food losses are estimated to be USD 4 billion per year, which would allow us to feed 48 million people. It might have a positive impact on *Millennium Development Goal-1*, to eradicate extreme poverty and hunger. It consists of 3 targets:

- Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day
- Achieve full and productive employment and decent work for all, including women and young people
- Halve, between 1990 and 2015, the proportion of people who suffer from hunger

To avoid food losses, a variety of practices and technologies are available such as storage containers, hermetically sealed bags, metallic silos. In Africa we can introduce technologies which have been successfully tested in Asia and might be adapted to Africa's conditions. Governments can also help in avoiding food losses, by investing in infrastructure like roads to facilitate the commercialization of food, electricity and water to process food. It is also important to invest in research and extension, to identify where along the food chain food losses are happening and how to tackle them. Ask a young person what they wish for their future, and very few will mention agriculture.

Whether as a farmer, researcher or extension officer, the production of food tends to be a last resort, not the positive choice of an ambitious young man or woman. This of course raises a fundamental question: ***who will grow the crops to feed the world*****?** One of our approaches should be to mobilize young agricultural professionals, through social media, which they will enthuse their brethren and sisters. And maybe, just maybe, we will then turn agriculture a "***young" rather than an "aging" profession.***

We are now 7 billion people in the world. To feed a world population that is estimated to reach 9 billion people by 2050 and assure their food security, we will have to increase food production and productivity, and we will have at the same time to reduce food losses and waste. Developing countries should strengthen food supply chains, by diversifying and up-scaling the production and marketing of small farmers, to assist them in being directly linked to the buyers. Private and public sectors could invest more in infrastructure, transportation, packaging, processing.

In developed countries we know that consumers are willing to buy products that do not meet appearance standards as long as they are safe and good. Education in schools and political initiatives are possible starting points to change consumer attitudes because throwing food away is unacceptable.

"We would also recommend having selling farms next to the consumers, with direct selling through "farms shops". It is also important to raise awareness among food industries, retailers and consumers on how to better use food that it is now thrown away. For the food which is still good in terms of safety and nutritional value, in place of throwing away at the supermarket level, we would suggest that commercial and charitable organizations collect it at the retailers, and selling it in social shops or giving it to poor people.

Nearly a billion people worldwide are starving, yet at least 1.3 billion tons of food is wasted annually. According to a recent report by the Institution of Mechanical Engineers, 30 to 50 per cent of the food produced globally is wasted every year. Both developing and industrialized countries waste food, but for different reasons. While developing countries lose a lot of food because of poor infrastructure and lack of proper storage facilities, consumers in wealthy

countries waste food because they tend to buy too much food, are picky about the appearance of food, or don't understand expiration dates. Irregularly shaped produce accounts for a lot of food waste in industrialized countries. The Institution of Mechanical Engineers report notes that 30 per cent of vegetables in the United Kingdom aren't harvested because they are aesthetically flawed. While the produce is perfectly edible, it is less marketable unless manufacturers can make it look more acceptable. For example, a 2012 Natural Resources Defense Council (NRDC) report mentions that some carrot farmers cut down waste by making ugly carrots into baby carrots. The NRDC report also highlights how wasted food means wasted resources. In the United States—where 40 per cent of all food is wasted—10 per cent of the country's total energy, 50 per cent of land, and 80 per cent of the freshwater go into food production.

In a world of 7 billion people, set to grow to 9 billion by 2050, wasting food makes no sense – economically, environmentally and ethically. Together, we can reverse this unacceptable trend and improve lives. In industrialized regions, almost half of the total food squandered, around 300m tonnes annually, occur because producers, retailers and consumers discard food that is still fit for consumption. This is more than the total net food production of sub-Saharan Africa, and would be sufficient to feed the estimated 870 million people hungry in the world.

According to the FAO, 95 per cent of food waste in developing countries are unintentional losses at early stages of the food supply chain, caused by financial, managerial and technical limitations in harvesting techniques; storage and cooling facilities in difficult climatic conditions; infrastructure; packaging and marketing systems. But in the developed world, the end of the chain is far more significant. At the food manufacturing and retail level, large quantities of food are wasted because of inefficient practices, quality standards that over-emphasize appearance, confusion over date labels and consumers being quick to throw away edible food due to over-buying, inappropriate storage and preparing meals that are too large. Per capita waste by consumers is between 95 kg and 115 kg a year in Europe and North America/Oceania, while consumers in sub-Saharan Africa, south and south-eastern Asia each throw away 6kg to 11kg a year.

KEY FINDINGS

- Roughly one third of the food produced in the world for human consumption every year - approximately 1.3 billion tonnes - gets lost or wasted.
- Food losses and waste amounts to roughly US$ 680 billion in industrialized countries and US$ 310 billion in developing countries.
- Industrialized and developing countries dissipate roughly the same quantities of food - respectively 670 and 630 million tonnes.
- Fruits and vegetables, plus roots and tubers have the highest wastage rates of any food.
- Global quantitative food waste per year are roughly 30 per cent for cereals, 40-50 per cent for root crops, fruits and vegetables, 20 per cent for oil seeds, meat and dairy plus 30 per cent for fish.
- Every year, consumers in rich countries waste almost as much food (222 million tonnes) as the entire net food production of sub-Saharan Africa (230 million tonnes).

- The amount of food wasted every year is equivalent to more than half of the world's annual cereals crop (2.3 billion tonnes in 2009/2010).
- Per capita waste by consumers is between 95-115 kg a year in Europe and North America, while consumers in sub-Saharan Africa, South and Southeastern Asia, each throw away only 6-11 kg a year.
- Total per capita food production for human consumption is about 900 kg a year in rich countries, almost twice the 460 kg a year produced in the poorest regions.
- In developing countries 40 per cent of losses occur at post-harvest and processing levels while in industrialized countries more than 40 per cent of losses happen at retail and consumer levels.
- At retail level, large quantities of food are wasted due to quality standards that over-emphasize appearance.
- Food loss and waste also amount to a major squandering of resources, including water, land, energy, labor and capital and needlessly produce greenhouse gas emissions, contributing to global warming and climate change.
- Even if just one-fourth of the food currently lost or wasted globally could be saved, it would be enough to feed 870 million hungry people in the world.
- In developing countries food waste occur mainly at early stages of the food value chain and can be traced back to financial, managerial and technical constraints in harvesting techniques as well as storage and cooling facilities. Strengthening the supply chain through the direct support of farmers and investments in infrastructure, transportation, as well as in an expansion of the food and packaging industry could help to reduce the amount of food loss and waste.
- In medium and high-income countries, food is wasted and lost mainly at later stages in the supply chain. Differing from the situation in developing countries, the behavior of consumers plays a huge part in industrialized countries. The study identified a lack of coordination between actors in the supply chain as a contributing factor. Farmer-buyer agreements can be helpful to increase the level of coordination. Additionally, raising awareness among industries, retailers and consumers as well as finding beneficial use for food that is presently thrown away are useful measures to decrease the amount of losses and waste.

EFFICIENT WATER AND ENERGY MANAGEMENT: CHALLENGES AND OPPORTUNITIES FOR FOOD SECURITY IN INDIA

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ABSTRACT

The water-energy nexus has been coming into focus over the last couple of years. The idea is that water and energy are inextricably linked: it takes water to make energy and energy to clean and move water. In the last year or so, a third critical human resource has been added to the mix: food. Theoretically, we can better and more sustainably manage each of these resources if we understand their impact on each other. The water, energy and food security nexus will be one of the major challenges in achieving universal access to these resources without compromising the health and stability of the environment.

The Water, Energy and Food Security Nexus refers to the interlinked risks of water security, food security and energy security. With the current combined challenges of degraded ecosystems, a rapidly increasing demand for resources, climate change, growing urbanization and globalization, there is a threat that social-ecological systems at all levels will be driven across critical thresholds. The nexus of water, energy and food security has attracted more and more attention from researchers, water managers and politicians, and is becoming a strategic development issue for countries, regions, and the world due to anticipated scenario of climate change. Managing this nexus is vitally important for ensuring economic performance, social equity, environmental sustainability, and political stability.

By consistently integrating these existing assessments, we can develop global scenarios for a new nexus approach, which will complement and advance the work of previous outlooks, such as those of the United Nations Environment Programme, the Organisation for Economic Co-operation and Development, FAO, and the World Energy Outlook. This will enable us to map current and future hot spots of available resources and resource productivity across sectors. From such "nexus maps" we can identify the potential to reduce overall resource use by improving the configuration of production patterns and sourcing of inputs, including opportunities associated with trade and foreign direct investment. For example, electricity trade schemes can promote hydropower generation in locations with low water loss and/or high water availability, as in the Nile Basin Initiative, and foreign direct investment can provide knowledge and technologies for co-production of bio-fuel and food/feed for improved water and land productivity.

Such a model-based, top-down approach to the nexus needs to be developed alongside a bottom-up approach, in order to build a knowledge base on best practice, policies, and solutions. Because these nexus solutions have to be driven by individual institutions, additional incentives

and mechanisms need to be established to bridge institutional and sectoral silos. This will reduce negative externalities of short-term sectoral optimization and instead build long-term systemic resilience, reduce total demand for resources, and decouple development from resource use. Only then we can meet the challenges of the "great acceleration" and achieve a transition to sustainability that delivers for the poor.

This paper presents initial evidence for how a nexus approach can enhance water, energy and food security by increasing efficiency, reducing trade-offs, building synergies and improving governance across sectors. A nexus approach can support a transition to sustainability, by reducing trade-offs and generating additional benefits that outweigh the transaction costs associated with stronger integration across sectors.

***KEY WORDS**: Energy policy; Energy, water and food; Access to basic services*

The Water, Energy and Food Security Nexus refer to the interlinked risks of water security, food security and energy security. With the current combined challenges of degraded ecosystems, a rapidly increasing demand for resources, climate change, growing urbanization and globalization, there is a threat that social-ecological systems at all levels will be driven across critical thresholds. The nexus of water, energy and food security has attracted more and more attention from researchers, water managers and politicians, and is becoming a strategic development issue for countries, regions, and the world due to anticipated scenario of climate change. Managing this nexus is vitally important for ensuring economic performance, social equity, environmental sustainability, and political stability. The areas of energy, water and food policy have numerous interwoven concerns ranging from ensuring access to services, to environmental impacts to price volatility. These issues manifest in very different ways in each of the three "spheres", but often the impacts are closely related. Identifying these interrelationships a priori is of great importance to help target synergies and avoid potential tensions.

INTRODUCTION

The water-energy nexus has been coming into focus over the last couple of years. The idea is that water and energy are inextricably linked: it takes water to make energy and energy to clean and move water. In the last year or so, a third critical human resource has been added to the mix: food. Theoretically, we can better and more sustainably manage each of these resources if we understand their impact on each other. The water, energy and food security nexus will be one of the major challenges in achieving universal access to these resources without compromising the health and stability of the environment.

The demand for water is increasing day by day due to population growth, urbanization, intensive agricultural as well as industrial development. Agriculture is the largest consumer of water in India and Australia and the use of groundwater is increasingly playing a critical role in food production in both countries. In this context, it is necessary for agriculture to address its sustainability particularly with regard to water scarcity, energy use and greenhouse gas emissions. As surface water is becoming increasingly scarce, farmer's dependence on groundwater for irrigation is steadily increasing. Groundwater use is also inextricably linked to energy use, as energy is required not only to lift the water but also to irrigate the crops. Water

and energy are usually treated separately and interactions between the two are frequently overlooked. Thus, the interrelation of energy, irrigation and food security has now reached a critical stage.

The paper is divided into XVII sections. Section II presents the Review of Literature Section III shall focus on Managing the Water Land –Energy Nexus for Sustainable Development. Section IV gives the Country's Total water and Energy Demand in Agriculture. Section V discusses about The Index of TFP in Agriculture. Section VI shall focus on Present Energy Crisis in India and their Solutions. Section VII gives the Climate Risk Management and Agriculture in India: Living with an uncertain monsoon Section VIII th shall focus on Impact of climate Change on water and Food Security Section IX gives the Impact of Coal Mining For Energy and Environment Section X presents the Food Security in India Section XI shall focus on Role of Mountains in resolve Energy Water and Food Security. Section XII gives the Water Energy and Food Nexus in Gujarat. Section XIIIth presents the Global Energy Crisis and its impact on Mitigation efforts. Section XIV shall focus on Global Energy Crisis and food security. Section XV gives the Government Initiative for Energy Crisis. Section XVI Presents the High Level Panel on the Water, food and Energy. In Section XVII we shall assess the Conclusions, suggestions and recommendations

REVIEW OF LITERATURE

Narayanmurty, (2007): The water savings due to widely spaced crop is 300 mm/year and closely spaced crop is 500 mm/year (National Mission on Micro Irrigation, 2003). This water savings is directly proportional to energy savings.

Mall et al., (2006): Drop of 1m in groundwater table after water withdrawal will increase India's CO2 emission by 1per cent.

Lal. M.,: (2001) it is predicted that there will be decrease in winter precipitation by 10 to 20per cent over central India.

Agrawal (2011): There are several factors behind the observed stagnation in agriculture. The first one is the decline in investment in agriculture. In the 1950s, investment in agriculture was 19per cent of total investment and has declined steadily to touch 85per cent in the 2000s.

World Bank (2010): Higher food prices have a substantial effect on poverty, even after accounting for second round adjustment in consumption and production. The poor are especially hit by high food prices given the large share of food consumption in their total expenditure and generally negative correlation between income levels and budget shares of food.

Chand (2010): Since there is chance of repeated occurrence of such surge of food prices, we need to have an effective food management strategy to deal with them.

Chauhan, Prithiviraj (2008**):** Energy security for India will be vital for our economic growth; the government has launched National Action Plan for Climate Change and aims to bring in clean technology which sustains development process.

Godrej, Jamshyd (2011): A new research report shows that demand for energy presents an opportunity for green businesses. If cleaner energy alternatives were available, there is a market willing to pay for them, even in very poor communities. The Washington-based World

Resources Institute and the Centre for Development Finance at the Institute for Financial Management and Research in Chennai estimate the potential market for clean energy products and services among India's rural poor at $2.11 billion a year. This conservative assessment of the market potential signals a huge opportunity for consumers and clean energy companies alike

Government of India (2010): India's federal government approved incentives totaling 950 million rupees ($21 million) for makers of electrical vehicles. The subsidy available for electrical and hybrid vehicles will be available until March 2012, as it plans to fund design, research and development and, supply chain development in the above field.

Government of India (2010): Our present indigenous petroleum production is only 33 MMT and is less than 50per cent of our annual requirement. Therefore, the Government attaches high priority to minimizing the gaps between indigenous production and consumption of petroleum products. The need of the hour is to conserve petroleum by its judicious use, substituting it by other resources wherever feasible and restricting its use only to the essential needs.

Jawahar lal Nehru National Solar Mission (2010): To achieve volume production at a scale which leads to cost reduction and rapid diffusion and deployment of solar technologies across the country? For this purpose set up enabling policy environment and regulatory framework

Ramesh, Jairam (2011): At the U.N. climate change summit in Copenhagen Dec.2009, rich nations had pledged to give $30 billion in "fast start finance" between 2010 and 2012 to help the poorest countries and those affected by climate change. 'US alone have listed an amount of $26 million to India as part of their fast start finances pledges' said Mr. Jairam Ramesh.

Singh, Pragya (2010): The Energy Efficiency and the Renewable Energy Management (EE and REM) Centre utilize the city's energy resources effectively and maximize the usage of renewable resources. It seeks to create partnerships among industry, consumers, manufacturers, financial institutions, NGO's and organizations to promote energy conservation.

TERI (2011): Energy security is crucial for India's economic prosperity. TERI's study showed that the country needs to manage its energy imports proactively, increase its production and ensure efficient consumption to make the future of the country energy secure.

Seckler et al (1998): The capacity of large countries like India to efficiently develop and manage water resources is likely to be a key determinant for global food security in the 21st century.

Kumar (2008): Since Agriculture is the major water consuming sector in India, demand management in agriculture in water scarce and water stressed regions would be centered to reduce the aggregate demand for water to match the available future supplies.

FAO (2007): With productivity growth and a modest growth in irrigated area of 0.2per cent annually, irrigated production is projected to account for nearly 40per cent of the increased agricultural production in the developing world by 2030.

MANAGING WATER-LAND-ENERGY NEXUS FOR SUSTAINABLE DEVELOPMENT

Rising incomes and reduced poverty have coincided with the growing demand for goods and services, such as food and energy, which in turn has increased the pressure on natural resources and ecosystems leading to their over-exploitation and degradation. Climate change adds to this

predicament, as several climate adaptation and mitigation measures such as irrigation, desalination, or bio-fuels, are also resource intensive.

In a recent attempt to quantify the limits of global resources, the Planetary Boundaries framework, a critical environmental threshold beyond which rapid and unexpected systemic or "regime" shifts may be triggered, was developed. This framework tries to establish global limits for water, land, and energy use and for other natural resources, such as nutrients or biodiversity. Current demand and resource use trajectories are threatening to undermine the inclusiveness and sustainability of development. For example, by 2050, the Food and Agriculture Organization (FAO) projects a 70 per cent increase in food production, and the World Energy Council (WEC) projects a 100 per cent increase in energy supply. These trajectories must be curbed by more efficient use of resources and reduced wastage, as well as demand management. The priority must be to address current water, energy, and food insecurity in particular, of the world's poorest, to provide a healthy diet, safe water, and access to modern energy for all, going beyond the Millennium Development Goals (MDGs). However, this goal should not only be pursued at the household level, but also at the industrial development level to enable economic development for all countries. Meeting these additional demands in closing these gaps poses even stronger resource challenges.

Sustainable Development Goals:

Sustainable Development Goals (SDGs) which would meet both these social and environmental challenges: staying within the environmental "ceiling", or planetary boundaries, and the socio-economic "floor", which, combined, define a safe and more equal operating space for humanity. When developing these SDGs, it will be important to recognize the interactions and feedback among planetary boundaries and among SDGs. For example, efforts to attain food security need to be water, land, and energy smart, which is not generally the case for agricultural intensification; efforts to achieve energy and climate protection goals need to be water and land smart, which is often not the case for renewable or non-conventional energy; and efforts to reach water goals need to be energy and climate smart, which is not the case for desalination or water transfers.

This nexus angle is particularly important given the strong links between sectors, i.e., agriculture, water, energy, environment, which are likely to get even stronger so that externalities across resources become co-constraints of sustainable development. For example, in Jordan, 25 per cent of all electricity is consumed for the supply of water, primarily the pumping of water. In the United States, power generation accounts for about 40 per cent of all water withdrawals. Large scale water transfers in China intended to mitigate water scarcity are energy intensive, partially depending on hydropower which, due to evaporative losses from reservoirs, contributes to water scarcity.

Hence, systemic thinking and integrated solutions—the nexus approach—need to guide the development and implementation of SDGs. In fact, the real innovation of SDGs may be in exactly that—their conjunctive developments—given that most of the individual goals were already formulated in the past in one way or another. The nexus approach also needs to inform

the emerging national green economy roadmaps, so that the resulting efficiency gains can help keep the cumulative effect of all national development agendas within the planet's safe operating space.

Opportunities in Nexus Approach:

A nexus approach can support a transition to sustainability, by reducing trade-offs and generating additional benefits that outweigh the transaction costs associated with stronger integration across sectors." A nexus approach can create a number of opportunities, including:

- ***Increased Productivity of Resources.*** The nexus focus is on system efficiency rather than on the productivity of isolated sectors.
- ***Waste as a Resource in Muti-Use Systems.*** Cross-sectoral management can boost overall resource use efficiency. Waste can be turned into a resource for other products.
- ***Stimulating Development through Economic Incentives.*** A nexus approach can help to avoid investments that lock development into non-sustainable pathways.
- ***Governance, Institutions and Policy Coherence.*** Enabling conditions for horizontal and vertical policy coherence include institutional capacity building, political will, change agents and capacity building.
- ***Benefiting from Productive Ecosystems.*** Green agriculture can provide benefits such as carbon sequestration and resilience to climate risks while improving food security.
- ***Integrated Poverty Alleviation and Green Growth.*** Green agriculture can generate more rural jobs and increase diversity and resilience of production systems.
- ***Capacity Building and Awareness Raising.*** This can help to deal with the complexity of cross-sectoral approaches, and to promote sustainable lifestyles and consumption patterns.
- ***Moving Towards a Green Economy.*** As the green economy approach seeks "to unite under a single banner the entire suite of economic policies of relevance to sustainable development", it is the nexus approach par excellence.

COUNTRY'S WATER AND ENERGY DEMAND IN AGRICULTURE

India is the largest freshwater user in the world, and the country's total water use is greater than any other continent. The agricultural sector is the biggest user of water, followed by the domestic sector and the industrial sector. Groundwater contributes to around 65per cent of the country's total water demand, and plays an important role in shaping the nation's economic and social development. On the other hand, feeding country's own population, which is 17per cent of the world with just 4per cent of world's water resources at hand, is a big challenge. Balancing water demand among all sectors with finite and fragile water resources will be crucial for future economic growth and development.

Apart from completing hydro projects for her economic needs, irrigation is a great moderator of vulnerability especially of the marketable surplus of exports and consolidation of food buffer stocks. Three States of Punjab, Haryana and Uttar Pradesh in the Indo-Gangetic plains collectively contribute 98 per cent wheat and 52 per cent rice to the central stock for maintaining food, nutritional, feed and national security. Punjab leads in irrigation with 97.6 per cent of its

net sown area under irrigation followed by Haryana (85.2 per cent), Uttar Pradesh (71.6 per cent) and all remaining states with less than 51 per cent. There is a conjunctive use of surface and ground water resources with about 20 million ground water extraction structures in the country. Overall, ground water accounts for 60 per cent of the net irrigated area (58.5 million ha) in India. Ground water contribution to the net irrigated area varies from 65 to 74 per cent in the States of Bihar, Gujarat, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and Uttar Pradesh. Overall ground water management is very crucial for meeting incremental demands and maintaining sustainability in the long term perspective.

Energy Consumption in Agriculture

In India about 52per cent of its total electricity is generated using fossil fuel (coal). Indian agriculture consumes about 30per cent of its total electricity. According to BERI (2007), India is among top 10 fastest growing economies in the world. Due to this its fossil fuel share is expected to rise to 74 per cent of total energy by 2010, the corresponding increase in CO2 emissions being 1,646 Million tons. The use of fossil fuels increases the Greenhouse gases (GHGs) emission. Thus, energy efficiency and increased water productivity in agriculture has huge impact on water and energy policy in India.

Micro-Irrigation Technology for Enhancing Water Efficiency

As water demand from cities and industries is increasing rapidly, pressure is also mounting on agriculture to enhance water efficiency. Traditional irrigation methods are no longer viable and a paradigm shift is required to increase irrigation efficiency. With around two third of Indians depend upon agrarian economy, water is becoming a bottleneck for country's socio-economic balance and growth. As water demand management measure in agriculture, recently micro-irrigation technologies, which mainly include drip and sprinkler irrigation methods, have been introduced. Unlike conventional flood irrigation, water in this method is supplied at a required interval and quantity using piped network, emitters and nozzles. Thus, the conveyance and distribution losses are reduced which results into higher water use efficiency. Minimizing water use also reduces energy use for pumping groundwater. Thus, micro-irrigation technologies co-optimize both energy and water use.

Conventional irrigation methods are employed for more than 80 per cent of the world's irrigated lands yet their field level application efficiency is only 40-50 per cent. In contrast, drip irrigation has field level application efficiencies of 70- 90 per cent as surface runoff and deep percolation losses are minimized. All agricultural operations require energy in the form of electricity, the magnitude of which varies as per different agro-climatic zones and even from farmer to farmer.

Reasons for Action and Targets

The largest share of energy is utilized for pumping of irrigation water. Various research studies have shown that water saving, electricity saving, irrigation efficiencies and yield of crops using drip irrigation are substantially higher than crops irrigated by the conventional flood irrigation method. The modern irrigation systems drip and sprinkler can act as a mitigation measure over this problem. Eventually with little water available in Indian subcontinent, crop can survive and we can virtually come out the over dependency on monsoon. Because, whatever rain is available

in arid regions can be will be stored and water applied to root zone with drip, will bring this region out 'rain feed' clutches with increased productivity. The water savings due to widely spaced crop is 300 mm/year and closely spaced crop is 500 mm/year (National Mission on Micro Irrigation, 2003). This water savings is directly proportional to energy savings (Narayanmurty, 2007).

INDEX OF TFP IN AGRICULTURE

Agriculture growth is one of the important components for productive inclusion. Global experience shows that GDP growth originating in agriculture is at least twice as effective in reducing poverty as GDP growth originating outside agriculture. The Index of Total Factor Productivity (TFP) in agriculture in India increased from 100 in 1961 to 170 in 2009. During the same period, it increased from 100 to 270 in Brazil, China and Indonesia. Yields of many crops in India are lower than in many countries. There is an opportunity to boost TFP and yields with appropriate price and non-price policies. These include technology, better water management, marketing and rural infrastructure. Diversification of agriculture, a focus on eastern and central regions, increase in supply chains and links to agro-processing can increase productive employment. Higher farm growth boosts the rural non-farm sector too.

India ranks second worldwide in farm output. Agriculture and allied sectors like forestry, logging and fishing accounted for 18.6 per cent of the GDP in 2005, employed 60per cent of the total workforce and despite a steady decline of its share in the GDP, is still the largest economic sector and plays a significant role in the overall socio-economic development of India. Yields per unit area of all crops have grown since 1950, due to the special emphasis placed on agriculture in the five-year plans and steady improvements in irrigation, technology, application of modern agricultural practices and provision of agricultural credit and subsidies since the green revolution. India is the largest producer in the world of milk, cashew nuts, coconuts, tea, ginger, turmeric and black pepper. It also has the world's largest cattle population (193 million). It is the second largest producer of wheat, rice, sugar, groundnut and inland fish. It is the third largest producer of tobacco India accounts for 10per cent of the world fruit production with first rank in the production of banana and sapota. The required level of investment for the development of marketing, storage and cold storage infrastructure is estimated to be huge. The government has implemented various schemes to raise investment in marketing infrastructure. Among these schemes are Construction of Rural Go downs, Market Research and Information Network, and Development / Strengthening of Agricultural Marketing Infrastructure, Grading and Standardization. Main problems of low TFP in the agricultural sector, as listed by the World Bank, are:

- India's large agricultural subsidies are hampering productivity-enhancing investment.
- Over regulation of agriculture have increased costs, price risks and uncertainty.
- Government interventions in labour, land, and credit markets.
- Inadequate infrastructure and services.

PRESENT ENERGY CRISIS IN INDIA AND THEIR SOLUTIONS

Energy crisis and finding a viable solution for it constitutes an important contemporary debate in India today. Energy crisis has a great bearing on all socioeconomic development of a country and its sovereignty. Indo-US nuclear deal trans-country pipelines and aggressive policy of securing petroleum fields in different parts of the worlds can be seen in light of the energy crisis. India is not the stand alone case facing energy crisis. The world on the whole is facing energy crisis. Energy intense economies of the developed world copied with increasing demand from rapidly developing countries such as India, China, Brazil is responsible for huge increase in demand. Plateauing of petroleum productions in traditional oil producing countries such as Saudi Arabia along with political instabilities in countries like Iraq, Iran, Libea and Nigeria has led to scenario where demand outstrips the supply.

In India there are number of factors which led to the situation of energy crisis. There has been sharp rise in the consumption of energy in India since the last decade of 20^{th} century. The year 1991 unlashed the forces of liberalization, privatization sector and accompanying rise in energy, tidal energy etc. These resources have failed to fill the gap of demand and supply of energy due to variety of reasons. Hydroelectricity is a cheap source of energy but is inflexible in terms of location. There are many social and environmental concerns such as displacement of tribal's, submergence of forests are associated with hydroelectricity. Other renewable energy resources such as solar power, geo-thermal, and wind energy tidal power are in nascent stage of development and are commercially unviable.

Production and Consumption of Different Energy Resources in India

India is among one of the growing economies of the world. Indian long term economic policy is extremely aggressive both on regional and global axis. India has to provide energy to her entire population along with keep its industrial growth on track. So, she cannot afford to meet these massive demands through imported energy. Feeding one billion people is another issue for India and being an agro-based country, the water requirements are also on the rise with increase in population.

As geo strategic developments in this part of the world are completely unpredictable so every regional player is busy in planning to exploit the domestic energy potential to its maximum. India and China are major regional competitors in energy security and, both are leading the regional progress and development race as well. Only reason that they are sustaining it is the consistent investment in energy infrastructure along with robust long term energy policies. China has been sustaining a 10per cent growth rate since last three decade which has turned it into world's third largest economy after the US and Japan.

Traditional Energy Resources:-

Traditional energy resources like firewood, dried cow dung cake and charcoal are being used in rural India. Such usage of traditional energy resources in inefficient and cause make life miserable for women. To achieve cent per cent rural electrification as envisaged by national programmed for rural electrification, availability of ample energy is must.

Non-Renewable Energy

Non-renewable energy forms major chunk of total energy resources of the country. Coal oil or gas fired power stations produce electricity. Petroleum derivatives are used in transportation sector. Problem with non renewable energy is that India has to import a major portion of petroleum products as it is not naturally endowed with them in sufficient quantum. Soaring international prices of crude oil entails heavy outflow of foreign exchange and there is omnipresence of energy insecurity in the event of disruption in supply.

Nuclear Energy

Nuclear energy is being offered as panacea for energy crisis being faced by India. Nuclear fuel is cheaper than the petroleum. India has gained a considerable expertise in the development and harnessing of nuclear energy. India's nuclear program is three stage programmes which encompasses the use of vast thorium reserves in the county. Nuclear energy is seen to be capable of bridging the gap between the demand and supply of energy in India. Of late, the nuclear energy program faced problem of non availability of natural uranium for rapid expansion of nuclear energy in country. Natural uranium occur in small quantities in India and India can not import natural uranium from outside as it is not a signatory to NPT and as a consequence NSF refuse to export any nuclear energy related material and technologies to India. Indo–US unclear deal should be seen in light of the projected benefits of nuclear energy.

India –US deal envisages that US will co operate with India for the development of civilian nuclear technology and use its good offices to ensure NSG rules are modified in a way so that India would be able to receive natural uranium as well as advanced nuclear technologies for civilian use. The deal in turn obliges India to demarcate its civilian as well as military establishment under IAEA regime. There are many strategic and defensive aspect undercurrents of the nuclear deal. Questions have been raised in parliament regarding India compromising its sovereignty independent foreign policy and about the reliability of USA as a long term strategic partner. Scientists have alleged that US have shifted the goal posts and are demanding more obligations from India than that were required by India-US deal.

Former honorable president Kalam has released a road map for achieving the energy security for the nation. He visualizes important contribution by hydroelectric power and nuclear power for the attainment of energy security. He also gives emphasis on conventional source as well as renewable sources of energy such as wind power for energy security of the country.

Hydro Power Plants Energy:-

Decentralized Hydro Electric Power (HEP) and wind power are the commercially viable resources of renewable energy in India today. Small hydroelectric power project made built to satisfy the energy needs of surrounding villages' offers a solution for the electrification of rural areas in mountainous regions. Hydro energy is the most economical mean to get clean energy. India, China, Afghanistan and Bangladesh are working restlessly to harness this resource. Chinese are leading the race in hydro power production as well. How aggressive Chinese are in their hydro energy ambitions can be gauged by a simple fact that total installed capacity of power generation is around 20,000 MW. This includes both hydro and non-hydel means, in China, 3-

gorges dam alone has a capacity of producing 22,500 MW. It is world's largest hydro power project. Apart from that, China is busy in constructing other large hydro power plants. 6 out of world's 20 largest hydro power plants are located inside China already. India is also building hydro power plants across the entire swath of country. Indian water and energy policies are actual demonstration of how water and energy would play a major role in future geopolitical and geo strategic reshaping of the region.

Wind Power

Wind power is already a major source of energy. State of Tamil Nadu, Maharashtra and Gujarat have taken lead in this sector. Government should encourage this private sector imitative by providing the required infrastructure at war footing. So that estimate potential can be harnessed private sector participation should be encouraged.

Ethanol and Bio-diesel

Ethanol and Biodiesel are the latest buzzwords in debates on energy crisis in India. Ethanol is produced from sugarcane and is mixed with petrol. Countries such as Brazil and USA are already using ethanol on large scale. Uses of ethanol in large scale will invariably boost sugarcane farming in country. Biodiesel is obtained by processing oil obtained from various plant seeds. Jatropha is being promoted in vast wastelands of the country. Experts feel that the problem of huge oil import bill and the price uncertainty can be mitigated by cultivating bio-fuel crop on the over 60 million hectare of wasteland available in the country. A northern railway is conducting experiment of running locomotive on biodiesel. Even if small per centage of ethanol and Biodiesel is blended, immense savings on import bill can be affected.

India's Production and Consumption of Oil

India had about 5.6 billion barrels (890,000,000 m^3) of proven oil reserves as of January 2007, which is the second-largest amount in the Asia-Pacific region behind China. Most of India's crude oil reserves are located in the western coast (Mumbai High) and in the north eastern parts of the country, although considerable undeveloped reserves are also located in the offshore Bay of Bengal and in the state of Rajasthan. The combination of rising oil consumption and fairly unwavering production levels leaves India highly dependent on imports to meet the consumption needs. In 2006, India produced an average of about 846,000 barrels (134,500 m3) per day (bbl/d) of total oil liquids, of which 77per cent, or 648,000 bbl/d (103,000 m3/d), was crude oil. During 2006, India consumed an estimated 2.63 Mbbl/d (418,000 m^3/d) of oil. The Energy Information Administration (EIA) estimates that India registered oil demand growth of 100,000 bbl/d (16,000 m3/d) during 2009.

India's oil sector is dominated by state-owned enterprises, although the government has taken steps in past recent years to deregulate the hydrocarbons industry and support greater foreign involvement. India's state-owned *Oil and Natural Gas Corporation* (ONGC) is the largest oil company, and also the country's largest company overall by market capitalization. ONGC is the leading player in India's upstream sector, accounting for roughly 75 per cent of the country's oil output during 2006, as per Indian government estimates. As a net importer of oil, the Government of India has introduced policies aimed at growing domestic oil production and oil

exploration activities. As part of the effort, the Ministry of Petroleum and Natural Gas crafted the New Exploration License Policy (NELP) in 2000, which permits foreign companies to hold 100per cent equity possession in oil and natural gas projects. However, to date, only a handful of oil fields are controlled by foreign firms. India's downstream sector is also dominated by state-owned entities, though private companies have enlarged their market share in past recent years.

Natural Gas

As per the Oil and Gas Journal, India had 38 trillion cubic feet (1.1×10^{12} m^3) of confirmed natural gas reserves as of January 2009. A huge mass of India's natural gas production comes from the western offshore regions, particularly the Mumbai High complex. The onshore fields in Assam, Andhra Pradesh, and Gujarat states are also major producers of natural gas. As in the oil sector, India's state-owned companies account for the bulk of natural gas production. ONGC and Oil India Ltd. (OIL) are the leading companies with respect to production volume, while some foreign companies take part in upstream developments in joint-ventures and production sharing contracts (PSCs). Reliance Industries, a privately-owned Indian company, will also have a bigger role in the natural gas sector as a result of a large natural gas find in 2002 in the Krishna Godavari basin. The Gas Authority of India Ltd. (GAIL) holds an effective control on natural gas transmission and allocation activities. In December 2006, the Minister of Petroleum and Natural Gas issued a new policy that allows foreign investors, private domestic companies, and national oil companies to hold up to 100per cent equity stakes in pipeline projects. While GAIL's domination in natural gas transmission and allocation is not ensured by statute, it will continue to be the leading player in the sector because of its existing natural gas infrastructure.

National Solar Mission of India

According to reports released on June 11, 2012, India's initiatives in the renewable energy sector have received praise from the UN. The UN Environment Programme (UNEP) hailed India's achievement in its report on renewable energy trends in 2011. The report highlights that India's National Solar Mission helped the country spur an impressive 62per cent increase in investments to $ 12 billion during 2011. It was the fastest investment expansion of any large renewable energy market in the world. As per report, the global investment in renewable energy, excluding large hydro increased by 17 per cent to $ 257 billion during the year under consideration. It represented a six fold increase over the 2004 figure and a 94 per cent rise over the total in 2007. India also found a place in the report as one among the top seven countries in the world for renewable energy capacity, excluding large hydro, accounting for about 70 per cent of the total non hydro renewable capacity worldwide. The other six countries are China, the US, Germany, Italy, Spain and Japan. In 2011, India China and Brazil together accounted for roughly one quarter of the global non-hydro renewable energy capacity.

CLIMATE RISK MANAGEMENT AND AGRICULTURE IN INDIA: LIVING WITH AN UNCERTAIN MONSOON:-

Monsoon does play an important role on the economy of a country. Economy of a country depends on Agricultural, Industrial sector especially in a country like India. In India, agriculture provides around 70per cent of employment either directly or indirectly. This is the major reason

for the economic growth of India to depend on Monsoon season. Monsoon season in India starts from June and continue till September. If the monsoon is good, it boosts up the economy of the country and helps in maintaining GDP growth.

Effects of Less Rainfall

Monsoon season has a direct impact on agricultural sector, which has an impact on industrial sector as well, particularly for FMCG companies which depends on agricultural and rural market. It also causes shortage of water supply for production of power and electricity. Electricity shortage has a strong effect on almost all sectors, which also causes delay in productions or increase in costing of products.

Monsoon rains has an impact on several crops of different states in India. It impacts the sowing of groundnut in Rajasthan and Gujarat, soya-bean in Madhya Pradesh and Maharashtra and paddy in Uttar Pradesh. Kharif crop also gets affected due to the delay of rains. Rains also affect the production of rice, millet, sugarcane, oilseeds and cotton. Less rain affects the purchasing power in rural areas and contract demand for products and services. With the global recession still pertaining, India is depending on the domestic demand which mainly comes from rural India.

In India, where over 60per cent of agricultural land is rainfed, a failed monsoon causes crippling impacts in rural communities. Farmers often face a complete loss of crops, threatening livelihoods and food security, and pushing already stressed areas into further poverty. Nationally, GDP drops and the government spends massive sums on drought relief for farmers. The magnitude of these human and economic costs – particularly as concern grows over the potential for climate change to increase extreme weather patterns – has highlighted the need to better manage climate risks and find ways to plan ahead.

The majority of India's over 100 million farming households depend upon the summer monsoon to water their crops from June through September. Advance information about the likely character of the upcoming monsoon season could be very helpful to both farmers and policy makers. They need information relevant to their specific region, and about specific climate variables that affect crop management and agriculture policy decisions. In addition to seasonal and sub-seasonal rainfall forecasts, analysis of past climate patterns, like timing of monsoon onset and dry or wet spells, at appropriate scales can help decision-makers better understand the climate risks they face. The International Research Institute for Climate and Society is partnering in an innovative new research effort led by the Government of India, aimed at addressing these challenges.

Extended Range Forecast System (ERFS) for Climate Risk Management in Agriculture:-

The Extended Range Forecast System (ERFS) for Climate Risk Management in Agriculture supported by the Department of Agriculture Cooperation, Ministry of Agriculture, seeks to improve monsoon forecasts and demonstrate approaches to using tailored climate information to benefit agriculture and rural livelihoods. The project includes demonstration districts in nine states affected by the monsoon. Leading partners in India include the Indian Institute of

Technology (IIT) Delhi, which serves as project secretariat, the India Meteorological Department (IMD); the National Centre for Medium Range Weather Forecasting, the Indian Council of Agricultural Research, and state agriculture universities. IRI is the lead international agency for the project, contributing climate and agricultural expertise and coordinating inputs from other leading international research centers such as the European Centre for Medium- Weather Forecasts (ECMWF), the Japan Agency for Marine Earth Science and Technology (JAMSTEC), Wageningen University, and others. In the area of climate science, the project will test new approaches to forecasting the Indian monsoon, which is notoriously challenging to predict. A new experimental "ensemble" forecast is being developed, combining outputs from multiple models from globally-recognized climate research centers. IRI and scientists from the India Meteorological Department and Indian Institute of Technology Delhi are also developing methodologies to create forecasts at a smaller scale and investigating the potential for information such as the likelihood of dry or wet spells and monsoon breaks, crucial for farmers. In the demonstration districts, researchers at state agriculture universities are identifying specific climate-related agricultural risks and the decision options of farmers and local officials, such as adjusting crop timing, seed type, and fertilizer use.

IRI scientists are working with researchers at Anand Agriculture University in Gujarat and the Acharya N. G. Ranga Agriculture University in Andhra Pradesh to analyze the impacts of climate variability on maize, cotton, groundnut and other key crops, and map out climate risk management opportunities. Through this project, the India Meteorological Department and state agriculture universities hope to expand the kinds of climate information they offer to farmers through the National Agro-Meteorological Advisory System. IRI and its partners are also identifying ways to integrate climate information into specific agricultural planning and drought-relief preparation policies.

With 60 per cent per cent of India's population dependent on agriculture for their livelihoods, better forecasting coupled with risk management approach haste the potential to help vast numbers of farming households better cope with the risks of an uncertain monsoon. The IRI works on the development and implementation of strategies to manage climate related risks and opportunities. Building on a multidisciplinary core of expertise, IRI partnered with research institutions and local stakeholders to best understand needs, risks and possibilities. The IRI supports sustainable development by bringing the best science to bear on managing climate risks in sectors such as agriculture, food security, water resources, and health.

IMPACT OF CLIMATE CHANGE ON WATER AND FOOD SECURITY

Climate change due to global warming is increasing complexities and vulnerability of food security both in the irrigated and rain-fed agriculture. Frequency of extreme weather events of heat waves, cold waves, cyclones, floods, droughts, outbreaks of pests and diseases have increased especially during the past 20 years. During 1951-2007 the frequency of dry spells (break in monsoon) and the number of dry spell days (break in monsoon days) showed an increasing trend. Particularly, there was a clear increase in the per centage of long breaks

compared to the total number of breaks. Rise in surface sea water temperature and levels have been mapped.

Climatic changes have a few opportunities and many problems of vulnerability of the futuristic food security. This calls upon short and long-term strategies for moderating, coping, adaptations, mitigation and safety-nets. Diversification into water saving land uses in Punjab, other similar areas and compensatory production in Eastern India is called upon. The sustainability of groundwater utilities is one of the core issues which require attention for meeting irrigation and drinking water requirements and ensuring food security. Holistic planning of groundwater development in the east and northeast and adequate recharge measures in the northwest and south are essential so that imbalances of the past are remedied. In other areas too, judicious planning of groundwater development and artificial recharge could result in maximum productivity without raising environmental concerns.

Climate Change May Force India to Import Corn

Scientists have claimed that India and China, Asia's largest corn producers, will experience severe dry conditions due to climate change, prompting them to import corn from Tanzania which would face comparatively wet weather. Researchers from Stanford University, the World Bank and Purdue University found that in the year's countries such as India, China and the US are forecast to experience severe dry conditions; Tanzania's weather will likely be comparatively wet. The African country can substantially increase its maize exports due to predicted dry and hot weather that could affect other countries' usual sources for the crop.

The researcher began by analyzing historical years in which Tanzania experienced grains surpluses or deficits. The researcher then attempted to predict how often Tanzania and key trading partners will experience severely dry years in response to continued global warming They predicted that during an average of 96 per cent of the years the US and China are predicted to have extremely dry conditions, Tanzania will not experience similarly dry weather. For India that per centage increases to 97 per cent the researchers said in a statement. The study was published in the Review of Development Economics. "This study highlights how government policies can influence the impact that we experience from the climate system," said study Noah Diffenbaugh, an assistant professor from Stanford's School of Earth Sciences Tanzania is a particularly interesting case, as it has the potential to benefit from climate change if climate model predictions of decreasing drought in East Africa prove to be correct, and if trade policies are constructed to take advantage of those new opportunities. The study used economic, climatic and agricultural data and computational models to suggest that Tanzania is likely to have adequate growing season moisture in most of the years that its key African trading partners experience severe dry weather.

IMPACT OF COAL MINING FOR ENERGY ON ENVIRONMENT

Environment activists warned that coal mining in forest areas would endanger wildlife, water resources and livelihood of millions of people. They demanded immediate moratorium on forest clearances for coal mines and asked the government to prioritize alternative sources of energy. Greenpeace and Wildlife Society of Odisha (WSO) jointly released a survey report, "How Coal

Mining is Trashing Tigerland", here highlighting the plight of forests falling prey to coal mining and its adverse impact on wild animals and human population. The report said coal mining has threatened more than 11 lakh hectares of forests in 13 coalfields alone in Central India. "The blackout in northern India due to grid failure is a wake-up call for the government to revisit its unsustainable energy policy. It is time the power generation sources and distribution models are diversified. Locking the country into a coal intense pathway is not going to guarantee power. "It is shocking that the ministry of environment and forests continues to clear coal power projects and mines way beyond requirements, often overriding the objections of its own officials and committees. There should be immediate moratorium on all new forest clearances until the criteria for determining forests off limits to mining are agreed on and implemented with proper public consultation and input.

The report quoted the Planning Commission as estimating the coal requirement for power generation in 2031-2032 was 1,475 to 1,659 million tons, which is more than double the current coal consumption of approximately 650 mtpa. This implies acceleration of destruction and fragmentation of forests in the coming days. In the last five years the country has witnessed a sharp rise in coal mining and thermal plants, mostly in Odisha, Madhya Pradesh, Chhattisgarh and Jharkhand, while the Centre has all but overlooked the long term survival of tigers in Central India. If the present trend is not reversed, the situation would worsen in the future, the report observed.

FOOD SECURITY IN INDIA

The most important lesson of the 2008-09 global economic slowdowns is that food security is of supreme national importance for maintaining social harmony, national integrity and sovereignty of India. India's current population of 1.12 billion (112 crores) is likely to grow to 1.35 billion (135 crores) by 2023 and demands 23 per cent increase in agricultural production. Probabilities of occurrence of droughts, crop failures and livestock damages vary from once in 2.5 to once in 15 years in various agro-ecological regions of India. Historical occurrences of devastating famines in India are well documented in the literature. After the Bengal famine of 1943 India could withstand severe droughts of 1972, 1987 and 2002 due to the Green Revolution leading to food buffer stock in the country. Similarly 40 million hectare of land is vulnerable to floods, loss of crops, livestock and livelihoods, devastations, miseries and periodic relocations of people. Water logging and accumulation of salts in the soil surface is a slow degradation process but sizable area is getting afflicted especially in canal commands year after year. This has happened in South Western Punjab, Southern Haryana, Indira Gandhi Canal command of Rajasthan, Sharda Sahayak of Uttar Pradesh and others.

Spending on Food in India

According to earlier data, an Indian, on average, spent as much as 53per cent of total expenditure on food requirements. With relentless food inflation this per centage would be far higher now. In comparison, Americans, on average, spend 9.3 per cent of their income on food, in Italy a family on average spends 25.7 per cent, in Japan 19.1 per cent, in France 16.3per cent, in the United Kingdom 11.5 per cent. While there is a difference in the method of calculation between India

and others, it does emphasis the Indian reality of higher food prices and lower levels of disposable income than other countries. The same estimates of poverty by the Planning Commission became the basis on which to exclude people. In spite of national outrage against the present poverty line figures of Rs 26 a day for an adult in rural India and Rs 32 for an adult in urban India (at 2010-11 prices) these still continue as the basis for access to the PDS. The critical issue here is to reverse targeting and ensure a universal public Distribution System. This is estimated to cost the exchequer an additional Rs 25,000 to Rs 30,000 crore, a small price to pay for a country, which has the largest malnourished population in the world.

Impact of Infrastructural Facilities in Foodgrains Production

Public investments into hydroelectric power generation, canal networks, rural electrification for energizing ground water harnessing, roads, markets, other infra-structure, research and development ushered in the Green Revolution. India's food grain production touched the ever highest record of 230.67 million tonnes in 2007-08 after hovering around 198 to 217 (average 209) million tonnes in the previous 40 years with a very high comfort level of buffer stocks. The net irrigated area of 58.5 million ha in India comprising 40 per cent of net sown area contributes 60 per cent to the food-grain production. About 60 per cent of the net sown area in India is rain-fed, complex, diverse, under-invested and contributing 40 per cent to the food-grain production and supporting 40 per cent population is highly vulnerable. Productivity of the rain- dependent 80 per cent area under fruits, 100 per cent grazing lands and forests is also very low, un-reliable and distress prone.

Impact of Energy Cost, Ground Water Quality on Food Production in Punjab:-

The northern State of Punjab in India has played a pivotal role in sustaining the national food security and is referred to as the 'Granary of India'. However, in sustaining the agricultural production, Punjab has already depleted its good quality ground water resources. The State is currently facing the problems of a declining ground water table in the central part, increased energy cost for pumping and deterioration of ground water quality and there are indications that the water availability would emerge soon as a limiting factor even to sustain the present production levels unless remedial measures are undertaken immediately. Remedial solutions such as artificial recharge of ground water, utilization of poor quality water, delaying rice transplanting, crop diversification, restructuring of incentives, improving productivity in the water-rich eastern States, etc. have been presented to rationalize the ground water use for sustaining the agricultural production for maintaining perpetual food security in the country.

Draught not a Big Calamity in India Anymore:-

Back in the 1960s, India could not afford to import food, and depended on charity in 1960s. But today GDP is almost $2 trillion, exports of goods and services exceed $ 300 billion and forex reserves are $ 280 billion. Even if we had to import 10 million tones of wheat at today's high prices, the cost, $ 3 billion, would be easily affordable. In fact, no imports are needed: government food stocks exceed 80 million tones. This is the real reason that droughts have ceased to be calamities. Foodgrains availability remains as low as in the 1960s, despite the green revolution. But rapid GDP growth, by hugely boosting the share of services and industry in GDP,

has made agriculture a relative pygmy, greatly reducing the economy's monsoon dependence. There remains a catch: a drought may no longer mean mass starvation, but still means food inflation.

The monsoon has failed badly this year (2012) as it did in 1965. But it's little more than an inconvenience this year, whereas in 1965 it was a monstrous calamity. The drought proofing of India is a success story, but one widely misunderstood. India in the 1960s was pathetically dependent on US food aid. Even in the bumper monsoon year of 1964-65, food aid totaled 7 million tones, over one tenth of domestic production. Then India was hit by twin droughts in 1965 and 1966. Grains production crashed by one fifth. Only unprecedented food aid saved India from mass starvation. The 1966 droughts drove India into a ship to mouth existence. Hungry mouths could be filled only by food aid, which reached a record 10 million tones.

Foreign experts opined that India could never feed itself. William and Paul Paddock wrote a best seller titled *famine* 1975, arguing that the world was running out of food and would suffer global famine by 1975. They said aid givers could not possibly meet the food needs of high population countries capable of being saved. Countries incapable of being saved, like India, should be left to starve, for the greater good of humanity. Indians were angered and horrified by the book, yet it was widely applauded in the West. Environmentalist Paul Ehrlich, author of The Population Bomb, praised the Paddock brothers sky-high for having the guts to highlights a Malthusian challenge. The green revolution certainly raised yields, enabling production to increase, even though acreage reached a plateau. But it did not improve food grain availability per person. This reached a peak of 480 grams per day per person in 1964-65, a level that was not reached again for decades. Indeed, it was just 430 gm per day per person 2010-11. Per capita consumption of superior foods –meet, eggs, vegetables, edible oils –increased significantly over the years. But poor people could not afford superior foods.

Employment schemes in rain deficit areas injected purchasing power where it was most needed. The slow but steady expansion of the road network helped grain to flow to scarcity areas. The public distribution system expanded steadily. Hunger remained, but did not escalate into starvation. By the 1990s, hunger diminished too. Second, the spread of irrigation stemmed crop losses. The share of the irrigated area expanded from roughly one third to 55 per cent of total acreage. Earlier, most irrigation was through canals which themselves suffered when droughts dried up reservoirs. But after the 1960s tube well irrigation rose exponentially, and how account for four fifths of all irrigation. Tube well is not affected by drought. More important, tube wells facilitated Rabi production in areas with little winter rain. Once, the Rabi crop was just one third the size of the Kharif crop. Today, both are equal. This explains why in 2009, which witnesses one of the worst monsoon failures for a century, agricultural production actually raised 1 per cent: good Rabi production offset the slump in Kharif production. However the biggest form of drought proofing lies outside agriculture. Rapid GDP growth has dramatically raised the share of industry and services. Agriculture accounted for 52 per cent of GDP in 1950 and for 29.5 per cent even in 1990. This is now down to just 14 per cent. Even if one-twentieth of this is lost to drought, it will be less than 1per cent of GDP.

Global Food Security

The UN Food Agency, the Food and Agriculture Organization (FAO) , said on June 13, 2012 that the overall 2012 forecasts for global food production were positive. The FAO , however warned that some regions were likely to struggle due to armed conflicts and displacement. The report forecasts a record increase of 3.2 per cent in world cereal production in 2012. The main reason behind this is a bumper maize crop in the US. Various other areas also projected good supply prospects, partly lifting the bleak specter of another food crisis coming back to haunt the world in 2012. Despite the overall positive trend, several regions are expected to struggle with the consequence of poor rainfall, inclement weather and conflict, said the report. A number of poor African countries are likely to face a risk of shortage due to weather –related reasons, while Yemen and Syria may face the heat in account of armed conflicts.

Role of Mountains in Resolve Energy, Water, Food Security Issues

Mountains are the earth's natural freshwater reservoirs. They store an immense amount of water and gradually release it to support livelihoods and natural and agro-ecosystems downstream. More than half of humanity relies on freshwater from mountains to grow food, produce electricity, sustain biological diversity, and provide drinking water.

More than half of humanity relies on water from mountains. Glaciers, ice fields, and snow pack store an immense amount of fresh water and gradually release it to meet year-round needs for irrigation, drinking, sanitation, industrial processing, clean energy, and food production. Mountains are sources of rich biodiversity providing numerous foods and medicinal products. These services are vital for human wellbeing, both in the mountains and downstream, and especially for improving the lives of indigenous, marginalized, and poor people.

Water Towers of Asia for Hydro Power and Food Security

Glaciers, ice fields, and snow packs provide immense water storage facilities. The Hindu Kush Himalayas are the 'water towers' of Asia and are vital to 1.3 billion people living in ten major river basins. They are the major source of water – both surface and groundwater – in the dry season, and as such are critical for hydropower and food security The Hindu Kush Himalayan mountain systems play a critical role in maintaining agricultural biodiversity. They help regulate micro-climate and the all-important monsoon precipitation. Many of the rivers originating in the Hindu Kush Himalayas support major bread-basket areas of regional and global significance such as, the basins of the Ganges, Indus, Mekong, Yangtze, and Yellow rivers. Rivers originating in the Himalayas contribute to groundwater storage, and during the dry season they are the main source of surface water, in the fertile plains of the Ganges river basin, for example. More than one-third of the arable land in the Hindu Kush Himalayan countries (excluding Bhutan and Myanmar) is irrigated mainly by water from rivers originating in these mountains. Adverse changes to this vital source of water would threaten food security at country, regional and global scales.

Fragile and Unique Ecosystem:-

Mountains are fragile ecosystems and highly vulnerable to climate change, impacts of globalization, and environmental problems such as atmospheric pollution and black carbon.

While current changes create opportunities for mountain people for livelihood diversification, for example, they also create pressures that can exacerbate poverty, food insecurity, and health risks. Much of the negative pressure on mountain communities and ecosystems comes from problems originating outside mountain regions. As global inaction on carbon emissions causes temperatures to rise – and they are rising faster at higher elevations – snow and ice melt away, diminishing the capacity of natural water storage systems.

The global community must look to mountains to resolve issues of energy, water, and food security. To date, the conservation efforts of mountain people remain ignored and unrewarded, yet we all benefit. We need to strengthen existing institutional mechanisms, and to establish new ones, to provide incentives for ensuring mountain ecosystem services, including surface and groundwater provision, water storage, carbon storage by mountain forests, and other services necessary for energy, food security, and sustainable livelihoods. Whether or not there will be enough food and energy for all will depend in large part on what happens in the mountains. Mountains face special problems because of their remoteness, unique ecosystems, and fragility. Consequently mountains need greater recognition in global negotiations.

WATER ENERGY AND FOOD NEXUS IN GUJARAT:-

The northern region of Gujarat State in western India is semi-arid and prone to droughts, receiving almost all of its rain during the monsoon season between June and September. But for the past three decades, many crop and dairy farms have remained green—even during the dry season. That's because farmers have invested in wells and pumps, using massive amounts of electricity to extract water from deep aquifers. The government has artificially propped up the agricultural sector through power subsidies and price supports. The pumping hasn't occurred without dire environmental impacts. Groundwater tables have fallen precipitously, 600 feet below the ground in some places, requiring even more powerful pumps to bring water to the surface. Over-consumption has taxed the power grid, constraining the electricity available for others.

Rising Thirst for Energy on Farm

North Gujarat is a well documented, extreme example of groundwater depletion and an unsustainable agricultural sector. But there are many other hot spots in places such as India, China, and the Middle East where energy demands are rising so enough water can be pumped to produce food. In essence, experts warn, agriculture in those areas is in peril because of its unsustainable relationship with energy and groundwater.

Potential impacts include not only dry aquifers and failing farms, but increased soil salinity and carbon dioxide emissions. Climate change exacerbates the situation. Poor farmers often are hit the hardest, because they can't afford to invest in expensive technologies to drill wells and pump water from them. The challenge for Gujarat and other areas lies at what is commonly known these days as the water-energy nexus. Broadly speaking, the term refers to the ways in which water and energy resources are interdependent. Meanwhile, as world population burgeons, demand for resources continues to rise. Agricultural production will need to increase by about 70 per cent by 2050, and primary energy by 50 per cent by 2035, barring significant changes to the

way food and energy are produced and consumed on the planet, according to a data by the UN Food and Agriculture Organization.

An Unsustainable Trend In Use Of Ground Water To Irrigate Crops:-

In China, the use of groundwater to irrigate crops has grown more than tenfold since 1950, According to research released by the University of East Anglia in England. The researchers estimated that pumping systems—operating from an average depth of 230 feet (70 meters) in some areas—emitted more than 30 million tons of carbon dioxide a year, roughly equivalent to the amount emitted in all of New Zealand every year. The researchers blamed the massive expansion of groundwater pumping on cheap energy and improved access to pumping technology. In India, the largest groundwater user in the world, agricultural electricity consumption increased more than 25-fold between 1970 and 2009, more than twice the pace of overall electricity consumption, according to government figures.

New research by the International Water Management Institute characterizes nine states in India, including Gujarat, as having "critical" groundwater condition, where pumping exceeds the long-term recharge of the aquifers. "Agriculture, groundwater and electricity sectors in much of India are now bound in an individual nexus of mutual dependence where the growth of one sector (agriculture) is being supported by unsustainable trends in the other two sectors (groundwater and electricity), so much so that even growth in agriculture is now threatened. The phenomenon is driven by the use of millions of electric pumps that run on cheap power. Farm power subsidies in India are estimated at $9 billion annually, up from $6 billion a decade ago. In Gujarat, tariffs have been raised over the years, but farmers still pay only about 20 per cent of the true cost of electricity, according to Modi of the Columbia Water Center.

Jon Strand, Senior Economist for the World Bank's environment and energy team, said in a policy research working paper that the optimal scheme to combat aquifer depletion would be tariffs that cover the full cost of electricity, with an extra charge to cover the "external cost" of groundwater pumping. That refers to the additional electricity costs to bring groundwater to the surface as water tables fall because of over-pumping. "When a groundwater basin is exploited by a large number of farmers, acting independently, each farmer has little incentive to practice conservation that would primarily benefit other farmers. India's government is in the process of revising its national water policy, and a draft recommends changing the "heavy under-pricing of electricity" to more closely reflect actual costs. But if farmers in north Gujarat paid for the full cost of their electricity, the agricultural sector wouldn't be economically viable, according to Columbia Water Center.

GLOBAL ENERGY CRISIS AND ITS EFFECT ON MITIGATION EFFORTS

An energy crisis is great bottleneck in the supply of energy resources to an economy. In popular literature though, it often refers to one of the energy sources used at a certain time and place, particularly those that supply national electricity grids or serve as fuel for vehicles. There has been an enormous increase in the global demand for energy in recent years as a result of industrial development and population growth. Supply of energy is, therefore, far less than the actual demand.

Emerging Oil Shortage

"Peak oil" is the period when the maximum rate of global petroleum extraction is reached, after which the rate of production enters terminal decline. It relates to a long term decline in the available supply of petroleum. This, combined with increasing demand, will significantly increase the worldwide prices of petroleum derived products. Most significant will be the availability and price of liquid fuel for transportation. The US Department of Energy in the Hirsch report indicates that "The problems associated with world oil production peaking will not be temporary, and past "energy crisis" experience will provide relatively little guidance."

Mitigation Efforts

To avoid the serious social and economic implications a global decline in oil production could entail, the 2005 Hirsch report emphasized the need to find alternatives, at least ten to twenty years before the peak, and to phase out the use of petroleum over that time. This was similar to a plan proposed for Sweden. Such mitigation could include energy conservation, fuel substitution, and the use of unconventional oil. Because mitigation can reduce the use of traditional petroleum sources, it can also affect the timing of peak oil and the shape of the Hubbert curve. Energy policy may be reformed leading to greater energy intensity, for example in Iran with the 2007 Gas Rationing Plan in Iran, Canada and the National Energy Program and in the USA with the Energy and Security Act of 2007. Another mitigation measure is the setup of a cache of secure fuel reserves like the United States Strategic Petroleum Reserve, in case of national emergency. Chinese energy policy includes specific targets within their 5 year plans.

Andrew McKillop has been a proponent of a contract and converge model or capping scheme, to mitigate both emissions of greenhouse gases and a peak oil crisis. The imposition of a carbon tax would have mitigating effects on an oil crisis. The Oil Depletion Protocol has been developed by Richard Heinberg to implement a power down during a peak oil crisis. While many sustainable development and energy policy organizations have advocated reforms to energy development from the 1970s, some cater to a specific crisis in energy supply including Energy-Quest and the International Association for Energy Economics. The Oil Depletion Analysis Centre and the Association for the Study of Peak Oil and Gas examine the timing and likely effects of peak oil.

Ecologist William Rees believes that "To avoid a serious energy crisis in coming decades, citizens in the industrial countries should actually be urging their governments to come to international agreement on a persistent, orderly, predictable, and steepening series of oil and natural gas price hikes over the next two decades". Due to a lack of political viability on the issue, government mandated fuel prices hikes are unlikely and the unresolved dilemma of fossil fuel dependence is becoming a wicked problem. A global soft energy path seems improbable, due to the rebound effect. The world is heading towards an unprecedented large and potentially devastating global energy crisis due to a decline in the availability of cheap oil lead to calls for a decreasing dependency on fossil fuel.

Social and Economic Effects

The macroeconomic implications of a supply shock-induced energy crisis are large, because energy is the resource used to exploit all other resources. When energy markets fail, an energy

shortage develops. Electricity consumers may experience intentionally engineered rolling blackouts during periods of insufficient supply or unexpected power outages, regardless of the cause. Industrialized nations are dependent on oil, and efforts to restrict the supply of oil would have an adverse effect on the economies of oil producers. For the consumer, the price of natural gas, gasoline (petrol) and diesel for cars and other vehicles rises. An early response from stakeholders is the call for reports, investigations and commissions into the price of fuels. There are also movements towards the development of more sustainable urban infrastructure. In 2006, survey respondents in the United States were willing to pay more for a plug-in hybrid car. In the market, new technology and energy efficiency measures become desirable for consumers seeking to decrease transport costs.

Crisis Management

An electricity shortage is felt most by those who depend on electricity for heating, cooking, and water supply. In these circumstances, a sustained energy crisis may become a humanitarian crisis. If an energy shortage is prolonged a crisis management phase is enforced by authorities. Energy audits may be conducted to monitor usage. Various restrictions with the intention of increasing energy conservation may be initiated to reduce consumption. To conserve power during the Central Asia energy crisis, authorities in Tajikistan ordered bars and cafes to operate by candlelight. In the worst kind of energy crisis energy rationing and fuel rationing may be incurred. Panic buying may beset outlets as awareness of shortages spread. Facilities close down to save on heating oil; and factories cut production and lay off workers. The risk of stagflation increases.

GLOBAL ENERGY SECURITY AND INDIA

In modern history, due to various reasons, the economic power of any state defines her strength and sovereignty. All the world powers are too sensitive about their energy security. All major global players have been vying for control over energy resources since decades now. It has played a major role in economic and military development as well. Economic collapse was a major reason for the Russian demise as she had no access to major energy corridors. Recently, the US has indulged into a prolonged and costly war to secure the energy resources along with capturing all the corridors for the transportation of these resources. Energy department is the integral part of the US strategic planning institutes.

As geo strategic developments in this part of the world are completely unpredictable so every regional player is busy in planning to exploit the domestic energy potential to its maximum. Exporting the foreign oil and gas is also among the major trends to keep the economic growth momentum. India and China are major regional competitors in energy security and, both are leading the regional progress and development race as well. Only reason that they are sustaining it is the consistent investment in energy infrastructure along with robust long term energy policies. China has been sustaining a 10per cent growth rate since last three decade which has turned it into world's third largest economy after the US and Japan.

China

China is second most strategically active player in energy arena. To secure her energy corridors

through Indian Ocean, China is pursuing a long term strategy of building naval ports and bases in the region on friendly countries' coastal lines. Chinese energy needs would increase with the time as its industrial complex is still expanding. Energy is the basic requirement for this giant manufacturing house of Asia that inhabits one billion people as well.

India

India is among growing economies of the world and third most active player in this game as well. Indian long term economic policy is extremely aggressive both on regional and global axis. Derived by a fanatical idea of becoming one of the major global power players, she is competing with regional developing countries and the established economies in the region at the same time. India has to provide energy to her entire populace along with keep its industrial growth on track. So, she cannot afford to meet these massive demands through imported energy. Feeding one billion people is another issue for India and being an agro-based country, the water requirements are also on the rise with increase in population.

GOVERNMENT INITIATIVES FOR ENERGY SECURITY

The government of India has been pursuing other avenues also in order to achieve energy security. Government has entered into the agreements with countries like Qatar for the supply of petro net has been established for the purpose of import, storage and then marketing of LNG in India. Government is also actually looking into the feasibility or transnational gas pipelines such pipelines being proposed Iran-Pakistan-India pipeline and Myanmar –Bangladesh India pipeline. It proposes to farm a grid of pipelines and also to rope in China so as to make such venture more secure and financially viable.

ONGC Videsh Limited is actively investing in overseas petroleum fields by acquiring stakes, farming partnerships with different multinational consortiums to secure hydrocarbons for the country. India has been given a membership to group of countries involved research in international thermo nuclear experimental reactor. This research is aimed at finding means to harness thermo-nuclear energy for peaceful purposes i.e. for the production of electricity. ITER is projected as means that can provide unlimited energy using the principle of nuclear fusion

Whole India is actively trying to achieve energy security at various international levels. It is imperative that already energy infrastructure should be upgraded and made efficient. National grid system should be able to provide electricity generated out of hydel potential in Himalayas to plains of India. And wind powered electricity from costal areas to interiors. In other words, country should be capable of transporting energy access regions to energy deficit regions of the country.

There should be grater emphasis on renewable sources of energy. Government should provide funds for research and development of commercially viable methods of harnessing renewable sources of energy. India being a tropical country offers a great potential of solar energy and total energy. Government should subsidies solar equipments as it has do for solar cooker. National policy on electricity now provides that private units can have their own captive power plants and can even sell the surplus electricity to interested buyers. Government needs to provide tax

incentives such as rebate in various taxes in order to achieve active private sector participation in energy generation.

HIGH LEVEL PANEL ON THE WATER, FOOD AND ENERGY NEXUS

The High Level Panel is a continuation of the dialogue initiated at the Bonn2011 Conference on the Water, Energy and Food Security Nexus and also reflects the recent recommendations of the UN Secretary General's High Level Panel on Global Sustainability to work across fragmented 'silos' and strive for development within planetary boundaries. The Water, Food and Energy Nexus (WFE) Panel brings together people with the highest level of experience across the three sectors in government, the private sector, international organizations and non-governmental organizations. It offers stimulating discussion and interaction with the audience on success stories of joined-up thinking that leads to broader benefits and of the enabling environment necessary to replicate this experience in other areas.

Expected Outcomes

The High Level Panel will demonstrate the imperative of taking a more coherent and synergistic approach to addressing water, food and energy security as set out in the Bonn2011 Conference. The case will be made through the lenses and experiences of Panel Members showing that new approaches can bring desired development results. It is not always going to be straightforward and the discussion will illustrate how barriers have been overcome. The Panel will be one further step in taking forward solutions to Rio+20 and beyond. The Output of the Panel will add to and support the Nexus case made by Bonn2011 and the High Level Panel on Global Sustainability. As the post-Rio discussions on sustainability development goals moves forward, momentum is expected to focus increasingly on Nexus considerations.

CONCLUSION:

While the nexus principles outlined above are universal, solutions need to be context-specific, and SDGs need to be interpreted to suit the local situation. Developing, transitional, and industrialized countries each require different nexus approaches, including addressing large differences between and within countries in terms of consumption patterns and resource use intensity, leading to new solutions.

For low income countries, the highest priority is to simultaneously close the large water, energy, and food security gaps, which are related to low resource productivity, in particular, to yield gaps in agriculture. These gaps often increase by natural resource degradation, in combination with rapid population growth and weak institutions. Hence, integrated knowledge and technologies are key for sustainable intensification. Green growth in developing countries will continue to depend largely on agriculture. For example, a nexus approach to water, land, ecosystems and energy in the Naivasha basin in Kenya has led to new solutions, including payments for ecosystem services which provide economic incentives for improved resource management.

Emerging powers, with their rapidly growing economies, a doubling of gross domestic product (GDP) over a 10 to 15 year period, and rapidly growing population and per capita demands, have to embark on more resource efficient development trajectories. The trend in China, India, the Middle East, and North African countries to increasingly solve their resource constraints through

better endowed regions, in particular South America and sub-Saharan Africa, must not slow down local nexus solutions within those countries. For example, in Gujarat, India, which is severely constrained in per capita availability of water and land, the so-called Jyotirgam scheme for improved energy access for households and irrigation (water pumping) has significantly reduced groundwater over-exploitation. Through an integrated approach, this scheme has increased energy and food security and has raised Gujarat's GDP growth above that of the rest of India.

Industrialized countries with their high per-capita resource demands and large external resource footprints (also externalizing resource degradation) will have to reduce consumption levels and wastage. They will also need to mainstream nexus approaches into economic and development cooperation, share innovative technologies, for example on modern renewable energies, and link nexus-conscious institutions with other countries. For instance, Australia's Carbon Credits Act, which provides incentives for afforestation to sequester carbon, and its National Water Initiative, which restricts water intensive afforestation, can be integrated through landscape zoning according to water availability.

The private and public sectors and civil society have different but complementary responsibilities when implementing nexus principles. The public sector coordinates, sets the regulatory and incentive framework, and spends public funds. It also needs to make policy more coherent across institutions and sectors—policy on agriculture, environment, land use, energy, and climate—while maintaining strong sectoral capacity. Meanwhile, the private sector should drive innovation for more efficient resource use and for sustainably increasing resource supply. If, for example, wind energy can be used to desalinate seawater or brackish water, some drylands may become highly productive in irrigated food production, and/or become carbon sinks. Supply chains, which are largely in the hands of the private sector, need to be managed as "supply nets", in which cross-resource optimization takes place, from production to consumption. Such a supply-net approach, which is facilitated by the generation of more comprehensive nexus knowledge and also appropriate pricing of inputs, can further reduce total resource use through smart sourcing of inputs according to the availability and productivity of resources.

Green agriculture, agro-forestry, and other multi-functional production systems apply a nexus approach for sustainable intensification by reducing external inputs, reusing waste products, and generating co-benefits. In doing so, biomass production can become a central element of a bio or green economy. The co-benefits of such an ecosystem approach can go even further when land is rehabilitated to simultaneously increase productivity and resilience. The importance of cross-sectoral links for increasing overall resource use efficiency applies at all levels, from local to national and even global. The scientific community is beginning to further refine and map planetary boundaries, and it is also looking at how they are interlinked. Recent work that addresses bilateral links includes the global mapping of:

(i)water availability and productivity constraints in food production, by LPJmL/WaterSim, which reveals that water productivity, expressed in kilo calories produced per cubic metre of water

consumption, varies between countries by an order of magnitude depending on crop mix, agricultural management, and climate.

(ii) combined water and land constraints in food and bio-energy production by the State of the World's Land and Water Resources for Food and Agriculture project of FAO, which shows that the most severe co-constraints are in parts of China and India; and

(iii) water constraints in power generation by World Resources Institute (WRI), which reveals, for example, that 17 per cent of global power plant design capacity is located in areas of high water stress.

By consistently integrating these existing assessments, we can develop global scenarios for a new nexus approach, which will complement and advance the work of previous outlooks, such as those of the United Nations Environment Programme, the Organisation for Economic Co-operation and Development, FAO, and the World Energy Outlook. This will enable us to map current and future hot spots of available resources and resource productivity across sectors. From such "nexus maps" we can identify the potential to reduce overall resource use by improving the configuration of production patterns and sourcing of inputs, including opportunities associated with trade and foreign direct investment. For example, electricity trade schemes can promote hydropower generation in locations with low water loss and/or high water availability, as in the Nile Basin Initiative, and foreign direct investment can provide knowledge and technologies for co-production of biofuel and food/feed for improved water and land productivity. Such a model-based, top-down approach to the nexus needs to be developed alongside a bottom-up approach, in order to build a knowledge base on best practice, policies, and solutions. Because these nexus solutions have to be driven by individual institutions, additional incentives and mechanisms need to be established to bridge institutional and sectoral silos. This will reduce negative externalities of short-term sectoral optimization and instead build long-term systemic resilience, reduce total demand for resources, and decouple development from resource use. Only then we can meet the challenges of the "great acceleration" and achieve a transition to sustainability that delivers for the poor.

The discussion on food and water security at Rio+20 focused on setting Sustainable Development Goals to replace the Millennium Development Goals, which are set to expire in 2015. While some progress was made in articulating them, per usual with these meetings, it's unclear whether these discussions will lead to meaningful change on the ground.

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PERFORMANCE OF LASER LAND LEVELING TECHNOLOGY FOR IMPROVING WATER PRODUCTIVITY IN PADDY CULTIVATION: A CASE STUDY OF PUNJAB AGRICULTURE

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ABSTRACT

Climate change poses uncertainties to the supply and management of water resources. While climate change affects surface water resources directly through changes in the major long-term climate variables such as air temperature, precipitation, and evapotranspiration, the relationship between the changing climate variables and groundwater is more complicated and poorly understood. In Punjab, almost 97 per cent of the cultivated area is under assured irrigation with nearly 80 per cent of the water resources being used for agricultural production. The availability of water from rainfall is highly uneven and is variable in both space and time. There has been a significant reduction in annual rainfall in the state by nearly 35 per cent from 1980 to 2008.Coupled with declining rainfall the substantial jump in the proportion of area under paddy from 5.57 per cent of cultivated area in 1960s to 64.9 per cent during 2008-09 and that of wheat crop from 34.4 per cent to 83.77 per cent over the same period have led to a situation of monoculture of rice-wheat in the state. Thus, the dominance of paddy wheat crop rotation has led to overexploitation of ground water resulting in rapid decline of water table in the entire state. In lieu of this, on farm resource conservation technologies in states like Punjab have an edge over other technologies. Land leveling through laser leveler is one such proven technology that is highly useful in conservation of irrigation water and enhancing productivity. The present study revealed that the average paddy yield for adopters of laser land leveling technology was 71.44 quintals per ha as compared to 66.59 quintals per ha for non-adopters. Gross returns worked out to be Rs. 73734.85 per ha for laser leveled fields and Rs. 68729.14 per ha for non-adopters fields. The water use of laser leveled farms was 6327 cu.m per ha whereas for conventional fields it came out to be 8702.5 cu.mper ha, thereby resulting into the irrigation water saving of 27 per cent. Thus, almost one-fourth of the irrigation water is saved due to the adoption laser land leveling technology. The per hectare water productivity on laser-leveled fields was 1.12 kg/m^3 as compared to 0.76 kg/m^3 on conventional fields, which clearly shows the 31 per cent incremental water productivity with the use of laser land leveling technology. In sum, laser land leveling has a great potential for optimizing the water-use efficiency in paddy cultivation without any disturbing and harmful effect on its productivity. Popularization of this technology among farmers in a participatory mode on a comprehensive scale, therefore, needs a focused attention.

KEY WORDS: *Water productivity, laser land leveling, resource conservation technology, paddy, Punjab*

The state of Punjab, in common parlance known as '*Food Bowl'* of the country, is the largest surplus state in terms of food grains. It has a total geographical area of 50.36 lakh hectares out

of which almost 83 per cent is under cultivation with cropping intensity of 189 per cent. The agriculture in the state is highly intensive in terms of use of land, capital, energy, and all other agricultural inputs, including irrigation water (Jeevandas*et al*, 2008). Punjab state with only 1.5 per cent geographical area and 3 per cent of agricultural area, contributes 43.8 per cent of wheat and 25.4 per cent of rice to the central pool of the country (Government of Punjab, 2009). Punjab being major contributor to the 'National food security' system of India is rightly known as food bowl of the country.The policy interventions of the state to shift more area to rice-wheat from traditional cultivation has led to increase in the total water requirement from 4.377 million hectare meter (m ha m) in 1994-95 to 6.15 m ha m in 2005 in the state accounting for more than 80 per cent of water use for rice growing season (Sondhi and Kheper, 1995; WRD, Punjab, 2005).

There has been a rapid increase in the area under paddy crop, a water- intensive crop, replacing relatively less water-intensive crops like oilseeds and pulses in the production pattern. The area under paddy crop increased from 227 thousand ha in 1960-61 to 2015 thousand ha in 1990-91 and further to 2642 thousand ha in 2005-06. Similarly, area under wheat crop increased from 1400 thousand ha in 1960-61 to 3468 thousand ha in 2005-06 (Government of Punjab, 2009). Thus, area under rice-wheat cultivation has increased 3.6-times during the past four decades due to government support through stable prices, massive procurement programme and other institutional and infrastructural backup, even though rice has not been a staple crop of the state. The dominance of paddy-wheat crop rotation has converted the Punjab state from a water-surplus to a water-scarce state. At present, gross water requirementsfor the state are estimated at 6.15 M ha-m, against the current availability of only 3.66 M ha-m, comprising 1.52 M ha-m of surface water and 2.14 M ha-m of groundwater resources. It indicates a deficit of about 2.49 M ha-m of water — a case of severe water imbalance in the state (Kaur *et al*, 2010; WRD, Punjab, 2005).

So, there is a need for developing efficient techniques to conserve underground water by increasing irrigation efficiency (Singh et al, 2009). Future food production in the state severely threatened by unsustainable underground water and inappropriate water management practices. In lieu of this, on-farm resource conservation technologies in the state like Punjab have an edge over other technologies. Laser-assisted precision land leveling system is also likely to increase the cultivable area in the range of 3-6 per cent (due to reduction in bunds and channels in the field). Furthermore, on laser-leveled fields, the performance of different crop establishment options such as of zero tillage, raised bed planting and surface seeding are known to improve significantly (Jat et al, 2006). Keeping this in view, this study was undertaken with the objective to access the impact of laser land leveling on the productivity of paddy crop by comparing it with the conventional practice and to find out the extent of water saving as a result of laser or precision land leveling.

METHODOLOGY

The study was conducted in Tarn Taran district of Punjab. A random sample of 10 farmers adopting the laser land leveling technology was taken from each of the two villages of Tarn

Taran district *viz.* Dhotian and Naushera Pannua. In order to undertake impact assessment task of this technology, almost an equal number of non-adopters from the same vicinity were taken as a control group in the analysis. Therefore, a total sample of 40 farmers (20 adopters plus 20 non-adopters) was finally chosen for the analysis.

Water productivity was calculated to describe the effect of laser land leveler on the productivity and water-use for paddy cultivation. Water productivity is the physical accounting of water with yield or economic output to assess how much value is being obtained from the use of water (Abdullaev*et al*, 2007).For this analysis, physical water productivity wascalculated by Equation (1):

$$WP = Output/Q \qquad \ldots(1)$$

where, WP is the productivity of water in kg/m^3, Output is the production of crop in kilograms and Q is water used by the crop (m^3).Total amount of water used in paddy crop wascalculated by multiplying the water discharge per hour (in litres) from the tube-well bore with total time taken (in hours) for irrigating the cropthroughout the season.

RESULTS AND DISCUSSION

SOCIO-ECONOMIC CHARACTERISTICS

Socio-economic profile of the farmers showed that more than half of the adopters were young i.e. age-group of less than 40 years, while identical per centage of non-adopters i.e. 70 per cent were old age farmers (Table 1). About 60 per cent of adopters had passed secondary level education, while, 80 per cent of non-adopters had passed up to matric level. About 75 per cent of adopters had family experience of less than or equal to 20 years, which clearly indicated that the adoption of this technology was made by young, educated and progressive farmers.

Table 1: Socio-Economic Characters of Sample Farmers, Punjab, 2011-12

Indicators	**Adopters**	**Non-adopters**
Age (years)		
up to 40	13*(65)*	6*(30)*
40 – 50	4*(20)*	11*(55)*
Above 50	3*(15)*	3*(15)*
Education		
Up to Matric	8*(40)*	16*(80)*
Secondary	10*(50)*	4*(20)*
Post-Secondary	2*(10)*	-*(0)*
Experience in farming (years)		
Up to 10	7*(35)*	4*(20)*
10 – 20	8*(40)*	6*(30)*
Above 20	5*(25)*	10*(50)*

ECONOMIC HOLDING AND OCCUPATION

The perusal of Table 2 revealed that the average operational land holding size of technology adopters was 3.55 ha, whereas, it was 4.14 ha in the case of non-adopters. About 15.9 per cent of

land was leased-in and 4.6 per cent was leased-out by the adopters of the technology. Occupation of the sample farmers clearly indicated that more than half of the sample farmers were engaged in farming only.

Table 2: Economic Holding and Occupation of the Sample Farmers, Punjab, 2011-12

Particular	Adopters	Non-adopters
Economic holding		
Area owned	3.15*(88.6)*	3.25*(78.5)*
Leased-in	0.57*(15.9)*	0.89*(21.5)*
Leased-out	0.16*(4.6)*	-
Total operational area	3.55*(100)*	4.14*(100)*
Occupation		
Agriculture	12 *(60)*	14 *(70)*
Agriculture + Dairy	4 *(20)*	2 *(10)*
Agriculture + allied activities	4 *(20)*	4 *(20)*

Allied activities include poultry, bee keeping, taxi or truck driving, custom hiring etc.

CROPPING PATTERN

Paddy crop dominated the cropping pattern in kharif season with 79.9 per cent and 68.9 per cent of kharif cropped area in the case of adopters and non-adopters respectively. Basmati stood the second major crop of kharif season with the 12.5 per cent and 22 per cent area under this crop for adopters and non-adopters, respectively (Table 3).

Table 3: Cropping Pattern of the sample farmers, Punjab, 2011-12

Crop	Adopters	Non-adopters
	Average area (ha)	**Average area (ha)**
Kharif		
Paddy	2.84 *(79.9)*	2.85 *(68.9)*
Basmati	0.45 *(12.5)*	0.91 *(22)*
Fodder	0.26 *(7.3)*	0.33 *(8.1)*
Vegetables	0.01 *(0.3)*	0.04*(0.9)*
Total *kharif* cropped area	3.55 *(100)*	4.14 *(100)*
Rabi		
Wheat	3.18 *(89.6)*	3.43 *(82.9)*
Fodder	0.26 *(7.3)*	0.33*(8.1)*
Maize	0.07 *(1.9)*	0.20*(4.8)*
Potato	0.03 *(0.9)*	0.10 *(2.4)*
Other vegetables	0.01*(0.3)*	0.07 *(1.7)*
Total *rabi* cropped area	3.55 *(100)*	4.14 *(100)*

Wheat crop dominated for the major crop in *Rabi* season with 89.6 per cent (adopters) and 82.9 per cent (non-adopters) of rabi cropped area. Fodder accounted for a mere 7-8 per cent area in both the seasons for adopters and non-adopters, whereas, potato accounted for 1-3 per cent area in Rabi season. So, paddy-wheat emerged as the major cropping pattern on the sample farms.

GROUND WATER STATUS

The average underground water depth in the Punjab was 9.3 m in the year 2001-02, 17.6 m in 2006-07 and presently it was estimated to be 25.6 m (Table 4). In 2001-02, about 93 per cent of the sample farmers had groundwater depth of less than 12 m, whereas in 2011-12, about 55 per cent of the sample farmers reported that their average water table had fallen more than 24 m, almost two times decline within a decade. Such a drastic change in groundwater level from 9.3 m in 2001-02 to 25.6 m in 2011-12 was due to 90 per cent of cropped area under paddy and basmati.

Table 4: Status of Groundwater Level of Sample Farmers, Punjab, 2011-12

Water level (m)	**2001-02**	**2006-07**	**2011-12**
Below 8	9 *(22.5)*	*-(0)*	*-(0)*
8 – 12	28 *(70)*	4 *(10)*	*-(0)*
12 – 16	3 *(7.5)*	15 *(37.5)*	*-(0)*
16 – 20	*-(0)*	7 *(17.5)*	6 *(15)*
20 – 24	*-(0)*	14 *(35)*	12 *(30)*
More than 24	*-(0)*	*-(0)*	22 *(55)*
Average Depth (meters)	**9.3**	**17.6**	**25.6**

Figures in the parentheses indicate per centages to the total

LABOUR-USE PATTERN

Human labour, a vital input to conduct various on-farm and off-farm activities is generally provided by family members, permanent labour and casual labour. An attempt has been made to examine the human labour employment pattern in the cultivation of paddy on adopter and non-adopter farms through tabular analysis.

It was observed from the table 5 that on adopter farms the total human labour used was 229.84 hours per hectare which was less as compared to non-adopter farms i.e. 260.81 hours per hectare. The family labour being an important component of total human labour came out to be 83.13 hours per hectare on laser leveled fields and 92.92 hours per hectare on conventional fields. The hired labour use accounted for the major use in the human labour employment pattern in the cultivation of paddy as most of the operations especially transplanting of paddy involves a lot of causal labour use. The per hectare labour use on transplanting of paddy was 130.58 hours on laser leveled fields as compared to 145.55 hours on non-laser leveled fields; thereby indicating a saving of 10.3 per cent. A use of electric motor/submersible pump hours for irrigating the crop

was much less as on adopter farms compared to non-adopter farms. A significant saving of 27.1 per cent was achieved for irrigating one hectare of the laser leveled farm as compared to non-laser leveled one.

Table 5: Labour-Use Pattern in Paddy Cultivation of Sample Farmers, Punjab, 2011-12

(Hours/hectare)

Particulars	***Family Labour***		***Hired Labour***		***Total Labour***		***Change in total labour (Adopters over Non-adopters)***
	Adopter	***Non-adopter***	***Adopter***	***Non-adopter***	***Adopter***	***Non-adopter***	
Laser leveler	*4.11*	*-*	*3.61*	*-*	*7.72*	*-*	*7.72*
Preparatory tillage	*10.37*	*10.30*	*0.24*	*0.27*	*10.61*	*10.57*	*0.04(0.4)*
Transplanting	*8.08*	*5.26*	*120.50*	*140.29*	*130.58*	*145.55*	*-14.97(10.3)*
Irrigation	*34.25*	*46.94*	*-*	*-*	*34.25*	*46.94*	*-12.69(27.1)*
Manures and Fertilizers	*9.36*	*9.66*	*1.88*	*1.05*	*11.24*	*10.71*	*0.53(4.9)*
Interculture/ Weeding	*4.16*	*8.56*	*5.41*	*10.02*	*9.58*	*18.59*	*-9.01(48.4)*
Plant Protection	*5.88*	*6.22*	*10.68*	*12.15*	*16.56*	*18.37*	*-1.81(9.9)*
Harvesting	*2.56*	*2.17*	*3.77*	*3.65*	*6.34*	*5.82*	*0.52(8.9)*
Transportation and Marketing	*4.36*	*3.81*	*0.62*	*0.46*	*4.98*	*4.27*	*0.71(16.6)*
Total	*83.13*	*92.92*	*146.71*	*167.89*	*229.84*	*260.81*	*-30.97(11.8)*

Figures in parentheses indicates the per cent change in total labour for adopters over non-adopters

About 48.4 per cent of labour hours used for weeding/interculture were reduced in case of adopters (9.58 hours per hectare) in comparison to non-adopters (18.59 hours per hectare). This was mainly due to the less occurrences of weeds on leveled fields as the soil becomes compact and the moisture content is uniform throughout. The human labour used in transplanting and marketing of paddy crop was higher on adopter farms as compared to non-adopter farms. The gain in productivity of 7.6 per cent on adopter farms as compared to non-adopter farms led to the increased labour use in harvesting and marketing of paddy crop. Among other operations like preparatory tillage, manure/fertilizer application, plant protection application etc. the difference between the adopter and non-adopter was more or less the same.

MACHINE-USE PATTERN

It was observed from the table 6 that on laser leveled farms the total machine-use was 175.40 hours per hectare which was less as compared to non-laser leveled farms i.e. 216.13 hours per hectare. Tractor-use accounted for the major use among the machine use pattern. All the sample farmer had their own tractor. Thus the owned machine-use hours per hectare were comparatively higher than the hired machine-use. Among the owned machine-use hours, the largest proportion accounted for irrigating the paddy crop i.e. 156.07 hours per hectare on laser leveled fields as compared to 203.33 hours per hectare on non-laser leveled fields. There was almost 23.2 per cent reduction in the electric motor on laser leveled farms.

Table 6: Machine-use pattern in paddy cultivation of sample farmers, Punjab, 2011-12

(Hours/hectare)

Particulars	Owned		Hired		Total		Change in total machine use (Adopters over Non-adopters)
	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	
Laser leveler	2.09	-	3.61	-	5.70	-	5.70
Preparatory tillage	8.05	7.98	0.24	0.43	8.29	8.42	-0.13 *(1.5)*
Irrigation	156.07	203.33	-	-	156.07	203.33	-47.26 *(23.2)*
Harvesting	1.12	1.05	1.44	1.24	2.56	2.29	0.27 *(11.7)*
Transportation and Marketing	2.78	1.96	-	0.14	2.78	2.10	0.68 *(32.3)*
Total	170.11	214.32	5.29	1.81	175.40	216.13	-40.73 *(18.8)*

Figures in parentheses indicates the per cent change in total machine-use for adopters over non-adopters

Due to the unevenness of the land surface, the tractor used for the operation of preparatory tillage was relatively more in non-adopter farms i.e. 8.42 hours per hectare as compared to adopter farms i.e. 8.29 hours per hectare respectively. The harvesting of paddy was done by hiring combine harvesters on per hectare hiring basis which accounted for the major share of hired machine-use. Rest of the field operations were performed by the use of owned tractors. The harvesting, transportation and marketing process consumes relatively higher amount of time in case of adopter farm because of the higher crop production due to the adoption of laser land leveling technology.

ECONOMICS OF PADDY CULTIVATION

The gross margins of paddy cultivation showed that the farmers who adopted the technology received Rs. 3850.1 per ha incremental gross margins over the traditional practice (Table 6).However, the per hectare returns over variable cost was estimated Rs. 53269.5 and Rs. 49419.3 on laser-leveledand conventional field, respectively.

Table 7: Economics of Paddy Cultivation under Laser Land Leveler and Conventional Method of Cultivation on the Sample Respondent Holdings, Punjab, 2011-12

Particulars	Laser leveled fields	Conventional fields	Change in value (laser leveled over conventional fields)
Laser Leveling Cost	1891.9	-	945.9
Seedling	1270.3	1292.8	-22.5*(1.7)*
Transplanting Cost	4266.9	4221.2	45.7*(1.1)*
Cost of preparatory tillage	2036.4	1662.9	373.5*(22.4)*
Plant Protection Chemicals	2146.3	2332.8	-186.5*(7.9)*
Urea	1995.9	1993.7	2.2*(0.1)*
DAP	1413.3	1340.2	73.1*(5.4)*
MOP	116.8	212.8	-96*(45.1)*
Micronutrients	202.3	105.5	96.8*(91.7)*
Irrigation charges	33.6	633.2	-599.6*(94.6)*
Casual labour payment	1267.1	1665.3	-398.2*(23.9)*
Harvesting cost	2189.1	2175.4	13.7*(0.6)*
Transportation Cost	407.3	333.1	74.2*(22.2)*
Marketing Cost	530.6	493.1	37.5*(7.6)*
Total Variable Cost	19768.5	18462.6	359.9*(1.9)*
Gross Returns	73038.1	67882.1	5156.1 *(7.6)*
Return Over Variable Cost	53269.5	49419.3	3850.1*(7.8)*

Thetotal cost incurred on the cultivation of paddy on laser-leveled field (Rs. 19768.5 per ha) was higher than on theconventional field (Rs. 18462.6 per ha); this was mainly duethe higher expenditure incurred for leveling the field with laser leveler as compared to non-laserleveled field.About 94.6 per cent decline in irrigation costs was alsoobserved on the laser leveled farms. The results indicatedthat the expenditureincurred on irrigation was only Rs. 33.6 per ha on laser-leveled fields, whereas it was Rs. 633.2 per ha onconventional fields. In a nutshell, laser leveling technology increased productivity, reduced irrigationand weeding costs and hence increased the returns tothe farmers from paddy

BENEFITS OF LASER LAND LEVELING

The mean paddy yield on laser leveled fields was 70.7 quintals per ha as compared to 65.8 quintals per ha on conventional fields (Table 8). Thus, leveling of land with a laser leveler resulted in 7.6 per cent increase in paddy yield over the conventional practice. The increase in yield was due to improved weed control, improved water coverage due to better land leveling which reduced labour-use in weeding by 48.4 per cent (Table 5). The per hectare water-use of

paddy came out to be 6977 m^3 for adopters of the technology against 8953 m^3 for non-adopters; resulting in 22 per cent saving of irrigation water. This water saving is of utmost importance as the groundwater situation of the state is under grim.

Table 8: Benefits of Laser Leveling in Paddy Cultivation of Sample Farmers, Punjab, 2011-12

Particulars	Adopters	Non-adopters	Per cent change (Adopter over non-adopter)
Productivity (kg/ha)	70.7	65.8	4.9 (7.6)
Weeding/Interculture (hrs/ha)	9.6	18.6	-9.01 (48.4)
Irrigation (m^3/ha)	6976.9	8952.6	-1975.6 (22.1)

Figures in the parentheses indicate per centage change for adopters over non-adopters

WATER PRODUCTIVITY

The water productivity of paddy crop increased by 38 per cent and labour input for irrigation reduced by 27 per cent on laser leveled fields as compared to conventional fields. Thus, laser land leveling proved to be an efficient technique for enhancing water-use efficiency of paddy crop (Table 9).

Table 9: Water Productivity of Paddy Crop of Sample Farmers in Punjab, 2011-12

Particulars	Water Productivity (kg/m^3)
Laser leveled fields	1.01
Conventional fields	0.73
Difference	0.28 (38.3)

Figure in the parentheses indicate per centage change for adopters over non-adopters

CONCLUSIONS

Precision land leveling with laser leveler is a recent resource conservation technology and has been proven to save water to the extent of 22 per cent, and increase in paddy yield by 7.6 per cent over the conventional method. The incremental per hectare increase in gross margins of the technology adopters has been to the tune of Rs. 3850.. The water productivity on laser-leveled fields has been found to be higher by about 38 per cent over the conventional field. Evenly distributed irrigation water on laser-leveled field could reduce the emergence of weeds in the paddy field which has further reduced the weeding time by about 48 per cent over the conventional fields. Hence, this technology has a great potential for optimizing the water-use efficiency in paddy cultivation without any disturbing and harmful effect on the productivity of paddy crop

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SUSTAINABLE AGRICULTURAL PRODUCTION AND LAND CLASSIFICATION UNDER CANAL IRRIGATION SYSTEMS

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ABSTRACT

The sustainable use of natural resources is the pre-requisite condition for enhancing the agricultural production and productivity. The sustainability is based on the technologies involved and management which conserves the natural resources and promote the agro- eco relationship by minimizing the adverse environmental impact. Eswarn (1992) defined the concept of sustainable management of natural resources as a system of technologies that aims to integrated ecological and socio - economic principles in management of land for agriculture and others uses to achieve inter - generations equity. It means that technologies involved and management for land use should conserve the natural resources and promote the agro – ecological relationship which have minimum adverse impacts on environmental. FAO (1989) has defined sustainable agriculture as one which successfully manage the natural resources for agricultural to satisfy changing needs of human while maintaining or enhancing the quality of environment and conserving the natural resources. Thus sustainable land use aims not only to increased the agricultural production but also maintain the resources for future use. Sustainable agriculture production thus meet the criteria as (i) adequate food of standard quality, (ii) friendly environment, (iii) maintain resource quality and (iv) profitable.

Water is one of the natural resource input for crop production to meet the growing demand for food and to generate employment opportunity as 60 to 70 per cent of Indians depend on agriculture. Irrigation is a key feature of India's agricultural strategy, but it has not been used potentially. A sizable investment has been made in creating assured irrigation facilities through major and medium irrigation projects with the target to increase food grain to a tune of 4-5 t/ha in long term without causing any adverse effects on environment. However, the present level of food grain production is only 1.7 t/ha. It is due to development of soil salinity and shallow water-table in arid and semi-arid regions, which has serious negative impact on agricultural environment in the areas covered under canal irrigation systems.

The production performance of a crop is directly guided by soil characteristics viz., soil depth, texture, slope, water-holding capacity, internal drainage, etc. Based on these criteria, land has been classified in eight categories called *'land capability classes'*. The first four land capability classes are considered suitable for crop production. The remaining four land capabilities classes are considered fit for pasture wood lots and wild-life use. The choice of crops and cropping patterns based on capabilities in order to produce higher returns per unit area with adequate

provision of conserving the natural resource (Van wambeke and Rossiter, 1987). Under the irrigated conditions these land capabilities are called *'land irrigability classes*'. Of late researchers and planners have laid much emphasis on *'Land Capability Classes'* as such to achieve sustainability in agricultural production (Alagh, 1990). Therefore, what is urgently called for is an appropriate land use policy so that optimal use of land resources based on land capability or sustainability is taken care of (Khosoo and Deekshatulu, 1992). In the present analysis, an attempt has been made to document the crop production under different land irrigability classes and its impact on natural resources like soil and water and other responsible factors in semi-arid region of *Gujarat* State, INDIA.

MANAGEMENT OF LAND AND WATER RESOURCES

There are two options available for increasing the agricultural production to meet the demand of growing population: Firstly to bring more area under cultivation and secondly to increase the production per unit area. There is little scope to bring more area under cultivation. Therefore, the scope is only confined to culturable waste and barren and uncultivated land which is degraded soils. There may be several ways maintained the use of land and water for sustainable use. The important way is only land use according to its capability

Land Use According To Land Capability:

As mentioned above choice of crop and cropping pattern depend upon its capability for sustaining these crops. Hence evaluation of this prime resource, based upon crop yield performance is of immense significance. Land evaluation is the ranking of soil units on the basis of their capabilities (under given circumstance including level of management and socio-economic conditions) to provide highest returns per unit area and conserving the natural resources for further use (Van Wambeke and Roster, 1987). The significant purpose of above categorisation is to assess the degree of limitation on land-use potential imposed by land characteristics on the basis of permanent properties. As the degree of limitation increases, the range of land-use options decreases. Land-use capability can be assessed separately for a number of land-uses viz.; agriculture, forestry, recreation, and water flow etc. Recently researchers and planners have laid much more emphasis on Land Capability Class as such to achieve sustainability in agricultural production (Alagh, 1990). Therefore, what is urgently called for is an appropriate land-use policy so that optimal use of land resources based on land capability or sustainability is taken care of (Khosoo and Deekshatulu, 1992).

Land Irrigability Class:

Sys and verheye (1974) state that the suitability of soils for irrigation in aid and semi-arid areas is mainly influenced by seven factors viz; Soil depth, calcium carbonate content, Gypsum status, extent of salinity and Alkalinity content, Texture , Soil drainage and Slope. The value of an overall index is obtained by multiplying various ratings. It is then possible to assign sites to one of the five classes ranging from very suitable to completely unsuitable. These classes are defined and can be summarized as follow:

Class I: Highly suitable for irrigation with negligible obstacles. Topography is flat; soils are well drained, have moderate permeability and are deep, medium textured, with good water holding capacity.
Class II: Suitable for irrigation with slight obstacles such as undulating topography, moderately well drained soils, moderate slow or moderately rapid permeability or moderate depth of soil.
Class III: Moderately suitable for irrigation with moderate obstacles such as easy rolling topography, imperfect or some what excessively drained soils, slow or rapid permeability or shallow soils.
Class IV: Marginally suitable for irrigation with severe obstacles, such as rolling topography, poorly or excessively drained soils, very slow or very rapid permeability or very shallow soils.
Class V: Unsuitable for normal irrigation with very severe obstacles in topography, drainage or soils. There drainage characteristics. Based on the payment capacity i.e. per hectare returns achievable, the above classes can be redefined as follow:
Class I: Highest level of irrigation suitability and highest payment capacity.
Class II: Intermediate irrigation suitability and payment capacity,.
Class III: Lowest suitability and payment capacity.

Concept of Water Logging and Salinity:

The suitability of soils for irrigation in and semi-arid regions is mainly influenced by the seven factors viz soil depth, calcium carbonate contents, gypsum status, texture, slope, *intern,)] drainage* and water holding capacity (Sys and Verheye, 1974). The status of soil internal drainage system is responsible for water logging. The water applied to the crops also percolates deep in profile of the soils. Due to imperfect and poor status of internal drainage of soils, the water accumulates in the soil profile. With passage of time water level reaches in the root zone of the crops. Sometime it may be on the surface. Such soils are prone to salinity and water logging (Sehgal et. al., 1989). Due to the brackish ground water, the salts come to the surface through capillary rise. Artificial drainage is poor (Benoit Lesalfre, 1992). Such soils are classified as land Irrigability class III, IV and V.

MATERIAL AND METHOD

Gujarat State is having two major irrigation projects, viz., Ukai-Kakrapar and Mahi Right Bank Canal Command Irrigation Project. The Ukai-Kakrapar irrigation project is having four main canals called Ukai Left, Ukai Right, Kakrapar Left and Kakrapar Right. Ukai right and Kakrapar right bank canal command areas are located between Narmada and Tapi rivers. Mahi Canal Command area in *Gujarat* is located in port of Kaheda and Panchmahal districts. Three canal command areas represented by Ukai-Kakrapar Right Bank (UKRB), Kakrapar Left (KL) and Mahi Right Bank (MRB) have been selected for investigation. The study is based on the data collected from 400, 180 and 500 farmers distributed over 40, 18 and 50 villages of UKRB, KL and MRB canal command areas, respectively during 1990-91 and 1991-92.

Land irrigability class	No. of villages selected		
	UKR	KL	MRB
I	1	-	15
II	9	3	9
III	21	10	9
IV	7	5	5
V	2	-	12
Total	40	18	50

A multistage stratified random sampling technique was used to select ultimate respondents (farmers). The selected villages were classified according to Land Irrigability classes, as shown below: UKRB was covered predominately by four crops viz., rice, sugarcane, cotton and pigeon pea, while KL was dominated only by rice and sugarcane. In case of MRB, six crops viz., rice, wheat, bajra, (summer as well as kharif), groundnut (summer) and tobacco equally dominated the scene. All these crops occupied more than 90 per cent of the total cultivated tract in the respective canal command areas. Simple tabular and production function approach were used for the present study.

RESULTS AND DISCUSSION

Existing and Suggested Cropping Pattern

The suggested cropping pattern in a canal command area is based on the classification of land in different categories. The existing cropping pattern reflected the choice of crops by the farmer. The recommended and existing cropping pattern in both command areas is shown in Table 1, which indicated high degree of divergence. More than 10 per cent area has been under high water requiring crops, which is much higher than the recommended cropping pattern. The sugarcane and rice dominated due to their ability to fetch high economic returns (Nilkantha and Mitra, 1986).

The different land classes had different cropping patterns based primarily on soil-water-crop relationship. As the land irrigability classes differ, the choice of crops also differs. The suggested and actual cropping patterns under different land irrigability classes are given in Table 2. Under the suggested cropping based on soil-water relationship, the choice of crops becomes limited as the land irrigability class sequence increased Infect, the choice of crop and cropping intensity have become limited. The land irrigability class V is at all not suitable for irrigation. The high water requirement crops like sugarcane and rice were grown in all the classes of land, which was basically violation of scientific norms i.e., choice of crop and cro intensity based on soil-water-crop relationship. The land irrigability classes III and IV are suitable only for seasonal crops, whose water requirement is relatively lesser. The internal drainage of land irrigability class III and IV is poor to very poor. The introduction of high water requirement crops under such land, will result in accumulation of water in sub-soil strata causing rise of water table. The artificial drainages is required where internal drainage is poor (Benoit Lesafre, 1992). By adopting recommended cropping pattern, land has to be kept fallow for one to two seasons. Such remedies measures are not being taken at al at any place in canal command area under

study. The land, which is not suitable for irrigation, has also been brought under irrigation. This has caused very adverse effect on plant-soil-water relationship.

Crops Productivity under Different Land Irrigability Classes and Soil Degradation Levels

The productivity in terms of output per ha of various crops under different canal commands showed decline in yields with increase in land irrigability class sequence (Table–3) simultaneously, land degradation also exhibited sharp increase with the increase in land irrigability class sequence. The maximum yield is obtained under normal soil condition of land irrigability class I and II which is very close to targeted yield of 4-5 t/ha Under National Demonstrations as fixed by National Commission on Agriculture (Rolsert 1992). The National Demonstration is predominately held on ideal soil condition (i.e. land irrigability class II and I). The minimum yield is obtained in severely degraded soils of land irrigability class V. The required yields under land irrigability class II is obtained only by better and efficient management practices. The occurrence of moderate and severe degradation under land irrigability class II is due to natural land heterogeneity. The land irrigability classes III and IV indicated reduction in yield level as well as increase in soil degradation level. The average yield of crops under land irrigability classes III and IV is half of the average crop yield obtained under land irrigability class I and II. This indicates that the inclusion of land irrigability classes III, IV and V reduce the crop yield drastically. It is due to adaptation of high water requirement crops along with high cropping intensity (300 per cent). The land irrigability classes III, IV and V are not suitable for high water requiring crops because high cropping intensity results into accumulation of water in sub-soil profile causing rise in water table and if the ground water is saline, it leads to secondary salinisation. If the existing canal irrigation is used only for land irrigability class I and II, the present level of crop production would have been much higher (nearer to double) without degradation of environment and sustainability of production could have also been maintained. The higher production at low cost could maintained food security. The area required for food security would be nearly half of the present level.

Unit Cost of Production

The sustainability and economic viability of agriculture in long-term depends upon the efficient utilization of natural resources like soil and water. The unit cost of production reflects how efficiently natural resources (soil and water) have been used. The unit cost of production at cost C level increased with increase in land irrigability class sequence coupled with increase in the degree of soil degradation level (Table 4). The cost of production under land irrigability class I to marginal level of land irrigability class II is far below as compared to unit cost under other land irrigability class IV to V. Therefore, crop production under land irrigability class I and II, where the unit cost of production is likely to be much lower, is the indicator of sustainability. The land irrigability classes IV and V are often subjected to economic and technical constraints for crop production (Donald, 1980). The land irrigability class III that is marginally economical had either soil-depth or internal drainage or both constraints, which adversely affected the production performance. Therefore, the inclusion of land irrigability classes III, IV and V have led to

increase in the unit cost of production, which is much higher than average cost of production. As mentioned earlier, if the canal irrigation potential could be limited to land irrigability classes I and II, the average unit cost of production is would have been much lower than the present level. The lower cost of production of these crops would definitely boost exports of sugar and rice in the world market. More over higher crop production coupled with low per unit production cost and eco-friendly environment, canal irrigation under land irrigability classes I and II will also prevent from the secondary Stalinization.

Measure of Profitability

The effects of soil degradation and land irrigability classes can further visualized from measurement of profitability. The net incomes were worked out and are presented in Table 5. Maximum net income generated by land irrigability class I and minimum by severely degraded soils of land irrigability class IV and V. The net incomes under moderately and severely degraded soils under land irrigability classes III, IV and V registered net losses in all most all crops. The reason for cultivation of such soils is that it generated some amount of farm business income (not shown in tables). In some cases, although even farm business with huge energy input in form of family labour, crops protecting chemical and also crops production increasing chemical. In some cases even small farm income also could not be generated, yet the farmers are found to cultivating crops. The main reason for cultivation of some crops may be due to retention of the title of the lands on their names otherwise the farmers may loose the land as per the state rule for retention.

Employment

The labour use under different land irrigability classes and soil degradation levels is set in Table 6. The labour use decreased with increase in land irrigability classes and soil degradation levels. The use of hired labour in moderate and severely degraded soils of land irrigability class III and IV is due to fact that certain operation has to be performed in time. For example, the transplanting of rice seedlings and removal of weeds are to be performed within a time frame. In case of sugarcane, sugar factory performs the transplanting of seed and harvesting of sugarcane. The labour charges for other cropping operation are to be met by the farmers. The agricultural sector is already facing a serious threat of unemployment and under employment. Therefore, it should be of serious concern for planner to devise strategies so that favorable production environment can be maintained and the rural sector continues to explore more avenues for employment instead of contributing to the already existing challenge of unemployment.

ISSUES RELATED WITH RECLAMATION TECHNOLOGY

Reclamation Technology

The reclamation of salt affected soil depends upon the nature of salts. There are three types of salt affected soils viz., alkali or sodic, saline (naturally) and waterlogged soils. The reclamation of alkali or sodic soils could be done by the application of gypsum.

The saline reclamation technology is depends upon the quality of ground water and nature of saline soils i.e. waterlogging with good quality of ground water, waterlogging with poor quality of ground water and salinity. The waterlogging with good quality of ground water can easily be

controlled by vertical drainage (construction of tube well). However, the reclamation technology of waterlogged saline and saline soils is through sub-surface drainage and leaching of salts, respectively.

(I)Sub-Surface Drainage: The nature of reclamation technology depends upon the quality of ground water. The reclamation technology for waterlogged saline soils (having saline groundwater) requires sub-surface systems. Drainage removes excess salts and water from the root zone of crops through leaching to create favourable conditions for crop production. Several studies (Joshi et al., 1987) indicated that the sub-surface drainage system is feasible. The crops grown under sub-surface drainage, as reported by Joshi et al. (1987) indicated that the cotton-wheat; cotton-barley; bajra-mustard; and bajra-wheat were the suitable rotations. The potential and existing saline and waterlogged areas need appropriate choice of crops as a strategy for prevention of further spread of the problems as well as for their reclamation. The crops which require low to moderate amount of water with some degree of salt tolerance are suggested for these soils. In the absence of the right choice of crops and their appropriate area allocation, the efficiency of the drainage systems in controlling the salinity and waterlogging will be far below the expectation. The success of any sub-surface drainage systems therefore depends upon the adoption of seasonal crops. If the recommended cropping pattern is followed strictly in the land irrigability class III and IV i.e., if only seasonal crop(s) are grown, the twin problems of salinity and waterlogging would never be arise.

Dhawan (1994) raised the question as to where the problem will appear and at what time? However, he has pointed out that it depends upon the pre-canal depth to water table, drainability of soils, conjunctive irrigation practices, proximity of fields to main canals, etc. From the above discussion, it is clear that the salinity and waterlogging will appear in lands comprising land irrigability class III, IV and V. The land irrigability class V soils has severe drainage problem. The land irrigability class IV comprises poorly drained soils, while land irrigability class V comprises imperfect drained soils. Land is heterogeneous in nature. The association of land irrigability class III, IV and V with land irrigability class I and II occurs in small area/pockets. Hence the problem of salinity and waterlogging will appear only in pockets in land irrigability class II.

(Ii) Leaching of Salts: The leaching of salts from waterlogged natural saline soils can be accomplished through sub-surface drainage. The leaching of salts from saline soils is possible by bunds the fields of small size. These bunds fields have to be filled by fresh water and then only salt tolerant rice has to be grown for first two years. The salt leaches out within two years time and farmers presume that the land has been reclaimed fully. Subsequently, farmers adopt rice - wheat rotation. This leads to rise in water table. These saline soils belong to land irrigability classes III, IV and V which are not suitable at all for rice cultivation. The lands which are initially saline turn into waterlogged saline soils. Hence the methods of salt leaching in such situation are not workable to desired extent.

WATER MANAGEMENT PRACTICES

Several water management practices have been advocated for controlling the salinity and water logging. These practices included use of sprinkler irrigation, drip irrigation system etc. Rice requires stagnant water and sugarcane also needed nearly 200 mm^3 water. The question arises as to how the sprinkler and drip irrigation systems are feasible to meet the water requirement for production of these crops. The application of low quantity of water to any crop would leads to reduction in yields. It is reported (Satyasai and Viswanathan, 1997) that under sprinkler irrigation system, which is more useful under water scarce areas, more area can be brought under irrigation. Narayanmoorthy (1997) reported that under drip irrigation system, expenditure is increased on weeding, fertilizer and irrigation. It is a well known fact that reduction in intensity of weed resulted into increase in the crop yield. However, it still not clear whether it is due to improvement of crop-water relationship or due to control of weeds. Drip and sprinkler irrigation systems cannot be used for rice and other high water requirement crops. Under these systems of irrigation yield of sugarcane is also reduced (Satyasai and Viswanathan, 1997). Hence these methods of water management cannot be generalized for all the crops. No study is available for arid region where high evapo-transparents process is exits. Therefore, it cannot be generalized for all the crops as well as for all the regions.

Tanks and Ponds:

Inadequate storage of water in the irrigation systems has been recognized as one of the major factors contributing to the low utilization of water resources. The success of any irrigation project depends upon the efficient use of water which depends upon the conservation of rain water during monsoon and its utilization in dry season. Irrigation tanks and ponds, which used conjunctively with canal irrigation, function as storage reservoirs into which surplus water could be diverted. The same could be utilized during periods of scarcity. The mahor tanks in the Mahi Right Bank Canal Command Area are Pariaj, Daloli, Salla, Kenewal, Tranja, Narda and Bhndrey. The silent features of these tanks are presented in Table 7. All these tanks are fed by feeder canals from the MRBC systems.

In spite of the existence of a number of large tanks in the MRBC command area, their effective utilization is reported to be poor. The irrigated areas under the command of the tanks have been declining. Problems of water logging have been attributed to be the major cause of low utilization of tanks because these tanks are located in land irrigability classes III, IV and V. The main constraint of these soils is internal drainage. The internal drainage of the soils in the command area of tanks is imperfect to poor in nature. The height of these tanks os 2 to 4 m from the ground level. The ground water is also saline. Few thousands ha of land have become completely barren and in the remaining lands productivity has been reduced considerably. The area which is marginally suitable fro crop production and has been confronted with technical and commercial constraints for irrigation purpose, the large water storage tank will certainly create salinity and water logging problem.

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15. Table 1: Suggested and Actual Cropping Pattern in Canal Command Areas (,000 Ha)

	Cropping pattern			
Crop	Suggested		Actual	
	UK	MRB	UK	MRB
Perennial*	46.8	7.7	162.4	13.3
Rice	79.8	45.8	45.7	75.1
Vegetable	25.2	-	5.6	-
Jowar, bajra and other kharif pulses	42.9	39.2	1.4	14.0
Wheat	49.2	52.2	7.3	10.7
Cotton	70.9	13.1	8.8	-
Tobacco	-	13.1	-	24.7[a]
Oilseed	25.9	-	7.3	3.7
Jowar and bajra**	-	15.4	-	0.8
Miscellaneous***	30.0	26.2	19.8	9.1
Total	370.7 (100.0)	212.7	258.3 (100.0)	151.4 (100.0)

*including banana, ** rabi crops, *** including fodder crops and including cotton crop.

Table 2: Suggested and Adopted Cropping Pattern Based on Land Irrigability Classes in the Canal Command Area

Land irrigability class	Suggested	Cropping pattern Adopted by farmers		
		UKB	KL	MRB
I	High water requirement/ perennial	S,R,C, and P.	-	R,W,B(K),T, B.(S) and G(S)
II	Light water requirement	-do-	S and R	-do-
III	Two season crops	-do-	-do-	-do-
IV	One season crop	-do-	-do-	R,W,B(K), B(S) and G(s)
V	Not suitable for irrigation	C and P.	-	R,W and B(K)

Where S = Sugarcane W = Wheat B(S) = Bajra (summer)
R = Rice P = Pigeon pea B (K) = Bajra (kharif)
C = Cotton T = Tobacco G(S) = Groundnut (summer)

Table 3: Production Performance of Different Crops under Different Land Irrigability Classes and Soil Degradation Levels

Crop/soil degradation	Land irrigability class					
	I	II	III	IV	V	Average
UKRB						
Sugarcane						
Normal	106.00	90.23	81.90	-	-	88.07
Marginal	-	60.68	56.83	-	-	59.72
Moderate	-	52.90	44.48	36.47	-	42.55
Severe	-	-	36.66	25.58	-	29.97
Average	**106.00**	**72.73**	**55.28**	**34.05**	**-**	**56.94**
Cotton						
Normal	25.05	21.74	15.16	-	-	20.45
Marginal	-	18.99	-	-	-	18.99
Moderate	-	11.63	5.69	4.54	-	6.45
Severe	-	-	3.72	2.63	1.79	3.02
Average	**25.05**	**17.11**	**6.31**	**3.78**	**1.79**	**8.41**
Rice						
Normal	36.34	25.81	19.82	-	-	27.38
Marginal	-	23.71	-	-	-	23.71
Moderate	-	17.78	11.68	8.08	-	10.95
Severe	-	-	4.22	4.14		4.21
Average	**36.34**	**23.00**	**9.44**	**6.86**	**-**	**12.51**
Pigeonpea						
Normal	14.82	12.26	11.68	-	-	12.55
Marginal	-	7.21	-	-	-	7.21
Moderate	-	5.93	3.54	1.87	-	3.93
Severe	-	3.84	3.08	1.86	2.05	2.83
Average	**14.82**	**7.08**	**5.63**	**1.87**	**2.05**	**5.52**
KL						
Sugarcane						
Normal	-	98.29	75.12	50.02	-	76.78
Marginal	-	-	61.75	41.99	-	46.93
Moderate	-	52.59	42.21	29.78	-	41.43
Severe	-	-	22.93	17.91	-	21.44
Average	**-**	**72.37**	**42.07**	**32.21**	**-**	**44.52**
Rice						
Normal	-	34.75	23.83	15.84	-	23.93
Marginal	-	22.23	18.47	-	-	20.40
Moderate	-	-	13.74	8.19	-	12.27
Severe	-	-	6.91	4.36	-	5.87
Average	**-**	**26.31**	**16.55**	**9.01**	**-**	**15.00**

MRB						
Rice						
Normal	42.60	34.65	-	-	-	40.06
Marginal	-	26.64	17.90	-	-	20.47
Moderate	-	18.30	12.55	10.27	9.30	13.29
Severe	-	15.15	9.70	7.33	6.80	7.93
Average	**42.60**	**22.08**	**12.43**	**8.54**	**7.91**	**17.09**
Wheat						
Normal	21.70	16.15	14.17	-	-	20.61
Marginal	-	-	11.04	-	-	11.04
Moderate	-	10.76	8.26	4.64	3.47	6.64
Severe	-	10.25	6.44	3.97	2.95	4.95
Average	**21.70**	**11.25**	**8.56**	**4.28**	**3.21**	**5.34**
Bajra (Kharif)						
Normal	17.91	14.45	-	-	-	17.45
Marginal	-	11.85	-	-	-	11.85
Moderate	-	-	7.84	6.25	4.12	5.61
Severe	-	7.59	-	-	-	7.95
Average	**17.91**	**11.86**	**17.84**	**6.25**	**4.12**	**13.99**
Bajra (summer)						
Normal	21.90	18.07	-	-	-	20.91
Moderate	-	14.04	11.40	9.88	-	12.47
Severe	-	11.90	10.73	6.69	-	9.87
Average	**21.90**	**15.79**	**11.13**	**8.29**	**-**	**17.95**
Tobacco						
Normal	19.67	12.80	13.68	-	-	18.90
Marginal	-	10.85	7.62	-	-	8.13
Moderate	-	8.35	5.91	-	-	7.58
Severe	-	6.14	-	-	-	6.14
Average	**19.67**	**8.79**	**9.53**	**-**	**-**	**16.37**
Groundnut (summer)						
Normal	17.08	14.51	11.58	-	-	16.01
Marginal	-	-	9.80	-	-	9.80
Moderate	-	8.56	7.48	3.86	-	7.41
Severe	-	6.39	5.09	3.01	-	4.27
Average	**17.08**	**14.49**	**8.64**	**3.29**	**-**	**10.57**

*Yield of sugarcane in t/ha

Table 4: Unit Cost of Production of Different Crops under Different Land Irrigability Classes and Soil Degradation Level at Cost C.

Crop/soil degradation	Land irrigability class					
	I	II	III	IV	V	Average
UKRB						
Sugarcane*						
Normal	187.85	201.02	214.80	-	-	205.72
Marginal	-	237.61	253.32	-	-	251.72
Moderate	-	260.82	284.47	-	-	284.36
Severe	-	-	303.06	455.32	-	381.62
Average	**187.85**	**220.76**	**277.13**	**455.32**	**-**	**275.78**
Cotton						
Normal	389.06	421.20	537.27	-	-	426.75
Marginal	-	445.17	-	-	-	445.17
Moderate	-	585.30	890.51	1119.36	-	843.60
Severe	-	-	1047.69	1485.63	1910.51	1258.09
Average	**398.06**	**484.85**	**860.63**	**1174.12**	**1910.51**	**715.78**
Rice						
Normal	158.37	177.52	215.89	-	-	183.05
Marginal	-	188.18	-	-	-	188.18
Moderate	-	236.86	299.89	381.41	-	314.25
Severe	-	-	552.87	546.31		545.62
Average	**158.37**	**203.98**	**362.05**	**422.93**	**-**	**311.40**
Pigeonpea						
Normal	311.67	318.67	325.71	-	-	322.03
Marginal	-	363.80	-	-	-	363.80
Moderate	-	412.16	644.05	1010.84	-	547.96
Severe	-	551.39	681.39	887.69	960.50	726.78
Average	**311.67**	**395.81**	**511.19**	**950.93**	**960.50**	**466.59**
			KL			
Sugarcane*						
Normal	-	248.53	275.56	337.02	-	273.19
Marginal	-	-	305.07	412.06	-	378.86
Moderate	-	333.13	386.50	458.28	-	384.41
Severe	-	-	606.40	640.12	-	614.82
Average	**-**	**275.25**	**363.30**	**438.94**	**-**	**352.89**
Rice						
Normal	-	207.19	216.36	232.57	-	219.23
Marginal	-	217.00	235.75	-	-	226.76
Moderate	-	-	278.49	324.10	-	286.69
Severe	-	-	345.23	394.34	-	367.44
Average	**-**	**211.93**	**249.14**	**265.61**	**-**	**246.17**
MRB						

Rice						
Normal	171.01	178.05	-	-	-	173.26
Marginal	-	186.17	246.92	-	-	229.05
Moderate	-	248.09	300.63	326.70	352.88	302.70
Severe	-	267.27	333.37	400.95	427.21	375.05
Average	**171.01**	**236.97**	**302.84**	**376.96**	**394.31**	**399.48**
Wheat						
Normal	242.04	283.25	311.84	-	-	289.57
Marginal	-	-	313.66	-	-	313.66
Moderate	-	355.03	350.07	527.88	565.68	450.15
Severe	-	352.22	384.61	576.67	704.70	543.50
Average	**242.04**	**336.56**	**351.80**	**555.76**	**635.19**	**432.04**
Bajra (Kharif)						
Normal	124.91	138.23	-	-	-	126.69
Marginal	-	148.36	-	-	-	148.36
Moderate	-	-	193.14	208.38	245.75	209.91
Severe	-	212.87	-	-	-	212.87
Average	**124.91**	**174.00**	**193.14**	**208.38**	**245.75**	**130.14**
Bajra (summer)						
Normal	144.19	158.43	-	-	-	147.19
Moderate	-	173.61	186.82	204.92	-	183.23
Severe	-	196.27	191.45	256.45	-	212.40
Average	**144.19**	**168.85**	**188.67**	**230.68**	**-**	**162.49**
Tobacco						
Normal	578.43	666.53	699.16	-	-	592.97
Marginal	-	686.02	866.44	-	-	837.95
Moderate	-	832.98	987.20	-	-	969.40
Severe	-	933.22	-	-	-	933.22
Average	**578.43**	**793.52**	**792.95**	**-**	**-**	**613.52**
Groundnut (summer)						
Normal	427.27	420.98	508.30	-	-	438.70
Marginal	-	-	544.31	-	-	544.31
Moderate	-	564.83	560.13	805.35	-	590.26
Severe	-	643.14	609.88	916.13	-	747.87
Average	**427.27**	**532.50**	**544.31**	**873.73**	**-**	**500.27**

* cost of production per tonne.

Table 5: Net Income from Different Crops under Different Land Irrigability Classes and Soil Degradation Levels.

Crop/soil degradation	Land irrigability class					
	I	II	III	IV	V	Average
UKRB						
Sugarcane						
Normal	22489.10	17953.66	15168.04	-	-	17110.01
Marginal	-	9853.61	7967.34	-	-	9209.93
Moderate	-	6693.18	4078.54	2258.08	-	2879.47
Severe	-	-	2637.15	-2054.71	-	-598.36
Average	**22489.10**	**12308.65**	**6239.25**	**479.57**	**-**	**6503.47**
Cotton						
Normal	9718.10	8235.05	3982.97	-	-	7632.88
Marginal	-	6738.27	-	-	-	6738.27
Moderate	-	2796.96	-800.01	-1676.91	-	-410.26
Severe	-	-	-1107.41	-1603.17	-2077.81	-1534.43
Average	**9718.10**	**6392.21**	**-508.76**	**-1633.17**	**-2077.81**	**540.29**
Rice						
Normal	4231.13	2385.93	1072.43	-	-	2400.55
Marginal	-	2029.61	-	-	-	2029.61
Moderate	-	756.17	-314.73	-898.98	-	-473.44
Severe	-	-	-1156.12	-1112.72		-1124.07
Average	**4231.13**	**1923.52**	**-819.38**	**-920.33**	**-**	**-522.12**
Pigeonpea						
Normal	5590.42	4062.11	3787.71	-	-	4115.98
Marginal	-	2063.49	-	-	-	2063.49
Moderate	-	1410.39	21.05	-674.78	-	397.97
Severe	-	378.66	-98.21	-442.11	-636.52	-217.28
Average	**5590.42**	**1799.64**	**782.02**	**-564.63**	**-636.52**	**1012.42**
KLB						
Sugarcane						
Normal	-	20411.47	13298.52	7904.72	-	14257.73
Marginal	-	-	8950.03	1593.12	-	3432.35
Moderate	-	5596.07	2313.36	-253.26	-	2398.82
Severe	-	-	-1719.95	-3364.70	-	-2207.28
Average	**-**	**13439.51**	**4515.69**	**885.02**	**-**	**5089.03**
Rice						
Normal	-	2462.57	1015.44	554.96	-	1009.13
Marginal	-	1333.68	645.54	-	-	956.39
Moderate	-	-	-55.60	-38.01	-	-52.40
Severe	-	-	-488.53	-562.23	-	-524.13
Average	**-**	**1817.49**	**286.34**	**119.20**	**-**	**398.08**
MRB						

Rice						
Normal	5674.80	3965.23	-	-	-	5129.19
Marginal	-	2111.17	488.52	-	-	965.77
Moderate	-	427.48	-367.81	-633.92	-820.58	-260.14
Severe	-	20.40	-580.15	-900.03	-1108.74	-623.66
Average	**5674.80**	**1317.78**	**-286.88**	**-790.46**	**-956.18**	**679.25**
Wheat						
Normal	2714.09	1604.97	1000.97	-	-	2481.17
Marginal	-	-	277.74	-	-	277.74
Moderate	-	289.99	-589.85	-715.92	-775.14	-488.18
Severe	-	192.28	-660.53	-853.06	-913.87	-697.06
Average	**2714.09**	**425.86**	**-358.64**	**-789.76**	**-844.51**	**15.53**
Bajra (Kharif)						
Normal	2240.28	1615.10	-	-	-	2156.92
Marginal	-	1179.53	-	-	-	1179.53
Moderate	-	-	445.77	220.14	-81.50	218.73
Severe	-	281.84	-	-	-	281.84
Average	**2240.28**	**946.42**	**445.77**	**220.14**	**-81.50**	**1549.05**
Bajra (summer)						
Normal	3194.62	2377.51	-	-	-	3665.70
Moderate	-	1634.16	1176.25	840.63	-	1349.27
Severe	-	1344.50	1057.48	224.38	-	893.66
Average	**3194.62**	**1969.63**	**1128.74**	**532.57**	**-**	**2133.46**
Tobacco						
Normal	5596.87	2637.96	3531.82	-	-	5301.39
Marginal	-	1468.98	-133.76	-	-	814.06
Moderate	-	289.38	-345.20	-	-	149.47
Severe	-	-817.36	-	-	-	-817.36
Average	**5596.87**	**1810.08**	**1256.40**	**-**	**-**	**3156.02**
Groundnut (summer)						
Normal	5512.75	4229.93	2798.92	-	-	4979.42
Marginal	-	-	2015.75	-	-	2015.75
Moderate	-	1583.06	1420.25	-406.64	-	1564.50
Severe	-	682.85	458.72	-500.03	-	-25.10
Average	**5512.75**	**1933.59**	**1629.45**	**-468.90**	**-**	**2550.59**

Table 6: Labour Utilization under Different Land Irrigability Classes and Soil Degradation Levels.

Crop/soil degradation	Land irrigability class					
	I	II	III	IV	V	Average
UKRB						
Sugarcane						
Normal	94.6(79.2)	80.5(71.4)	71.3(67.3)	-	-	88.4(72.3)
Marginal	-	69.3(55.1)	64.1(46.7)	-	-	67.2(51.7)
Moderate	-	62.8(45.8)	55.2(39.8)	47.8(30.8)	-	54.8(43.3)
Severe	-	-	44.3(33.8)	42.1(28.9)	-	42.9(29.9)
Average	**94.6(79.2)**	**74.1(60.1)**	**58.3(45.7)**	**45.8(30.1)**	**-**	**61.2(42.7)**
Cotton						
Normal	77.5(63.3)	70.1(54.7)	58.7(46.2)	-	-	71.6(57.1)
Marginal	-	62.7(52.6)	-	-	-	62.7(52.6)
Moderate	-	48.5(35.9)	39.6(24.7)	31.7(13.7)	-	37.1(21.6)
Severe	-	-	31.7(18.1)	22.5(11.4)	18.9(8.1)	21.6(10.5)
Average	**77.5(63.3)**	**60.5(44.9)**	**44.1(32.7)**	**24.5(12.3)**	**18.9(8.1)**	**42.9(28.3)**
Rice						
Normal	57.4(44.8)	48.3(32.8)	41.1(29.9)	-	-	47.3(39.8)
Marginal	-	44.4(30.2)	-	-	-	44.4(30.2)
Moderate	-	36.9(26.7)	29.7(22.9)	18.7(10.8)	-	29.1(18.9)
Severe	-	-	21.1(14.1)	15.3(6.8)		17.8(9.3)
Average	**57.4(44.8)**	**43.3(31.6)**	**28.3(23.1)**	**16.7(8.1)**	**-**	**38.5(26.7)**
Pigeon pea						
Normal	44.5(30.4)	34.8(27.0)	32.7(24.5)	-	-	36.7(26.8)
Marginal	-	31.5(20.9)	-	-	-	31.5(20.9)
Moderate	-	28.9(18.9)	21.6(12.3)	16.5(9.5)	-	23.1(12.1)
Severe	-	24.7(14.6)	19.1(11.5)	16.2(7.5)	17.5(5.2)	18.3(9.1)
Average	**44.5(30.4)**	**30.4(20.1)**	**22.9(12.1)**	**16.3(8.1)**	**17.5(5.2)**	**26.9(17.3)**
			KL			
Sugarcane						
Normal	-	91.2(67.2)	74.8(61.5)	60.1(43.5)	-	76.6(54.3)
Marginal	-	-	70.2(51.7)	57.7(48.6)	-	68.3(49.4)
Moderate	-	59.1(40.5)	55.8(38.5)	49.1(34.4)	-	54.8(37.9)
Severe	-	-	43.4(27.4)	34.7(20.8)	-	40.8(25.4)
Average	**-**	**76.1(54.6)**	**62.9(39.1)**	**49.4(34.0)**	**-**	**58.8(40.4)**
Rice						
Normal	-	58.7(35.9)	53.9(34.0)	34.5(19.9)	-	47.6(29.3)
Marginal	-	46.1(30.9)	44.1(25.3)	-	-	45.0(27.7)
Moderate	-	-	36.8(17.5)	26.8(9.1)	-	33.3(14.6)
Severe	-	-	26.0(12.4)	18.0(5.5)	-	25.3(10.4)
Average	**-**	**51.7(33.1)**	**40.7(23.0)**	**28.4(13.6)**	**-**	**41.4(21.4)**
MRB						

Rice						
Normal	56.1(40.9)	51.0(34.8)	-	-	-	54.5(38.9)
Marginal	-	45.5(29.5)	42.9(21.1)	-	-	43.7(26.1)
Moderate	-	41.1(23.2)	35.7(18.8)	29.8(17.5)	28.9(14.9)	36.3(18.5)
Severe	-	36.8(19.0)	31.3(17.0)	28.6(16.4)	27.1(9.9)	29.8)13.9)
Average	**56.1(40.9)**	**46.7(27.3)**	**35.4(17.7)**	**29.1(16.6)**	**29.0(13.3)**	**37.8(19.5)**
Wheat						
Normal	42.1(29.1)	39.6(22.9)	43.5(20.5)	-	-	42.1(28.1)
Marginal	-	-	35.6(16.1)	-	-	35.6(16.1)
Moderate	-	38.2(18.3)	24.8(9.5)	25.3(11.2)	23.5(6.7)	27.1(10.3)
Severe	-	31.3(18.9)	25.8(9.1)	27.0(9.0)	23.9(7.1)	25.5(7.7)
Average	**42.1(29.1)**	**39.3(19.6)**	**28.9(15.1)**	**26.3(10.9)**	**23.7(6.9)**	**30.7(13.8)**
Bajra (Kharif)						
Normal	20.0(10.4)	18.9(8.6)	-	-	-	19.3(10.2)
Marginal	-	17.9(8.4)	-	-	-	17.9(8.4)
Moderate	-	-	12.3(6.0)	13.2(4.3)	10.1(3.1)	12.7(4.9)
Severe	-	16.0(5.0)	-	-	-	16.0(5.0)
Average	**20.0(10.4)**	**17.3(9.0)**	**12.3(6.0)**	**13.2(4.3)**	**10.1(3.1)**	**16.8(8.1)**
Bajra (summer)						
Normal	25.2(11.6)	22.3(9.1)	-	-	-	25.0(11.4)
Moderate	-	20.2(7.3)	18.6(5.9)	19.4(4.0)	-	19.3(6.2)
Severe	-	17.8(5.3)	16.0(4.5)	19.4(2.9)	-	18.3(5.0)
Average	**25.2(11.6)**	**21.2(8.6)**	**17.7(5.8)**	**19.4(3.1)**	**-**	**22.6(9.0)**
Tobacco						
Normal	69.3(51.2)	66.5(42.9)	57.5(38.6)	-	-	68.1(42.6)
Marginal	-	61.3(38.2)	51.5(35.5)	-	-	58.5(36.2)
Moderate	-	50.8(34.1)	39.1(24.9)	-	-	47.6(26.6)
Severe	-	42.9(20.7)	-	-	-	42.920.7)
Average	**69.3(51.2)**	**57.9(33.3)**	**44.9(26.6)**	**-**	**-**	**62.7(44.3)**
Groundnut (summer)						
Normal	36.6(23.6)	31.4(19.4)	26.4(17.1)	-	-	34.5(22.9)
Marginal	-	-	29.1(17.8)	-	-	29.1(17.8)
Moderate	-	23.3(11.6)	20.2(9.3)	17.6(9.7)	-	22.5(13.2)
Severe	-	20.5(10.3)	19.2(11.3)	16.8(8.6)	-	18.0(9.5)
Average	**36.6(23.6)**	**25.6(16.8)**	**20.9(13.1)**	**17.2(8.9)**	**-**	**24.9(12.7)**

Parenthesis indicated number of hired labour

Table 7: Salient Features of Some of the Irrigation Tanks in MRBC Command Area.

Name of Tank	Gross Command area (ha.)	Culturable command area (ha.)	Irrigated area (ha.)	Capacity m.cu.m	FSL m	Land irrigability class
Pariaj	457	378	354	10.889	8.99	V
Daloli	598	504	404	1.694	15.54	V
Salla	191	191	124	0.972	21.95	V
Kenewal	1866	1764	1411	16.500	13.72	V
Tranja	280	276	-	-	23.47	V
Narda	-	-	118	0.574	18.14	IV
Bhandrej	-	-	138	1.142	16.50	III

STATUS OF FOOD SECURITY IN MANIPUR

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ABSTRACT

Food is a basic need and every citizen of the country should have access to food which provides minimum nutritional level. Manipur, an isolated hill-girt state is a charming place encircled by nine hill ranges on all sides with a small and beautiful oval shaped valley at the centre. Manipur has witnessed low economic growth in last one decade, low total production of food grain at the state level. People are being forced off their land due to erosion, low yields and high levels of indebtedness. Food Security is a chronic problem in Manipur. There can be no food security without the security of the small farmers. Innovation strategic interventions are the needs of the hour to ensure food availability, food access and affordability. If government provides proper agricultural infrastructure, credit linkages and also encourages the use of latest techniques

INTRODUCTION

Manipur is an isolated hill-girt state stretching between 92 ^{o} 58' E to 94^{o}45'E longitudes and 23^{o}50'N to 25^{o}42'N latitudes. It is a charming place encircled by nine hill ranges on all sides with a small and beautiful oval shaped valley at the centre. The state has 352 km long international border with Burma (Myanmar) to the south-east and 502 kms long border with the adjacent states of Nagaland on the north, Cachar District of Assam on the West and Chin Hill (Myanmar) and Mizoram on the south and the south-west and Surma Tract and upper Chindwin of Myanmar(Burma) on the East. It has a geographical area of 22327 sq. kms which constitutes 0.7 per cent of the total land surface of India. Ninety per cent of the total geographical area of the state i.e 20,089 sq. kms is covered by hills, the remaining area is a small valley covering only 2,238 sq. kms and accounting for only one-tenth of the total area of the state.

According to 2011 census, the population of the state is 27.24 lakhs registering a population density of 122 per sq. km. The population of state has increased by 4.27 lakhs during the decade 2001 to 2011. There is apparent disparity in the level of income and consumption between the rich and the poor, between the urban elite and the rural poor, between the haves and haves- not and between the public living in the hills and in the valley.

People are being forced off their land due to erosion, low yields and high levels of indebtedness. Food Security is a chronic problem in Manipur.

Food Security implies access by all people at all times to sufficient, safe and nutritious food to meet their dietary needs and food preference for an active and healthy life.

DIMENSIONS OF FOOD SECURITY

Food is a basic need and every citizen of the country should have access to food which provides minimum nutritional level.

- ***Physical availability*** of food means food production within the state, food imports and the previous year's stock stored in government go-down.
- ***Physical accessibility*** to food means food is within reach of every person.
- ***Affordability*** implies that an individual has enough money to buy sufficient, safe and nutritious food to meet one's dietary needs.
- ***Stability*** of the other three dimensions over time: access on a periodic basis. Weather, political conditions, or economic factors (unemployment, rising food prices) have an impact on food security status.

Manipur has witnessed low economic growth in last one decade, and low total production of food grain at the state level.

AGRICULTURE PRODUCTION

Permanent cultivation is generally practiced in the valley districts, while terrace cultivation is practiced in some pockets of the hills where jhuming or shifting cultivation is widely adopted in most of the hill districts. Rice is the staple food of Manipur and is grown in both the hill and plain areas. Rice continues to dominate acreage of the crops with 166.15 thousand hectares (68.77 per cent of cropped area in the State) in 2007-08 as against 165.37 thousand hectares (70.22 per cent) in 2006-07. Area under cereals was 169.11 thousand hectares (70.00 per cent) in 2007-08 as against 168.71 (71.64 per cent) in 2006-07 and 161.39 (77.73 per cent) in 1999-00. The area under pulses was 12.51 thousand hectares or 5.18 per cent of the cropped area of the State in 2007-08 as against 10.57 thousand hectares or 4.49 per cent in 2006-07. The food-grains alone accounted for 75.18 per cent of the sown area during the year 2007-08. While 0.86 per cent area was occupied by oilseeds and the remaining 23.96 per cent area was occupied by Cotton, Sugarcane and Others. It means that all the crops are increasing yearly. The following below table gives an idea of the cropping pattern of Manipur.

AVAILABILITY

The food-grains production, estimated requirement and shortfall of the State is given in Table 2.

During 2000-01, the food-grain production was 395.75 thousand tonnes thereby showing an increase from the previous year of 378.92 thousand tonnes in 1999-00. The food- grain production was up and down increasing yearly. In 2007-08, the food-grain production was 419.23 thousand tonnes. The requirement of food-grains for human consumption excluding livestock/ poultry/seed/wastage etc. In the state would be of the order of 442.80 thousand tonnes in 1999-00 and 448.34 thousand tonnes in 2000-01. The state requirement of every year was increasing of household consumption of food grain in 2007-08 (516.29 thousand tonnes) requirement. The shortfall of food-grains in the year 1999-00 was about 63.88 thousand tonnes as against 97.06 thousand tonnes in 2007-08.

TABLE NO. 1 CROPPING PATTERN OF MANIPUR

Area : 000 hectares
Yield rate: kg/hectare
Production:'000 tonnes

Year	***Name of Crops***						
	Cereals	*Pulses*	*Oil seeds*	*Cotton*	*Sugarcane*	*Other Mis.Crops*	*Total*
1	2	3	4	5	6	7	8
1999-00	161.39	6.33	3.09	0.05	0.65	36.13	207.64
	(77.73)	(3.05)	(1.49)	(0.02)	(0.31)	(17.40)	(100.00)
2000-01	161.66	6.19	3.24	0.06	0.74	36.81	208.70
	(77.46)	(2.97)	(1.55)	(0.03)	(0.35)	(17.64)	(100.00)
2001-02	167.63	5.96	1.66	0.09	0.65	40.17	216.16
	(77.55)	(2.76)	(0.77)	(0.04)	(0.30)	(18.58)	(100.00)
2002-03	156.65	7.80	2.62	*	0.32	47.81	215.20
	(72.79)	(3.62)	(1.22)	*	(0.15)	(22.22)	(100.00)
2003-04	160.17	5.06	1.15	*	0.33	63.16	229.87
	(69.68)	(2.20)	(0.05)	*	(0.14)	(27.48)	(100.00)
2004-05	179.53	9.23	2.13	*	0.30	50.47	241.66
	(74.29)	(3.82)	(0.88)	*	(0.13)	(20.88)	(100.00)
2005-06	169.11	8.31	1.36	*	0.06	54.90	233.74
	(72.35)	(3.55)	(0.58)	*	(0.03)	(23.49)	(100.00)
2006-07	168.71	10.57	1.94	0.21	0.50	53.56	235.49
	(71.64)	(4.49)	(0.82)	(0.09)	(0.21)	(22.75)	(100.00)
2007-08	169.11	12.51	2.08	0.21	0.51	57.17	241.59
	(70.00)	(5.18)	(0.86)	(0.09)	(0.21)	(23.66)	(100.00)

I. For the years from 1999-2000 onwards, soya bean is excluded from pulses and included in oilseeds according to the CSO's classification of agricultural items.

II. Figures in Brackets are per centage shares to the respective total.

***Source: Directorate of Economics and Statistics, Manipur*.**

Figure 1 Estimated Cropping Pattern of Manipur from 1999-00 to 2007-08

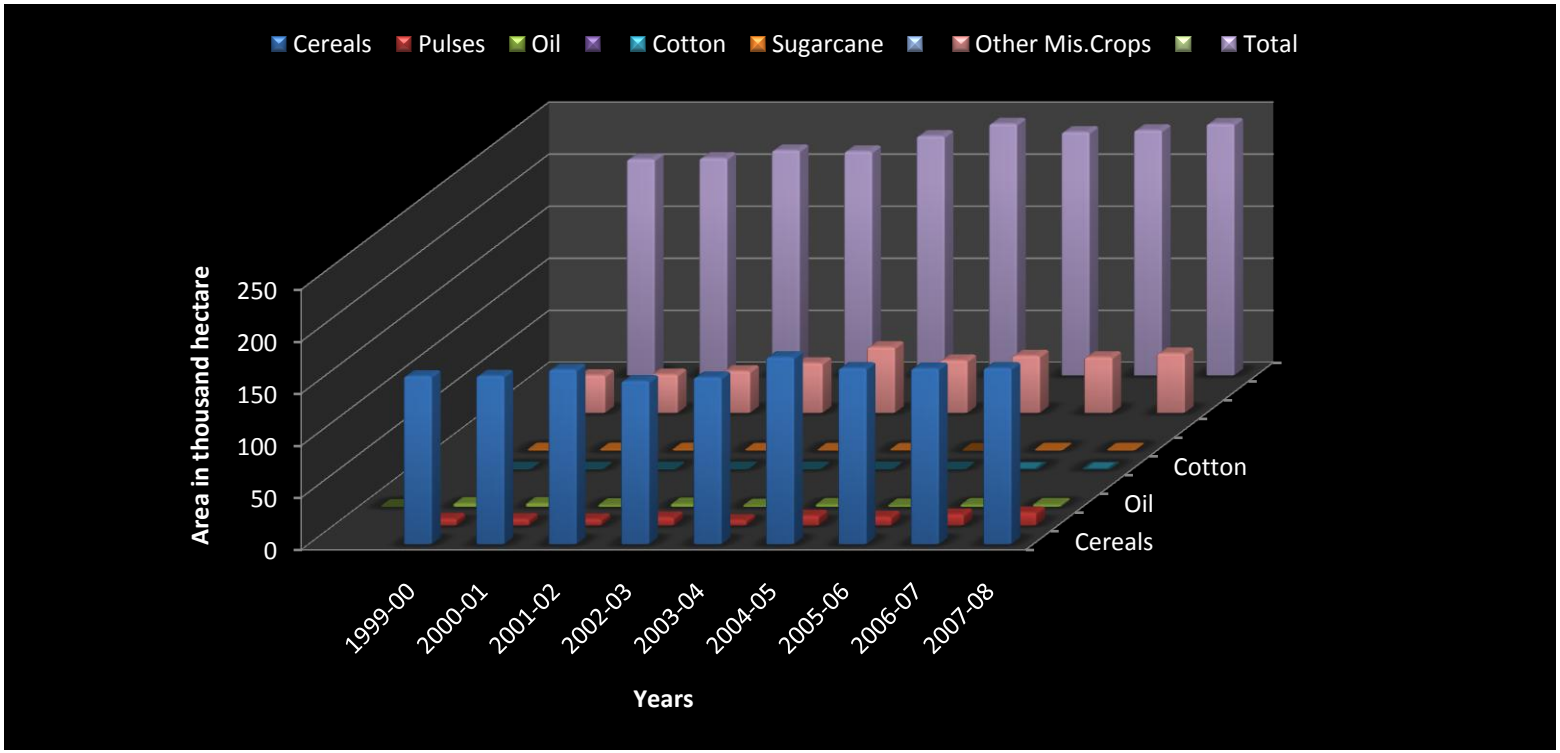


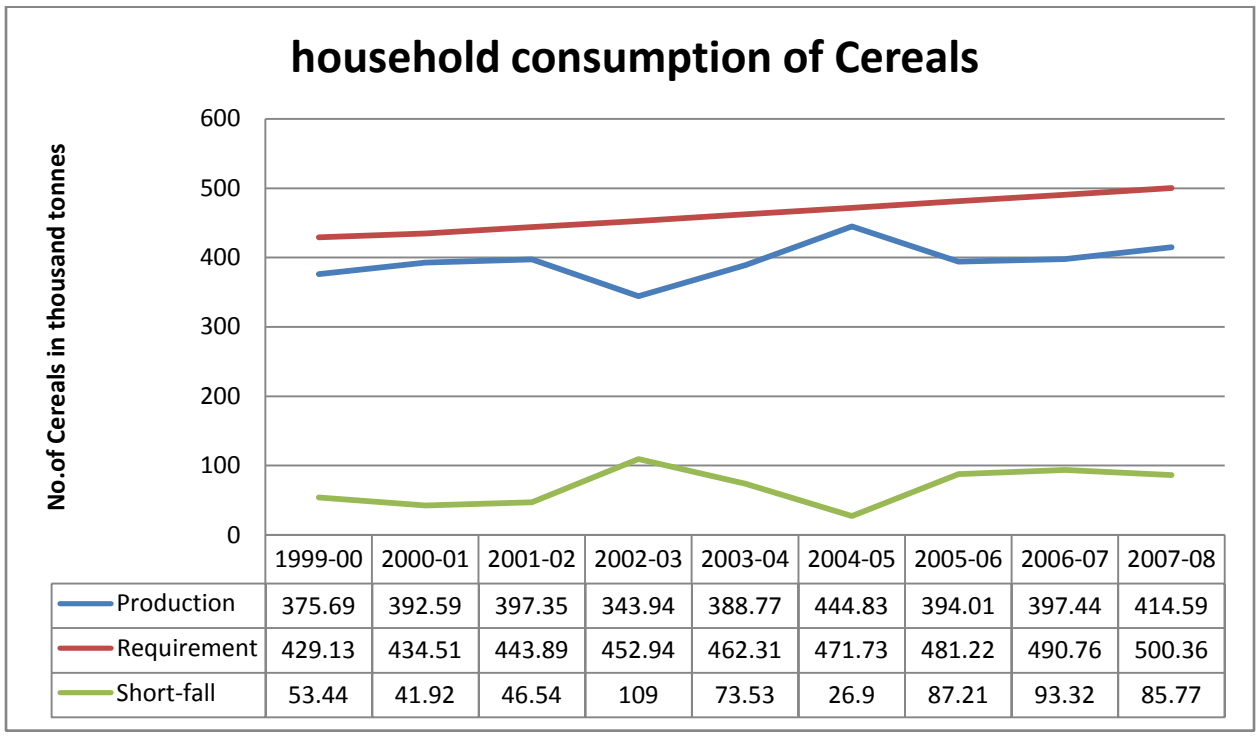
TABLE NO. 2 ESTIMATED PRODUCTIONS, REQUIREMENT AND SHORTFALL OF HOUSEHOLD CONSUMPTION OF FOOD-GRAINS IN MANIPUR

('000 tonnes)

Year		***Production***			***Requirement***			***Short-fall***	
	Cereals	***Pulses***	***Food grains***	***Cereals***	***Pulses***	***Food grains***	***Cereals***	***Pulses***	***Food grains***
1	2	3	4	5	6	7	8	9	10
1999-00	*375.69*	*3.23*	*378.92*	*429.13*	*13.67*	*442.80*	*53.44*	*10.44*	*63.88*
2000-01	*392.59*	*3.16*	*395.75*	*434.51*	*13.83*	*448.34*	*41.92*	*10.67*	*52.59*
2001-02	*397.35*	*3.04*	*400.39*	*443.89*	*14.12*	*458.01*	*46.54*	*11.08*	*57.62*
2002-03	*343.94*	*3.13*	*347.07*	*452.94*	*14.41*	*467.35*	*109.00*	*11.28*	*120.28*
2003-04	*388.77*	*3.24*	*392.01*	*462.31*	*14.71*	*477.02*	*73.53*	*11.47*	*85.01*
2004-05	*444.83*	*4.49*	*449.32*	*471.73*	*15.01*	*486.74*	*26.90*	*10.52*	*37.42*
2005-06	*394.01*	*4.38*	*398.39*	*481.22*	*15.32*	*496.54*	*87.21*	*10.94*	*98.15*
2006-07	*397.44*	*5.24*	*402.68*	*490.76*	*15.62*	*506.38*	*93.32*	*10.38*	*103.70*
2007-08	*414.59*	*4.64*	*419.23*	*500.36*	*15.93*	*516.29*	*85.77*	*11.29*	*97.06*

Source: Directorate of Economics and Statistics, Government of Manipur.

Figure 2 Estimated production, requirement and shortfall of household consumption of Cereals in Manipur



	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
Production	375.69	392.59	397.35	343.94	388.77	444.83	394.01	397.44	414.59
Requirement	429.13	434.51	443.89	452.94	462.31	471.73	481.22	490.76	500.36
Short-fall	53.44	41.92	46.54	109	73.53	26.9	87.21	93.32	85.77

Food Access

Issues:

- Food Prices inflation
- Public Distribution System
- Budget share on total food.

State Income and Prices

State Domestic Product (SDP) is one of the most important economic indicators to measure the growth and structural changes in the economy of the state. The estimates of SDP are prepared both at constant and current prices. The estimates of SDP at constant prices reflect the growth in production, while the estimates at current prices depict the combined effect of growth in production as well as changes in price levels of goods and services produced. In here discuss only at constant prices of GSDP and NSDP. The Gross State Domestic Product (GSDP) and Net State Domestic Product (NSDP) of Manipur from 1999-00 onwards at constant prices is presented in table.

Table No. 3 Gross State Domestic Product and Net State Domestic Product of Manipur, 1999-00 to 2007-08

(Rs. In lakhs)

Year	***At constant price (1999-00)***		***At constant prices (1999-00)***	
	GSDP	***Growth per cent***	***NSDP***	***Growth per cent***
1	2	3	4	5
1999-00	*326016*	-	*295411*	-
2000-01	*305323*	*(-) 6.35*	*276525*	*(-)6.39*
2001-02	*326087*	*6.80*	*293745*	*6.23*
2002-03	*324559*	*(-)0.47*	*292104*	*(-)0.56*
2003-04	*359822*	*10.86*	*324038*	*10.93*
2004-05	*394653*	*9.68*	*354002*	*9.25*
2005-06	*410315*	*3.97*	*366773*	*3.61*
2006-07	*431770*	*5.23*	*386591*	*5.40*
2007-08	*446417*	*3.39*	*399990*	*3.47*

- Not Available

Source: Directorate of Economics and Statistics, Govt. of Manipur

Table reveals that the GSDP of Manipur State is continuously increasing over years. The GSDP of Manipur at constant prices increased from Rs. 326016 lakhs in 1999-00 to Rs. 446417 lakhs in 2007-08. The growth rate between 1999-00 to 2007-08 is worked out to be 3.93 per centages for constant price. The NSDP of Manipur at constant prices also increased from Rs. 295411 lakhs in 1999-00 to Rs. 399990 lakhs in 2007-08. The annual growth rate between 1999-00 to 2007-08 is worked out to be 3.47 per centages for constant price.

Public Distribution System

Public Distribution System is an important constituent of the strategy for poverty alleviation. PDS is operated under the joint responsibility of the Central and State Governments.PDS is a programme which provides food grains and other essential commodities subsidized prices in rural and urban areas. The State Govt. on their part will operate a network of fair prices fixed by the Government will be provided to the target group. The Department procured PDS rice and levy sugar from the central pool against the allocation made by the Government of India for every month within a validity period. During the year 2006-07, 58.57 thousand tones of rice and 7.18 thousand tones of levy sugar and thousand tones of wheat were procured. The projected target for procurement and distribution of PDS rice, sugar, and wheat are shown in below table.

Figure 3: Per centages growth rate of GSDP and NSDP at constant prices

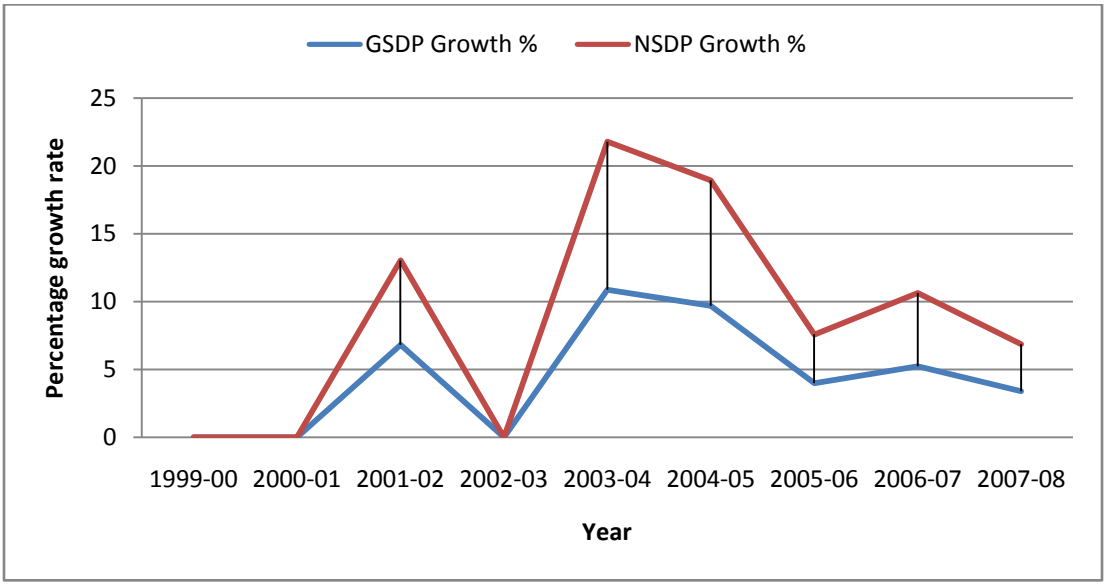


Table No. 4 Procurement and Distribution of different commodities

Year	***Procurement (in thousand tonnes)***			***Distribution (in thousand tonnes)***		
	Rice	***Wheat***	***Sugar***	***Rice***	***Wheat***	***Sugar***
1	2	3	4	5	6	7
1999-00	*43.17*	*7.16*	*0.12*	*41.11*	*0.12*	*6.74*
2000-01	*27.01*	*7.77*	*-*	*22.61*	*-*	*6.73*
2001-02	*21.69*	*9.49*	*-*	*22.73*	*-*	*11.20*
2002-03	*39.93*	*5.97*	*9.25*	*44.13*	*5.85*	*6.00*
2003-04	*43.92*	*3.38*	*21.16*	*42.05*	*20.86*	*3.34*
2004-05	*35.78*	*3.39*	*16.72*	*33.69*	*16.72*	*3.43*
2005-06	*28.03*	*4.73*	*14.67*	*21.08*	*11.06*	*4.30*
2006-07	*58.57*	*7.18*	*8.35*	*50.75*	*5.75*	*6.51*

- Not Available

Source: Annual Administrative Report, F.C.S., Manipur

Table 4 explained that the distribution of Rice, Wheat and Sugar though the PDS was continued during the year 2006-07 in the State. During the year 2006-07, 50.75 thousand tonnes of rice, 5.75 thousand tonnes of Wheat and 6.51 thousand tonnes of sugar were distributed though PDS in the State. During the year 1999-00, 41.11 thousand tonnes of rice, 0.12 thousand tonnes of wheat and 6.74 thousand tonnes of sugar were distributed thought PDS in the State.

Targeted Public Distribution System:

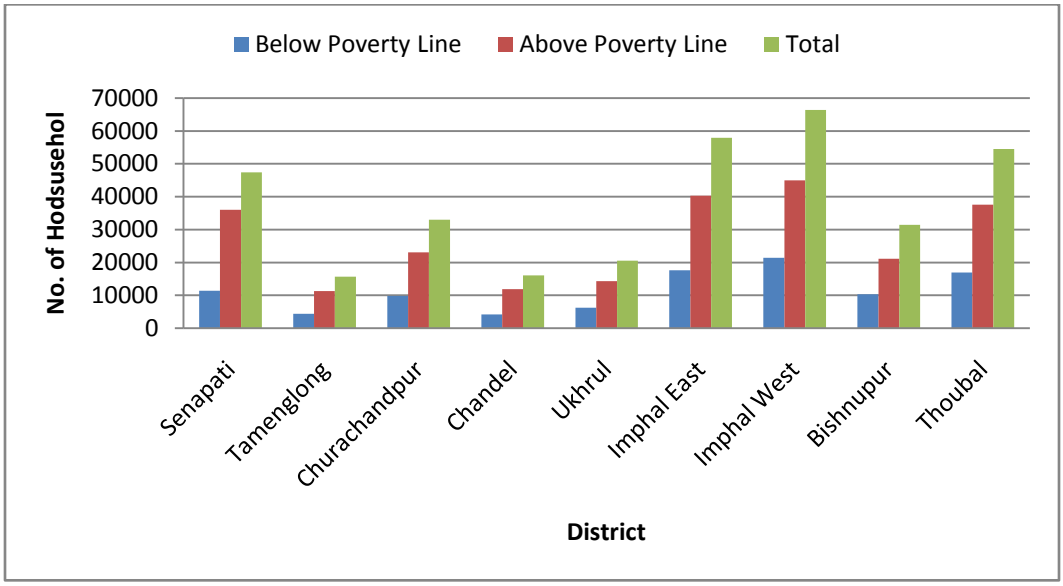
PDS more responsive to the needs of the poor, the Government of India introduced TPDS (Targeted Distribution System) from 1st June, 1997 and the same have been implemented in Manipur w.e.f. 1st September 1997. This system attempts to target families below poverty line (BPL) at heavily subsidized rates. The district-wise numbers of households below and above poverty line for the year 2007-08 are shown in Table 5.

TABLE 5: FAMILIES BELOW POVERTY LINE AND ABOVE POVERTY LINE OF THE MANIPUR STATE DURING 2007-08

District	***Number of Households***		
	Below Poverty Line	***Above Poverty Line***	***Total***
1	*2*	*3*	*4*
Senapati	*11362*	*36016*	*47378*
Tamenglong	*4395*	*11270*	*15665*
Churachandpur	*9881*	*23109*	*32990*
Chandel	*4180*	*11869*	*16049*
Ukhrul	*6240*	*14264*	*20504*
Imphal East	*17651*	*40318*	*57969*
Imphal West	*21438*	*45001*	*66439*
Bishnupur	*10298*	*21150*	*31448*
Thoubal	*16955*	*37596*	*54551*
Manipur	***102400***	***240593***	***342993***

Source: Annual Administrative, Report, 2007-08, Food and Civil Supplies Department, Government of Manipur.

Figure 5: Below Poverty Line and Above Poverty Line of the Manipur District during 2007-08



BUDGET SHARE ON THE TOTAL FOOD

The number of authorized fair price shops in the state in 1999-2000 was 1927 and 2000-01 to 2006-07 were 2551 continuously constant. The distribution of food grains though the public distribution system during 2001-02 was 35 kgs. per family per month in the Below Poverty Line (BPL) group. In Manipur state's the difficult terrain and sparse population in the hill areas, it is still felt that there is urgent need for opening fairer price shops.

SUSTAINABILITY

- Rationalism
- Naturalism
- Humanism

FOOD SECURITY: EMERGING CHALLENGES

- Change in weather pattern, alterations in the soil moisture storage, pets and weeds may affect productivity.
- Flood and Drought due to heavy rains.
- Higher temperatures favor the growth of bacteria in food which may raise the issue of food safety.

FOOD SECURITY: POLICY OPTIONS

- Community farming
- Reduction in cost of production though R andD interventions targeting increased productivity
- Expand utilization of public storage food facilities, and encourage private sector investment in these facilities
- Enough food is available for all the persons

- All persons have the capacity to buy food of acceptable quality
- Dissemination of food and nutrition information to consumers
- Assessment and monitoring of the nutritional status of school children and adolescents and create awareness on healthy diets.
- Need for opening fairer price shops in the hills area such as Ukhrul, Chandel, Tamenglong, Churachandpur and Senapati.

CONCLUSION:

Food security is ensured in a state only if enough food is available for all the persons and all persons have the capacity to buy food of acceptable quality. But a natural calamity say drought, total production of food grains decreases. It creates a shortage of food in the affected areas. Due to shortage of food, the prices go up. At the high prices, some people cannot afford to buy food. If such calamity happens in a very wide spread area or is stretched over a longer time period, it may cause a situation of starvation. The Farmers are badly affected by the uncertainties of production and market. They suffer from a double disadvantage as they pay high prices for inputs such as HYV seeds, fertilizer etc. but lack the bargaining power to fix prices in their favors. All the production reaches the market simultaneously. The higher the supply the lower is the demand. This causes distress sale also. Therefore, there can be no food security without the security of the small farmers. Innovation strategic interventions are the needs of the hour to ensure food availability, food access and affordability. If government provides proper agricultural infrastructure, credit linkages and also encourages the use of latest techniques.

GIS BASED MAPPING AND ENSURING FOOD SECURITY IN BONGAMUNDA (BOLANGIR) AND KOTGARH (KHANDHAMAL) DISTRICTS IN ORISSA

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ABSTRACT

Today ending hunger is not primarily a technical or a production issue. Hunger persists because we as human beings have failed to organise our societies in ways that assure every person the chance to have a healthy and productive life. Periodic reports of starvation death in Orissa have been an issue of serious concern to the State Government. Such reports are usually followed by discussion about the role of the State, definition of starvation, question about BPL enumeration, functioning and efficacy of public distribution system and performance of local institutions. It has even led to judicial intervention. Lack of precise data about the families under risk and malnutrition or starvation complicates the situation. It makes the preventive action highly difficult and targeting almost impossible. Addressing this problem in an effective way necessitates a systematic institutional arrangement for identifying and GIS mapping of areas/habitations/households vulnerable to food/nutrition insecurity for the State Government to devise a field tested strategy to eradicate the problem of hunger and to ensure food security in areas of endemic poverty and destitution.

In order to reach the objectives of the study a foolproof research methodology was adopted which included both primary and secondary research. Huge volume of data was generated regarding the socio-economic condition of the target villages from this exercise. Then 10 per cent of the total people who were at risk were taken for detailed survey through semi-structured schedules. PRA techniques were also used extensively to validate and also to get quality feedback regarding the existing socio-economic condition of the target population. After the data so gather using a multiplicity of methods they were analysed and an effort was made to identify the vulnerable people.

A Geographic Information System (GIS)-based surveillance system for hunger monitoring was prepared and handed over to various authorities for better monitoring and surveillance of the people at risk. There is no denying the fact that hunger and starvation does exist, if not starvation deaths in some parts of the state especially in the western and tribal areas. There are varying reasons for this malady. But generally speaking ensuring adequate food for all, the four major hindering factors found in the rural area are, lack of self sufficiency in food production (production at par with the land carrying capacity), inadequate food availability for the people, less food entitlement for the rural mass and inadequate nutritional intake.

These factors are interlinked with each other and cannot be addressed separately. A holistic approach needs to be taken to deal with issues relating to hunger. Therefore, diversification of

activities needs to be stressed adequately to find out possible solution for hunger. Diversification in agricultural practices (such as cultivating low water intensive crops, opting for cash-crops and food-crops instead of the customary paddy which has become highly unremunerative over the years) and combination of agricultural and non-agricultural activities may also facilitate further towards ensuring a community free from hunger. As all these components substantially inbuilt in the concept and approach of "The Hunger Free Zone" it was felt that such a holistic approach could give specific direction in this regard addressing all dimensions of misery rather than providing solutions in isolation.

BACKGROUND

Recently Oriya press was abounding with stories of starvation death in different parts of Orissa, especially in the western and tribal parts of the state. Though the government of the day was quick to dispel the allegation there is no denying the fact that many people suffer from food insecurity round the year. Instead of passing the buck everybody should keep thinking of a way out how to ensure food security to these people. The reports relating to alleged starvation deaths in different parts of the country including Orissa have drawn the national attention and Honorable Supreme court in recent judgment have focused on the accountability of the civil administration in this regard. In spite of various schemes that aim at the amelioration of poverty and food security issues, there is huge gap between the goals set and results achieved.

OBJECTIVES

The broad objective of this project is to identify individual/families at risk of starvation in villages which have high food insecurity in distress times. The specific objectives are:

1. To identify the district, block, GP, village and individual through pre-determined indicators/parameters
2. To evaluate their access to social safety net interventions (including public distribution system) and develop a GIS based surveillance and monitoring system of such individual families during distress time.
3. To suggest follow-up tracking system for continuous monitoring of their distress condition.

METHODOLOGY

In order to reach the objectives of the study a foolproof research methodology was adopted which included both primary and secondary research.

Secondary Research

In the beginning a comprehensive study was made of all the probable districts where food insecurity might be quite high. For the purpose of short listing the target area existing literature and data were extensively analyzed.

- Use census data/WFP approach for identification of districts and blocks in Orissa
- Remote forest-dependent communities
- High concentration of STs/SCs
- High Concentration of landless or functionally landless.
- Low availability of food grains and poor access to PDS.
- Low per capita intake of calories.

- High level of out-migration
- High per centage of people belonging to BPL
- Marginal workers representing a high per centage of total working population (age-specific and gender-specific labour force).
- High unemployment rates and chronic underemployment.
- Low educational status (gender specific).
- High morbidity/mortality trends (IMR/MMR), gender specific.
- Insufficient healthcare facilities and low access to health care.
- High per centage of female-headed households.
- Low level of decision-making by women in all aspects of family and community life, women's access and control of assets and benefits.
- Presence of potential NGOs/CBOs or other agencies with proven capability to plan and undertake development activities.

This step of secondary research gave a deeper insight of the prevalence of poverty and level of food insecurity in different pockets of the state. Based on this information the final area of study was selected.

Primary Research

After the district and blocks were identified detailed a door-to-door survey was undertaken to identify individual/families at risk by trained personnel in all the villages using the following parameters.

- Prolonged illness
- Physically/mentally challenged
- Unable to work due to age factor/old age/child
- Living alone
- Negligible/very limited source of income
- Non-affordability to purchase grains
- Low accessibility to social security system
- Schedule caste/schedule tribe
- Out-migration of all able bodied persons
- Not presently enrolled in emergency feeding
- Not enrolled as BPL family
- Dependent on forest food (fruits/roots) for at least one month
- Whether children/parents live in the same village
- Whether in the Vulnerable age group (0-6) or (>50)
- Any other (specify)

Huge volume of data was generated regarding the socio-economic condition of the target villages from this exercise. Then 10 per cent of the total people who were at risk were taken for detailed survey through semi-structured schedules. PRA techniques were also used extensively to validate and also to get quality feedback regarding the existing socioeconomic condition of the target population.

GIS MAPPING

After the data so gather using a multiplicity of methods they were analyzed and an effort was made to identify the vulnerable people. A Geographic Information System (GIS)-based surveillance system for hunger monitoring was prepared and handed over to various authorities for better monitoring and surveillance of the people at risk.

THE STUDY:

Before the survey was undertaken a sensitization camp was organized in each of the Block Headquarters. In this workshop the participants were District Collector, BDOs, Sarpanches, ward members, Samiti members, and other block and district level officials. The Basic objective of the meeting was to acquaint the representatives of PR institutions as well as other block and sub-divisional officials on Food insecurity mapping and vulnerability assessment study and to get their feedback so that the study can be conducted smoothly and in a participatory way involving all the stakeholders of the block. Issues like lapses in social fabric, Exploitative Migration, Social security services and lapses, Economic/livelihood related vulnerability, Seasonal food vulnerability, Health/education related vulnerability were widely discussed. The grass-roots level functionaries actively participated and came out with their observation and understanding regarding the problem of food insecurity. Some of the more important observations made by these people at these workshops are

- . Follow up mechanism need to be developed for the identified vulnerable HHs.
- . Immediate and Appropriate measures need to be taken at Panchayat and village level both by the community as well as by the PR institution to address hunger and starvation.
- . Vulnerability is basically related to poverty and creation of employment and assuring the same
- could be a possibility for its reduction.
- . Emergency feeding should be given both the time i.e. on lunch and dinner rather than once in a day prevalent at present (during lunch).
- . Enough scope needs to be created for developing irrigation potential at Panchayat and village level through lift irrigation points and other water harvesting structures.
- . There are a number of HHs where there is none to feed the aged people though food is available at Panchayat for supply.
- . In many HHs, no food is available for consumption purposes.
- . Govt. Social security measures not reaching to the people who need the most.
- . Involvement of all stakeholders is highly required in this direction for food vulnerability reduction.
- . For labourers, wage is available only during agriculture season resulting in less number of food security days.
- . Steps taken towards creation of employment opportunity are not enough at district as well as block level.
- . High infant mortality rate in both the areas.

- . Depletion of assets is common. During employment scarcity, people compel to sell/mortgage HH articles at throw away prices.
- . Nuclear family approach (separate living of son after marriage) is a customary in the tribal community which is affecting the social fabric.
- . Lapses in social security mechanism and economic insecurity make people more vulnerable.
- . Per capita HH land holding is very low. As land occupancy is less, production is also affected which has got a direct link with food vulnerability.
- . Improper water and sanitation facility prevails in rural area, which deteriorates health condition of people and by the micro nutrient absorption.
- . Many villages are still in an inaccessible zone for which district machinery finds it difficult to reach them.
- . Food for work is not utilized properly to address hunger and poverty issues.
- . Food, health and education are three major aspects, which need to be emphasized in the district for vulnerability reduction of people in general and tribal in particular.

GRAM PANCHAYAT LEVEL WORKSHOP

After the Block level a series of Gram Panchayat level workshop were organized at Gram Panchayat level. The participants in this workshop were Sarpanches, ward members, Samiti members, Block Chairperson, VLWs, AWWs, ANMs, Govt. representatives etc. The main focus of the workshop was to explain about the checklist of the proposed Household survey at Village level. These people were trained by professionals of XIMB how to conduct the survey. An effort was made to make the survey foolproof and authentic by making the respective officials accountable. This made the exercise authentic. After the door-to-door survey 10 per cent of the total identified individuals/households were selected on a random basis for detailed household survey.

PRA EXERCISE

In order to validate the quantitative data and to get further information on vulnerability PRA exercises were conducted in sample villages in which the entire village participated. Women were encouraged to participate and come forward with their views.

GIS MAPPING

Based on this huge volume of data gathered at different time GIS-based mapping was done to identify the most vulnerable individual/households of the society. The GIS-based database of the vulnerable people and households has been handed over to the respective Sarpanches, BDOs, and District Collectors for follow up action.

FINDINGS OF THE STUDY

As this study is mainly is to identify the vulnerable people and individuals who are threatened by possible starvation deaths no statistical presentation is made. However during the course of the study 2672 individuals in Bongamunda Block of Bolangir district and another 1120 families in Kotgarh Block of Kondhamal district. Apart from mapping the individuals the research team came across many findings related to hunger which should be taken care of with due importance.

There is no denying the fact that hunger and starvation does exist, if not starvation deaths in some parts of the state especially in the western and tribal areas. There are varying reasons for this malady. But generally speaking ensuring adequate food for all, the four major hindering factors found in the rural area are, lack of self sufficiency in food production (production at par with the land carrying capacity), inadequate food availability for the people, less food entitlement for the rural mass and inadequate nutritional intake. These factors are interlinked with each other and cannot be addressed separately. A holistic approach needs to be taken to deal with issues relating to hunger.

Therefore, diversification of activities needs to be stressed adequately to find out possible solution for hunger. Diversification in agricultural practices (such as cultivating low water intensive crops, opting for cash-crops and food-crops instead of the customary paddy which has become highly non-remunerative over the years) and combination of agricultural and non-agricultural activities may also facilitate further towards ensuring a community free from hunger. As all these components substantially inbuilt in the concept and approach of "The Hunger Free Zone" it was felt that such a holistic approach could give specific direction in this regard addressing all dimensions of misery rather than providing solutions in isolation.

SUGGESTIONS

Instead of shying away from this very fact that hunger and starvation does exist everybody responsible addressing the problem should stand up and devise a workable plan to execute. As pointed out in contextual term "The Hunger Project" is a vision to realize and to make people free from hunger. Based on Gandhian philosophy, the project looks for a healthy and productive future of people in harmony with nature. For its actualization, the strategies to be adopted are based on principles of empowerment, gender equity and self-sustenance. Utilisation of available local resources and involvement of people's institutions/local institutions could be helpful in strengthening strategic intervention for a society free from the domain of hunger. Through the holistic characteristic of "The Hunger Project" we can focus on empowerment process of people especially the weaker section of the society and to create opportunities for betterment.

The hunger project never sees hungry people as objects of charity but as the authors of their own lives. The investment is to empower their self-reliance. The Hunger Free zone strategy is not about creating ideal villages by focusing resources into certain areas "that has been done hundreds of times and it seldom works". They don't spread because the status quo is so powerful that ideal villages remain isolated. The key is empowerment of the poorest members of society to become self-reliant. There must be (a) a focus on reaching the unreachable, those living in remote areas, (b) social empowerment, a commitment by the people to set aside social evils such as drinking (c) economic, so that people gain productive assets and (d) information empowerment, to ensure people gain access to opportunities that are rightfully theirs and lastly (e) mainstreaming the sections which are being deprived or sidelined from the process of development.

FOLLOW-UP ACTION

The study indicates that there are not many disproportionately high numbers of people who are perennially starving. But the problem is that these people are not tracked properly. At present there are no dearth of schemes and programmes to take care of these distressed people. But the question is who would own for follow-up and tracking them? Obviously the government machinery is not geared up to provide such individualistic service. PRIs, SHGs/CBOs and local NGOs can play a vital role in addressing this peculiar problem. These community-based institutions should be encouraged and in fact should be entrusted to keep a track of the targeted individual and provide the service to overcome their distress conditions.

CONCLUSION

It is beyond the comprehensive of any right-thinking individual that when godowns are overflowing with grains and there is bumper production why people should starve? Even if the logic that starving people do not have purchasing power does not hold good as there are social safety nets for the most vulnerable section of the society. If the existing schemes and programmes aimed at these people are implemented in the right earnest, the stigma of starvation can be addressed in the right perspective. It is high time government, PRIs and civil society organizations took up their responsibilities to ensure that nobody goes without food for a considerable period to be branded as starving.

ROLE OF BIOTECHNOLOGY IN FOOD SECURITY

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ABSTRACT

The Green Revolution that took root in a few pockets to begin with slowly spread throughout the country. Over the past ten years the daily calorie supply increased from 2208 to 2496 kcal per person, against a minimum energy requirement of 2100 kcal/day for urban and 2400 kcal/day for the rural population. Moreover, as a result of eleven consecutive normal monsoon years in a row total stocks of wheat and rice were almost always above the minimum stock theoretically, the country has enough in stock to meet the minimum energy requirements of its citizens. At many places in the country small farmers are being forced to look for better avenues. Many of them are increasingly abandoning farming in search of more lucrative urban employment. One also often reads reports of small farmers, unable to produce enough to support their livelihoods and heavily in debt, committing suicide. Besides, surplus foodgrain stock notwithstanding, it is also a fact that the country has a vast populace who do not have enough to feed themselves. Access to food for the poor who account for 40 per cent of India's population, has decreased sharply over the last five years as cereal prices rose between 120 and 140 per cent, while incomes largely stagnated. Over the past five years, there has been a 4 per cent decrease in the area sown with cereals, 13 per cent decrease in the acreage under millets (consumed principally by the poor), and a 3 per cent decrease in the case of pulses (lentils), the most important source of protein in Indian diet. With the population estimated to grow to about 1,400 million by 2050, the declining food production puts a big question mark over the country's future food security.

INTRODUCTION

Food security in developing countries is increasingly in danger. The mainproblems are limited natural resources, their overuse in both intensive andextensive production systems, and the impacts of climate change. Researchinstitutions face the challenge to rapidly achieve sustainable increases inproductivity while at the same time preserving the ecosystems.Consequently, many authors dealing with the issue of biotechnologyand development point to the lessons learned from the 'Green Revolution' when thewestern industrial model of agriculture was exported to the developing world, producing mixedresults (Miquel, 2000;Miquel, 2002;Philip McMichael, 2000;Gerad et al., 2000;Vandana Shiva. 1998).Potentials today are seen in breeding less demanding high-yield varieties forintensive agriculture, as well as salt-tolerant and drought-resistant varietiesfor rainfed agriculture. At the same time, soil and water resources in semiaridand arid areas are to be used in a sustainable manner, and agriculturalproduction systems are to be adapted to the new conditions brought aboutby climatic change and biotic stress due to viral diseases. Biotechnology is only one of many measures that come to mind when trying to achieve these goals. Until now, biotechnology is applied only to few commercial crops. If the poor – i.e. small-scale farmers – are to benefit from the technology,research must take more

account of the consumer needs and regional agriculturalproblems faced by the less wealthy populations in developing countries,and focus on crops that have so far been neglected, such as pulses,tubers, and local vegetable and fruit varieties. Given that biotechnologicalprocesses are expensive and technologically demanding, building updecentralised high-level research capacities in developing countries cannotbe a priority goal. On the contrary, the objective must be to ensure that thepriorities of public international research are adapted accordingly; thatknowledge, laboratory capacities and technology are made widely accessibleas public goods; and that the capacity to establish and implement regulationis encouraged and made available. Considerably more expensivethan research itself, regulation is the most costly aspect of biotechnologyand represents the greatest obstacle for public research to effectively implementproducts (Kropiwnicka, 2005).

Biotechnology is not a substitute for the conventional plant breeding methods; rather it is a supplementary tool available to the agricultural scientists, which can be used for genetic modification to produce more productive transgenic crops in the decades to come, to meet our future food, animal feed and fibre needs. To feed the ever-increasing population, more and more food has to be produced from less and less land, water and other natural resources available. This means that increased food production has to be achieved in a sustainable and environment-friendly manner. India has had the dubious distinction of having recorded the world's worst food famine. This was the Bengal famine in 1942-43 in which an estimated four million people died of hunger in eastern India (that included today's Bangladesh). That was the time when self-sufficiency in foodgrains looked a distant goal. However, in 1966-67 a new strategy of agricultural development based on scientific advances in farm technology ushered in what is popularly known as the Green revolution. This bought self-sufficiency to the nation and even allowed a surplus availability of food. In the past 50 years the total foodgrain production in the country has increased substantially from a level of 51 million tonnes in 1950-51 to the current level of about 206 million tonnes. Over the past ten years the daily calorie supply increased from 2208 to 2496 kcal per person, against a minimum energy requirement of 2100 kcal/day for urban and 24oo kcal/day or the rural population. Moreover, as a result of eleven consecutive normal monsoon years in a row total stocks of wheat and rice were almost always above the minimum stock. Theoretically, the country has enough in stock to meet the minimum energy requirements of its citizens. The problem is aggravated by the constant rise in population by 2020; India's population is likely to be around 1.3 billion.

The agricultural biotechnological tools will have to be applied to ensure food security by way of increased food production which will come largely from intensification of agriculture on existing land, already fatigued and shrinking further, and from efficient use of water, energy and labour. Improved transgenic crops in a number of species have already been generated and commercialized in different countries. According to the 1999 data, the area planted under transgenic crop has increased from 1.7 million hectares in 1996 to 39.9 millions hectares in 1999. During this period, 12 countries-eight industrial and four developing have contributed to more than twenty-fold increase in the global area of transgenic crops.

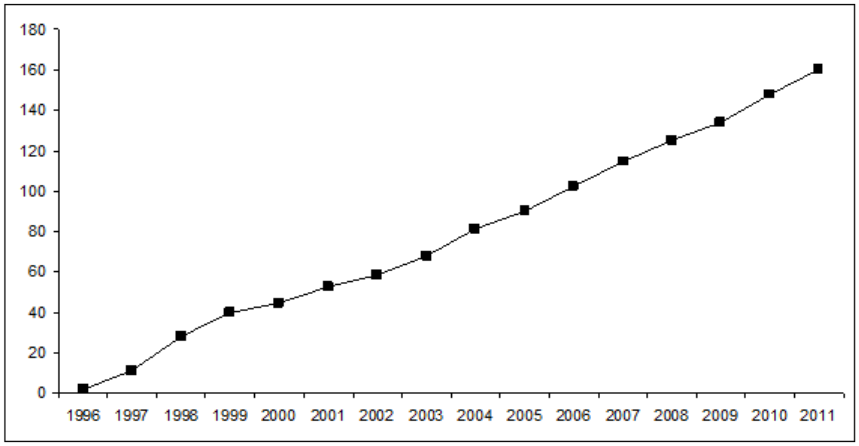

Figure 1. Global Area of Biotech Crops, 1996 to 2011 (Million Hectares)

Source: *Clive James, 2011.*

In 2011, a total of 16.7 million farmers planted biotech crops in 29 countries, wherein over 90 per cent or 15 million (up from 14.4 million in 2010) were small and resource-poor farmers from developing countries. The highest increase in any country, in absolute hectarage growth was Brazil with 4.9 million hectares and the highest proportional increase was Mexico with a 146 per cent increase to reach 175,500 hectares.In summary, during the period of 1996 to 2011, biotech crops have been successfully grown in accumulated hectare of 1.25 billion hectares (3.1 billion acres).

TABLE 1: GLOBAL AREA OF BIOTECH CROPS (1996-2010)

Year	**Hectares (Million)**	**Acres (Million)**
1996	1.7	4.3
1997	11.0	27.5
1998	27.8	69.5
1999	39.9	98.6
2000	44.2	109.2
2001	52.6	130.0
2002	58.7	145.0
2003	67.7	167.2
2004	81.0	200.0
2005	90.0	222.0
2006	102.0	250.0
2007	114.3	282.0
2008	125.0	308.8
2009	134.0	335.0
2010	148.0	365.0
Total	**1,097.9**	**2,716.0**

Increase of 10 per cent, 14 million hectares (35 million acres) between 2009 and 2010

Source: James C., 2010

However, biotechnology offers a solution through another revolution-the 'generevolution'-to hait the fatigue of green revolution and to tackle the issue of food security in India. Biotechnology can solve the problems which are unique to agriculture and certainly can add value of Indian Agriculture. If agriculture is considered the "engine" of the Indian economy, then biotechnological tools can apply act as the needed fuel. Moreover, the 'gene revolution', as compared to the 'green revolution', is poised to benefit both rich and poor farmers equally, and is more environmentally safe and sustainable. It can reduce the dependency on chemical inputs such as pesticides and fertilisers, and has a great potential to improve the general appeal and quality of the food. Other developing countries like Mexico, Argentina, China and Chile have already accepted this new technology to boost their economies and so is the case likely to be in Cuba, Egypt and South Africa. India too has taken up ambitious programmes in agricultural biotechnology to ensure food security, with liberal support from the United Nations and the World Bank, and some successes have already been achieved. Transgenic crop cultivars are being developed with a goal to reduce the input cost and increase the efficiency of crop production per unit land area.

GIS AND FOOD SECURITY

Agricultural scientists are today using GIS (Geographical Information System) to bring about rapid changes in agricultural research and management with the help of spatial information regarding pattern of soil properties, cropping practices, pest-infestations, weather conditions and topography. This tool coupled with remote sensing A GIS provides the analytical capabilities that let farmers perform site-specific analyses of agronomic data. The results help to identify the interactions between physical, chemical and crop data that can be the cause for variations in yield. The yield limiting factors include physical environmental variables, chemical variables and biological variables. Determining the role that a specific pathogen plays in limiting yield requires quantitative knowledge of the interaction between host and pathogen. The degree of departure from normal plant function is measured in populations of plants by assessing the visible signs or symptoms of the disease. The specific properties of the vegetation, healthy or diseased, influence the amount and quality of radiation reflected or emitted from the leaves and canopies which is utilised in GIS technology. GIS holds great promise in helping the country achieves the goal of future food security for its hungry millions (Verma, 2001).

Need for New Approach

The majorityof commercialised GM crops so far have been developed by profit-orientedcorporations for large-scale industrial agriculture. Until now, these cropshave hardly contributed to food security for small-scale farmers in developingcountries. Biotechnological applications must be adapted to each specificcontext (). Environmental conditions, eating habits, and socio-culturalfactors have a fundamental influence on whether the introduction of a cropmakes sense.Research geared towards improving the situation for poor small-scale farmersin a specific context could very well lead to positive results. It requirespragmatic approaches that respect the sovereignty of developing countries.The final decision on the development and cultivation of GM crops must bemade by the countries concerned. However, these decisions

should bemade in an informed and transparent manner. When a country decides infavour of biotechnology, safety should be given a high priority.Biotechnology is leading agriculture into new dimensions. Its use is a stepthat most probably cannot be reversed. The question of whether geneticallymodified and conventional crops canexist side by side remains controversial.Moreover, biotechnology may further promote the expansion of largescaleindustrial production systems. Finally, control and safety in the use ofGM crops poses great challenges, particularly in developing countries.Development cooperation is faced with the question of how future foodsecurity can be achieved in view of population growth and limited naturalresources. Conventional technologies of varietal improvement and new cultivationpractices continually produce advances. Improvements in theaccess of small-scale farmers to fertile land, water, credits and marketswould already considerably reduce hunger. In combination with other technologies,and in a form adapted to the needs of small-scale farmers, biotechnologycould accelerate the process of achieving global food security. Its useshould be based on the precautionary principle. However, as there can beno full guarantee of its harmlessness, careful weighing of risks and benefitswill always be necessary.

CONCLUSIONS

Appropriate use of biotechnology offers considerable potential to improvefood security. A number of these technologies, such as tissue culture andmolecular markers, are already being used safely to speed up conventionalplant breeding. But given the potential risks of genetically modified organisms (GMOs) for human health and the environment, caution isneeded in introducing them. And with the development of biotechnologylargely in the hands of commercial interests, efforts must be made tospread its benefits to small-scale farmers, the poor and the hungry.Yet, beyond the well-acknowledged need for expensive researchfunding, governments should demonstrate their commitment to food security by strengtheningand implementing existing environmental legal mechanisms.Given today's context ofglobalisation, the protection and enhancement of developing countries' food security necessitatesactions on global forums such as that provided by the FAO's instruments and by the newbody of environmental law enshrined in the painstakingly negotiated Cartagena Protocol onBiosafety and the International Treaty on Plant Genetic Resources for Food and Agriculture.Furthermore, urgent implementation and more widespread ratification of these instruments,which have operationalised the compromise needed in order to minimise the risks and maximisethe benefits of the new technologies, are not only in interest of the developing countriesbut in interest of any developed country government paying lip service to food security andenvironmental concerns.

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SUSTAINABLE INTEGRATED WATER RESOURCES MANAGEMENT FOR ENHANCED ENERGY PRODUCTION AND FOOD SECURITY IN NEW LIBYA

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ABSTRACT

Paper is designed to present an overview of integrated water resources management at global, regional, national and local level for enhanced energy and food security towards sustainable development in New Libya. It demonstrates that how actions, accords, and commitments by institute industry interaction (3Is) initiative with special reference to water resource efficiency for enhanced energy and food security are being debated by using awareness and preparedness for environmental emergencies at local level (APELL) along with numerous both Libyan and UNEP priority initiatives and programs. Based on case studies to recognize some of the most common problems experienced in Integrated Water Resource Management (IWRM) planning for enhanced energy and food security and developing options for overcoming them a set of recommendations on how to enhance institutional and legal reforms for its implementation at the national/local levels are briefly outlined. Finally it shows that how lessons learnt and best practices especially from UN agencies are assisting to promote water resource efficiency to achieve energy and food security of case study in Libya for its wider application in both developed and developing countries.

World over rising interdependence of water, energy, food resources raises security concerns. These resources are tightly interconnected and needed to sustain life on earth. Food production which is the largest user of water globally is responsible for 80–90per cent of consumptive water use from surface- and ground-water. Water used to generate electricity accounts for about 8per cent of global water withdrawal. Energy is lifeline for transport and fertilizes crops. Food production and supply chains are responsible for around 30 per cent of total global energy demand. Crops are now being used to produce biofuels. Recent estimates show that by 2050, world population would rise to 9.2 billion resulting in 70per cent increase in demand for food and a 40per cent rise in demand for energy. As per another estimate by 2030, the world would confront a water supply shortage of about 40per cent.

Increasingly resource problems that cross boundaries have scaled up in recent years. Sustainable water resource management for enhanced energy production and food security is a complex business. World Water Council way back in 1996 alerts us that, the wars of the next century will be for water, "unless we change the way we manage water. Indeed water is a key driver of economic and social development. It also has a basic function in maintaining the integrity of the natural environment. Bearing in mind that water is only one of a number of vital natural resources, it is imperative that water issues are not considered in isolation. Both public and private sector managers, have to make difficult decisions on water allocation. It requires apportion diminishing supplies between ever-increasing demands. Drivers such as demographic and climatic changes further increase the stress on water resources. The paper shows that how traditional fragmented approach is no longer viable. It needs a comprehensive and more holistic approach to water management including issue of energy production and food security.

Water security is rightly defined as an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water- related risks to 'food security' and people, environments and economies. Tackling water security requires reliable access to sufficient supplies using adequate and affordable water resources management. The present paper highlights that how integrated sustainable water resource management is being tackled based on best practice case study in Libya based on needs assessment that assists in framing the issue infrastructure to store and transport water, treat and reuse waste water information and the robust institutions, able to take and implement decisions. It demonstrates that how sound understanding of water security does help to clarify our capacity to predict, plan and cope and support structure to better tackle social issues, poverty goals and thinking about the institutions best able to help us to achieve them. It further shows that how sustainable regional and national development needs assessment helps in promoting water security that in turn contribute to climate change resilience for economic growth and human security.

An Appraisal of Existing Situation

World economy that runs on the finite water, energy and food resources can no longer be sustainable unless policy makers and industry leaders take vital steps to balance the many competing demands of these interactions. Resource scarcity problem is under debate way back from 1970s, when the discussion on limits to growth was built around the idea of physical scarcity of a single natural resource, such as oil and minerals. Resource availability then was mainly a local or national challenge. The present debate and discussion on resource scarcity includes market, governance and geopolitical concerns, while the question of physical scarcity remains. This is mainly because of the reason that in recent years, resource problems that cross boundaries have scaled up, and they also involved supply chain concerns. The food crisis in 2007–2008 and oil price hike in 2008–2009 are just two examples of global shocks caused by resource scarcity. Many blame the market distortion of resource pricing for these crises. As per McKinsey study (2011), there has been a 147per cent increase in real commodity prices since the turn of the century. Around US$1.1 trillion is spent annually on resource subsidies. As per World Bank estimates around 44 million people were driven into poverty by rising food prices in the

second half of 2010. The problem of food security is indeed becoming a source of socioeconomic problems. This situation is leading to the current global resource scramble requiring effective policy frameworks to tackle the scramble for resources leading to land grabbing and resource nationalism. Japan, for instance, has three times more land abroad than at home to ensure its food security.

In recent years many climate change activists are focusing on the enormity of government subsidies for agrofuel production, which can harm the environment, displace indigenous peoples and lead to food shortages. An overview of the state of the art on African Union Heads of State Sharm el Shelkh Declaration and commitments on water an climate change gave birth to Water, Climate Development Programme (WCDP) November 2011. It is supported by Climate Development Knowledge Network (CDKN). It provides a Strategic Framework for Water Security and Climate Resilient Development that gave a short, easy to use strategic document which outlines how to develop 'no/low regrets' investments strategies. It focuses on how countries can develop 'no/low regrets' investment and financing strategies for water security and climate resilient development. It shows how to incorporate water security and climate resilience into national development plans, macroeconomic frameworks, MTEF, national budgets and overall economy based on the analytical work in the Technical Background document. Oflate, 9 Water Ministers attended the WCDEP Launch during 2011 Stockholm World Water Week consultation that gave at least 23 countries in Africa from 5 River Basins to Benefit 4 River Basins plus 1 aquifer in North Africa Basin/aquifer approach. It enables the programe to benefit at least 23 countries Limpompo, Volta, Lake Victoria(Kagera),Lake Chad, North-Western Sahara Aquifer System, (Nile Basin -through collaboration with UNEP). In-depth work in some countries has helped to generate lessons, tools, experiences, to share with other countries like Ghana, Burkina Faso,Cameroon, Tunisia,Burundi,Rwanda,Mozambique,Zimbabwe. Other Key Activities involve Identification of priority activities for detailed implementation from 2012 onwards-ongoing Setting up Programme Management structures setting up WACDEP Africa Coordination Unit AMCOW Secretariat Desk Officer appointed Sub-regional and country structures. Developing a Programme Website in both French and English - www.gwp.org/wacdep Promotion of WACDEP in global climate change processes and the world water week in Stockholm Africa Day

Activities in Developing a Framework for Water Security and Climate Resilience Development find IWRM as a Tool to support implementation Joint publication with UNFCCC on Fresh water resources and climate change adaptation. These activities are helping in Promotion of WACDEP in global climate change processes and the world water week in Stockholm COP 16, Mexico, COP 17, Durban. The Water, Climate Development Day too is helping to support African regional process for the World Water Forum. Global Water Partnership: (GWP) in Africa is designed to Target Coordinator for Climate Change and WACDEP that is central to the Targets for WWF. Global Linkages of WACDEP Part of the GWP Pledge under the UNFCCC's Nairobi Work Programme is officially recognized by UNFCCC as a mechanism in Africa for the user Interface Platform of the Global Framework for Climate Services under WMO. Framework for

Water Security and Climate Resilient Development is indeed a useful tool to enable implementation of WACDEP, supported by Climate Development Knowledge Network (CDKN). Technical Background Document Strategic Framework for Water Security and Climate Resilient provides a Development Capacity Building Plan for the Framework Policy Briefs

Technical Background Document to guide robust decision-making in developing practical low or no-regret adaptation measures captures international best practices in defining water security and climate resilient strategies, assessment methods, etc critique on pros/cons of various methods in existence develops/adapts methods for understanding water futures, climate futures and development futures that provides guidance on dealing with uncertainty, increased climate variability and climate information gaps. It provides knowledge on relevant investments required to enhance water security and climate resilience. It also clarifies links between water security, IWRM, CC, development Basis for the Strategic Framework on Water Security and Climate Resilient Development.

Strategic Framework for Water Security and Climate Resilient Development provides a short, easy to use strategic document. It outlines how to develop 'no/low regrets' investments strategies focuses on how countries can develop 'no/low regrets' investment and financing strategies for water security and climate resilient development. It also shows that how to incorporate water security and climate resilience into national development plans, macroeconomic frameworks, MTEF, national budgets and overall economy based on the analytical work in the Technical Background document

In order to developing the Framework Milestones 2011 World Water Week-Inception meeting of COP 17 prepared -1st Draft consultations. It helped in developing the Framework CORE TEAM HR Wallingford- lead Oxford University Centre for Environment Oxford Policy Management Institute for Development Studies Associate Partners University of East Anglia Water Security Centre International Office for Water (host of INBO) IWMI-Africa Climate Systems Analysis Group . GWP Experts Review Panel Chair - Prof. Torkil Clausen Alan Hall ---- EU FWG Prof. Micheal Scoulos. In the face of climate change, partnerships such as those launched in the Water, Climate and Development Programme with Global Water Partnership represent a good first step'.

Case Studies Related to Water Resources Management of Libyan Coastal Areas

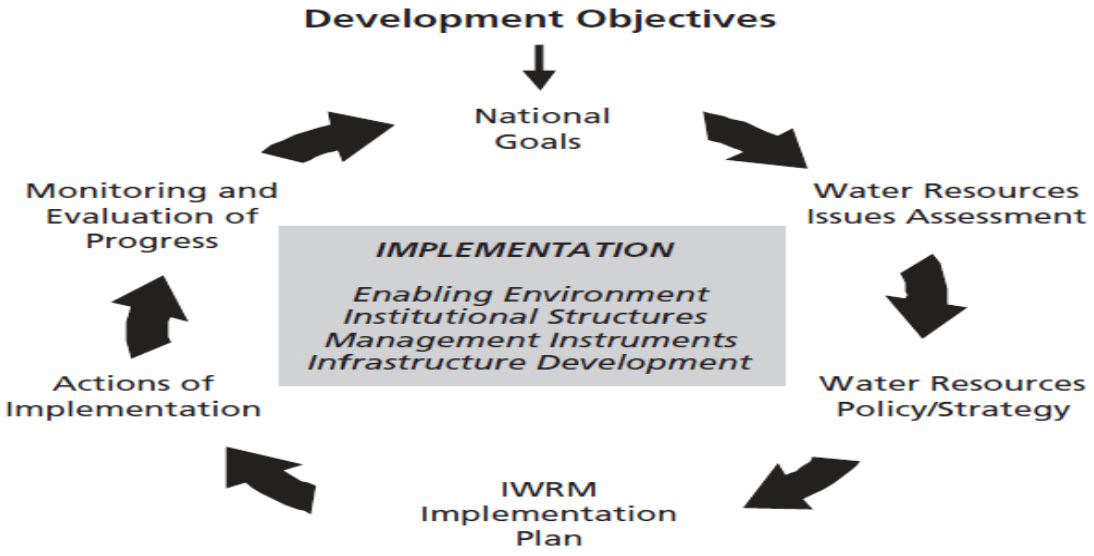
Libya has 2000 km coast line. All most all Mangroves have been destroyed. Untreated and Under treated Domestic sewage and industrial effluents being discharged into Sea. Coastal Road is undertaken in violation of CRZ. Cement Projects will have serious adverse impact. Precautionary Principle requires adoption of Risk based approach asks "how much damage is acceptable or can we get away with?"The system sets numerical limits to allow that much damage to occur, but we end up with more than acceptable damage. Under Precautionary Principle we ask "how little damage is possible?. Precautionary system urges a "Better Safe Than Sorry" approach decisions. Seas are polluted when relationships between Plankton and Light, Plankton and other Marine Organism and Sea Bed and Surface are damaged. The

message is let us not play with Seas and Oceans as "Life on earth is sustained by the existence of Sea, since life began in Sea about 2.5 billion years ago"

United Nations and Water

Figure below by United Nations shows the rationale for the Integrated Water Resources Management (IWRM) approach is the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands.

Global overview shows that there are great differences in water availability from region to region - from the extremes of deserts to tropical forests. In addition there is variability of supply through time as a result both of seasonal variation and inter-annual variation. All too often the magnitude of variability and the timing and duration of periods of high and low supply are not predictable; this equates to unreliability of the resource which poses great challenges not only to water managers but also to societies as a whole. Most developed countries have, in large measure, artificially overcome natural variability by supply-side infrastructure to assure reliable supply and reduce risks, albeit at high cost and often with negative impacts on the environment and sometimes on human health and livelihoods. Many less developed countries, and some developed countries, are now finding that supply-side solutions alone are not adequate to address the ever increasing demands from demographic, economic and climatic pressures; waste-water treatment, water recycling and demand management measures are being introduced to counter the challenges of inadequate supply. In addition to problems of water quantity there are also problems of water quality. Pollution of water sources is posing major problems for water users as well as for maintaining natural ecosystems.



Stages in Iwrm Planning and Implementation

Overview further shows that in many regions the availability of water in both quantity and quality is being severely affected by climate variability and climate change, with more or less precipitation in different regions and more extreme weather events. In many regions, too,

demand is increasing as a result of population growth and other demographic changes (in particular urbanization) and agricultural and industrial expansion following changes in consumption and production patterns. As a result some regions are now in a perpetual state of demand outstripping supply and in many more regions that is the case at critical times of the year or in years of low water availability

In summary, IWRM is an empirical concept built up from the on-the-ground experience of practitioners. Although many parts of the concept have been around for several decades - in fact since the first global water conference in Mar del Plata in 1977 - it was not until after Agenda 21 and the World Summit on Sustainable Development in 1992 in Rio that the concept became both the object of debate and practice. The Global Water Partnership's definition of IWRM is widely accepted. It states: 'IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.'

Some Salient UN Sponsored Activities for Water Use Efficiency

In 2006 a Task Force on IWRM was created by UN-Water, with members drawn from UN-Water agencies and from partner organizations. In May 2008, the Task Force on IWRM completed its mandate when it presented the 'Status Report on Integrated Water Resources Management and Water Efficiency Plans' at the sixteenth session of the Commission on Sustainable Development. In 2008, UN-Water combined the Task Force on IWRM and the Task Force on Monitoring to establish the Task Force on Indicators, Monitoring and Reporting.

UN-Water Decade Programme on Advocacy and Communication (UNW-DPAC) was first launched in 2010. World Water Assessment Programme (WWAP), DHI Water Policy, UNEP-DHI Centre for Water and Environment was set up in 2009. It helped to set out how to explore some of the practical aspects of the implementation of Integrated Water Resources Management (IWRM). It covers the following aspects: 1) the relevance of IWRM for a number of key development issues, 2) the key characteristics of the concept, 3) the global status of IWRM, 4) practical implementation - the challenges, 5) practical implementation - case studies showing successful applications to problematic management scenarios, and 6) how IWRM programmes are being linked with the **Millennium** Development Goals and adaptation to climate change by the setting of achievement milestones.

World Water Assessment Programme (WWAP) report first published by UNESCO-International Hydrological Programme (IHP), 2009 reviews currently available information on cases related to IWRM and Integrated River Basin Management (IRBM. It summarizes these findings with some conclusions and recommendations. **UN-Water. 2008** Report aims to illustrate progress made on meeting the target to "Develop integrated water resources management and water efficiency plans by 2005, with support to developing countries, through actions at all levels" agreed at the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, through the Johannesburg Plan of Implementation. The Report is based on a survey covering 104 countries of which 77 are developing or countries in transition and 27 are developed. **Cap-Net, United**

Nations Development Programme (UNDP) in 2008 provided a framework of IWRM. The manual provides the necessary general information and specific tools in a user-friendly way so that any water resource stakeholder may be able to resolve existing or head-off impending disputes in a way agreeable to all parties. The emphasis is on Alternative Dispute Resolution (ADR), in particular, principled negotiation - an approach that seeks to embed outcomes and processes that serve sustainable, equitable and efficient long-term social needs.

UN-Water, Global Water Partnership (GWP) in 2007 assisted in preparing statement to support countries in their efforts to improve water management through an IWRM approach, and to stimulate the development of a robust framework for monitoring, evaluating and reporting on the outcomes of such an approach. **Cap-Net, United Nations Development Programme (UNDP), Global Water Partnership (GWP) in 2005** prepared a training material for a 3-4 day course on how to achieve a water resources management plan that brings in the principles of IWRM. Useful tools are identified to support the planning process in each step. While the material is targeted for national IWRM plans it is readily adaptable for basin level planning and trainers. **Food and Agriculture Organization of the United Nations (FAO) in 2004** provided a background document that gives a brief overview of the development of the concept of Integrated Water Resources Management. **World Water Assessment Programme (WWAP), UNESCO-International Hydrological Programme (IHP) in 2009 gave** Guidelines to help provide information to help practitioners implement IWRM in line with their own set of circumstances. These guidelines consist of the fundamental concepts of IWRM as well as provide insights into the perspectives of various stakeholders with regard to water issues, keys for success for overcoming problems, and good examples where such keys for success were applied. This first publication serves as an introduction to the Guidelines and outlines the main points contained within them. **UNESCO-International Hydrological Programme (IHP), World Water Assessment Programme (WWAP), Network of Asian River Basin Organizations (NARBO) in 2009** issued Part 1 of the Guidelines that provides basic principles of IWRM and explains the benefits of IWRM at river basin level and the need to promote it at the policy level. It also proposes a spiral model of IWRM, which illustrates the evolving and dynamic nature of the IWRM process.

UNESCO-International Hydrological Programme (IHP), World Water Assessment Programme (WWAP), Network of Asian River Basin Organizations (NARBO) in 2009 issued Guidelines for IWRM Coordination' intended for practitioners involved in IWRM coordination. It can be used as introductory guidance for those tackling IWRM for the first time, or as training material for intermediary practitioners and trainers of IWRM. For IWRM experts, it can be used as a reference guide to tackle the various issues and problems they face in their IWRM activities. **UNESCO-International Hydrological Programme (IHP), World Water Assessment Programme (WWAP), Network of Asian River Basin Organizations (NARBO). In 2009** also issued Guidelines for Flood Management. It' is intended for IWRM practitioners of flood management. It is recommended to be used as introductory guidance for those tackling IWRM for the first time, or as training material for intermediary practitioners and trainers of

IWRM. For IWRM experts, it can be used as a reference guide to tackle the various issues and problems they face in their IWRM activities. **UNESCO-International Hydrological Programme (IHP), World Water Assessment Programme (WWAP), Network of Asian River Basin Organizations (NARBO) during 2009** gave good practices for Irrigation Practitioners' on how to tackling irrigation planning. It consists of three parts: 1) sectoral perspectives, 2) key for success, and 3) IWRM process. **Cap-Net, United Nations Development Programme (UNDP) in 2008** developed a training material to improve efficiency and effectiveness in the application of integrated water resources management (IWRM) for sustainable management and development of water resources. The training is particularly targeted at the staff of river basin organisations (RBOs).

United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2003 issued a manual as an introduction to the principles underlying the integrated water resources management concept. The focus is on the approaches and management tools that facilitate its application, taking into account the size of the territory, whether it is national and international basins or sub-basins of local interest. This manual is destined first to trainers who, through a national or a regional seminar, would bring the participants to produce a diagnosis of their basin and an action plan. The manual is divided into two sections. The first one, of a more conceptual nature, presents a review of several definitions and some of the most pressing issues related to integrated basin-wide management. The second section of the manual, aimed at training, takes the reader and the trainer through the steps of the management framework.

ACP-EU, United Nations Environment Programme (UNEP), UNEP-DHI Centre for Water and Environment, Global Water Partnership (GWP) published case studies to recognize some of the most common problems experienced in IWRM planning and developing options for overcoming them. Each case study considers the following aspects: 1) problems of water resources management that need to be addressed, 2) context in which the problems and solutions need to take place, 3) decisions and actions taken in order to execute the roadmap process, 4) outcomes of the decisions and actions taken, 5) lessons learnt that will be of value to others involved in similar situation, and 6) relevance of the case to IWRM.

United Nations Economic and Social Commission for Western Asia (UNESCWA) in 2007 made a study to help provide ESCWA member countries with guidelines on how to implement Integrated Water Resources Management national strategies, with particular focus on institutional and legal dimensions. The study: (a) assesses the status of institutional and legislative settings; (b) evaluates the progress towards implementing institutional reforms within IWRM national strategies as well as challenges, constraints and gaps; (c) proposes scenarios for the implementation of legal and institutional reforms; (d) reviews institutional and legislative measures taken by developed and developing countries; and (e) presents a set of recommendations to ESCWA member countries on how to enhance institutional and legal reforms in order to implement IWRM at the national/local levels.

United Nations Economic and Social Commission for Western Asia (UNESCWA) in 2004 presented an overview report that introduces the process of Integrated Water Resources

Management (IWRM) to senior policy and decision makers with the aim of mobilizing political and decision support to implement IWRM at the basin, national and regional levels.

Libyan Initiative

Libya based academies, universities, high institutes and Research Centers have launched initiative to reduce, reuse and recycle resources product and services (3Is) for rebuilding the country to combat climate change impacts induced by 2011 Libyan crisis. The country is engaged in preparing actions, accords, ideas and best practices to mitigate the impact of projected extreme events and weather by considering **low carbon**, **resource efficient** measures and enhanced use of renewable to tackle impending climate change. 28 hot spots in Libya are identified to convert them to bright spots. An initiative on water-energy-food nexus is established to focus on the interdependence of the three strategic resources by understanding the challenges and finding opportunities. The nexus objectives are:

- To improve energy, water and food security;
- To address externalities across sectors and decision-making at the nexus and
- To support transitions towards sustainability.

Concluding Remarks

Paper presents challenges and opportunities of current global scramble for scarce resources – water, energy and food. It highlights, appraisal of global, regional, national and local issues related to water resources management to demonstrate that how actions, accords, and commitments by 3Is initiative with special reference to water resource efficiency are being debated by using awareness and preparedness for environmental emergencies at local level (APELL) along with numerous both Libyan and UNEP priority initiatives and programs. Based on case studies to recognize some of the most common problems experienced in IWRM planning and developing options for overcoming them a set of recommendations on how to enhance institutional and legal reforms for its implementation at the national/local levels are briefly outlined. Finally it shows that how lessons learnt and best practices especially from UN agencies are assisting to promote integrated water resource management and sustainable consumption and production of water in Libya for its wider application in both developed and developing countries.

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SUSTAINABLE WATER RESOURCES IN ALBANIA

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GENERAL BACKGROUND

Albania is rich in water res sources, including rivers, groundwater, lak kes, lagoons and seas. Overall its resources exceed b by far its consumption, although locally water r shortage and conflicts among users may occur in the e dry season. The hydrographic basin of Albannia covers 43,305 km^2, of which 28,748 km^2 lie withiin its boundaries. The rest (i.e. 33 per cent) is s in Greece, the former Yugoslav Republic of Maced donia and Yugoslavia, so Albania shares upsttream and downstream water resources with its neigh hbours. Albania's 247 natural lakes are an im mportant component of the country's hydrographicall network. Resources are unevenly distri ibuted throughout the country. The major water reso ource is surface water, and is found in rivers, llakes, and lagoons.

PARTICULARS OF LAKES

Lakes	***Area in square km2***	***Altitude above Sea level in meters***	***Maximum Depth in meters***
		Natural lakes	
Shkoder	149	4.5	9.0
Ohri	111.4	695.0	287.0
Prespa	49.5	853.0	35.0
Butrinti	16.3	0.0	21.4
		Artificial lakes	
Fierza	72.5	295.0	128.0
Vaui Dejes	24.7	74.0	52.0
Ulza	12.5	128.5	61.0
Komani	13.0	170.0	96.0

There are four natural freshwater lakes 9326km), Shkodra, Ohri, Prespa, Butrinti, all of which share borders with Greece and former Yugoslavia. Lura Lakes (12 lakes) situated in the northern part of Albania cover a square of 100 hectare. There are also numerous artificial lakes (9174 km) created as a result of hydroelectric power stations damming key rivers. The largest artificial lakes are concentrated in the North, around Tropoja, Kukes and across to Shkodra. Five lake zones are potentially available for tourism development, mainly hotels, holiday villages and individual leisure facilities.

RIVERS

The total inland water surface is 1350 km2, composed by natural lakes, artificial lakes, coastal lagoons and river network. Island surface 95.8 km2 is constituted of sandy islands, parts of coastal lagoons, rocky islands, which are separated from the lad. Albania is rich in rivers (721 km) and streams. The regime of the rivers and streams is torrential with great differences in the amount of water they carry from season to season, a fact that explains their eroding capacity. The rivers are very important for the irrigation of the land and for the production of hydroelectric power. The most important rivers are Drin in the north, Shkumbin and Seman in the south. The

Drin River has two springs, one coming from Lake Ohrid and the other from Kosova. The longest river in Albania is Seman, which is 281 km and is divided into two separate branches, Devoll and Osum. The river Vjosa, 272 km long, originates from Smolika mountain, which is the most torrent s in Albania. Other rivers to mention are Erzen, Mat and Ishem, however the only navigable river is Buna in the north of the country.

COASTLINE AND LAGOONS

Albania's coastline is one of its greatest assets. Its total length is 427 km, which is very clean by Mediterranean norms. There are two distinct zones: the Adriatic and the Ionian. The Adriatic coast is 273 km long, which has shallow water and long sandy beaches (up to 5 km). Much of the coast is pine forest. The southern Ionian coast is 154 km long, being rugged and dramatic, with steep backdrops to fine white sandy beaches.

The beaches are smaller and rockier here, and the water is deep right from the shore. Citrus, fig and olive trees dominate the landscape, giving it a classical Mediterranean beauty. There are several environmentally sensitive lagoons (coastal lagoons 130 km2) along the coast, the most important being Karavasta, near Divjaka in the central region, and Butrint in the south. Many migratory birds visit the coasts. Twenty-four coastal zones have been chosen for potential tourism development. This will consist of hotels, holiday villages and marinas in the future.

WATER AND THE ALBANIAN ECONOMY

Much of Albania's economic activity is dependent on the utilization of water resources. Over 90 per cent of energy production is from hydropower plants, while agriculture is critically dependent on irrigation. However, the inadequate and poorly maintained infrastructure in each of the water-using sectors and the absence of institutional coordination has resulted in the lack of water supplies becoming a key constraint to many economic activities and to satisfying basic social needs.

LEGAL FRAMEWORK

Albania's 1996 Law on Water Resources (No. 8093) (Water Law) is the primary legislation governing the country's inland, maritime, surface, and groundwater and is intended to ensure the protection, development, and sustainable use of the country's water and provide for its proper distribution. The Water Law addresses water rights, water use, and governance of water resources. A new law on water management has been drafted and was being circulated internally for review in 2010.

The '1999 Law on Irrigation and Drainage (No. 8518) established the structure for Water User Associations (WUAs), which are private groups that manage water irrigation infrastructure at and below the secondary canal level. Federations of WUAs manage the primary canal networks. The government maintains ownership of the infrastructure.

The Law on Organization and Functioning of Local Government (No. 8652) (2000) transferred responsibility of water supply and management of water utilities to local government (communes and municipalities).

The 2008 Law on the Regulatory Framework in the Sector of Water Supply and Waste Water Administration (No. 9915) and 2009 Ministerial Order No. 66 provide authority for the

establishment of an inter-ministerial working group for the evaluation of projects and issues related to drinking water supply and sewage sector in Albania. The working group is led by the Minister of Public Works.

TENURE ISSUES

Under the 1996 Water Law, the state owns all water resources in Albania. The Water Law provides that surface water may be used freely for drinking and other domestic uses, such as livestock watering, so long as the use is limited to individual and household needs. Water use is also subject to administrative controls imposed by water authorities. Water authorities may restrict free use of water during periods of water shortages or in the event of contamination. The draft Law of Water Management circulating in 2010 retains these provisions (GOA Water Law 1996; GOA Draft Water Law 2010b).

Under the 1996 Water Law, non-domestic water users, and users of groundwater for domestic purposes must obtain permission, authorization, a concession, or a license from the appropriate water authority, subject the following conditions:

1. Permission. Water authorities may grant administrative permission for the use of underground water for any purpose, water supplied by permanent installations, and water used for irrigation, livestock, aquaculture, and industry. Permission is also required for planting of trees and crops on river beds and the removal of solid material from river banks. Permissions are granted to WUAs for 10-year periods and 5 years for all other users.
2. Authorization. Authorizations for water use necessary for research, exploration, and study of surface and groundwater are available for periods up to 2 years.
3. Concession. Water authorities may grant concessions for the use of surface and groundwater for public purposes, including hydropower stations, supply of potable water, and irrigation by agricultural enterprises. Concessions are available for initial terms of 30 years with a potential 10-year extension.
4. License. Commercial well drillers must obtain a license and separate permission for every well drilled.

The draft Water Management Law circulating in 2010 maintains the system of water rights set forth in the 1996 Water Law. In addition, the draft law adopts a national water strategy and establishes river basin districts and a river basin-level management structure.

WATER PRIVATIZATION

Water privatization in Albania was initiated by the Albanian government in the early 2000s with the support of the World Bank and German development cooperation. The stated objective was to improve the quality and efficiency of urban water supply and sanitation. At the time, many households received water only for a few hours every day, utilities were overstaffed, water tariffs were low and many customers did not pay their water bills. There was no single municipal wastewater treatment plant in the country of 3 million, which is among Europe's poorest countries. In 2002-03 three contracts were signed with foreign private operators covering six secondary cities. Water privatization never covered more than a fifth of the country’s population.

The contracts expired or were terminated early five years later with few tangible improvements in service quality.

INSTITUTIONAL FRAMEWORK

The National Water Council, which is under Albania's Council of Ministers, is the primary authority responsible for water resources management. The National Water Council has responsibility for: proposing legislation; managing the drainage basin plan; approving any water management plans relating to agricultural, urban planning, industrial development or other projects; establishing necessary agencies and organizational units; and approving water concessions. The Technical Secretariat is the executive agency of the National Water Council and has responsibility for: implementing national water policy and the legal framework; creating an inventory of water resources; issuing permissions and authorizations for water use; and promoting research and development. The General Directorate of Water Supply and Wastewater (GDWW) is a public institution established by the Council of Ministers specializing in water infrastructure. The GDWW is responsible for providing technical support to the water and wastewater policies and creating the strategic framework of the water and wastewater sector. Responsibility for municipal water utilities was devolved to Albania's local governments (municipalities and communes) under the Law on Organization and Functioning of Local Government (2000). Local governments have four areas of authority: administrative, investment, maintenance, and regulatory. Tariffs are based on the principle of cost recovery under the discretion of local government and within general national policies. Actual transfer of responsibility for water resource governance to local governments was a slow process that took place over several years. Most local governments were ill-prepared to take on responsibility for water distribution; they did not have sufficient human and financial capacity to create and rehabilitate infrastructure or manage the utilities effectively. Water utilities tend to have high losses, low revenues and low collection rates. Illegal connections, especially by poor households, are common.

Water User Associations (WUAs) can be established at local levels to manage water resources. WUAs are designed to be financially independent entities that create water schedules and distribution plans, maintain water distribution infrastructure, set and collect fees, and resolve conflicts. As of 2007, 489 WUAs had been established (covering 280,000 hectares), of which 316 (about 65 per cent) were fully functional. A national union of WUAs has been established to represent the interests of WUAs at various institutional levels. Some observers have attributed improved irrigation system management, reductions in farmer disputes and increases in farm production in some areas to the work of WUAs. However, despite some positive outcomes, overall, WUAs have suffered from low membership numbers, poor collection rates and low cost recovery. In many areas WUAs have been unable to maintain infrastructure for the distribution of water or to manage conflicts between different water users effectively.

GOVERNMENT REFORMS, INTERVENTIONS AND INVESTMENTS

The GOA adopted a Water Supply and Sanitation Strategy in 2003. The strategy included a short-term priority reform and investment program (2003-2006) and medium-term reform and

investment program (2007-2012) to stabilize and improve water supply and sanitation services. The long term objective of the strategy for the water supply and sanitation sector is to achieve sustainable water supply and sanitation services at the EU Standards in urban and rural areas. Implementation of the ambitious strategy was slow, but by 2008, ownership of the utilities had been transferred from the government to local authorities. The utilities are not yet financially self-sustaining. With support from the World Bank, the GDWW provides technical assistance to local government and water supply and sewage companies, including helping the water supply and sewage companies prepare five-year business plans and developing a phased program on the reduction of subsidies covering the gap between tariffs and total cost, with a goal of eliminating subsidies by 2012. With support from the Japanese Government, the GDWW prepared a study designed to support the regionalization of water supply and sewage utilities. In addition, the water companies serving Berat and Kucova were successfully merged and infrastructure constructed and rehabilitated with a grant by the German Government.

The European Union, Government of Germany, and other donors are supporting the GOA's effort to prepare an updated National Water Strategy, which is contemplated as part of a new Draft Water Management Law under internal consideration. Other government projects include participation in the Albania-Montenegro Lake Shkoder Integrated Ecosystem Management Global Environment Facility, which is establishing a Bilateral Lake Management framework for the shared water resource.

TRENDS IN WATER USE, MANAGEMENT AND SANITATION

The Government of Albania has begun the preparation of a National Water Strategy (with funding by the EU) to set out polices on the efficient management and protection of water resources, and to specify an appropriate legal framework for the management of water resources. However, the lack of adequate monitoring systems, the rapid changes in economic activities, and the continuous movements in population make it difficult to assess the use of water resources. Available data suggests that irrigation and mining rely mostly on surface water, while households and industry on groundwater from aquifers. Domestic water demand is increasing not only because of population growth but also because of the increase in the level of water losses, estimated to be greater than 50 per cent in all cities.

PROBLEMS, CHALLENGES AND OPPORTUNITIES

While Albania has made progress in increasing the provision of safe drinking water and sanitation - with 78.4 per cent of the population having access to potable water and 76.2 per cent benefiting from improved sanitation – drinking water safety and supply shortages, as well as the pollution of lakes due to untreated sewage disposal, remain important concerns. Despite being naturally rich in water, Albania suffers from a shortage of available drinking water. This is partly because the rainfall is unevenly distributed across the country and partly because more than two thirds of the water is lost during transport and distribution as a consequence of the obsolete supply infrastructure. The towns are supplied with drinking water for only a few hours each day while, in rural regions, the public supply does not even reach one citizen in two. In all rural areas as well as in the majority of towns, sewage is discharged in an uncontrolled manner. The

consequences are that water is contaminated and the environment polluted; gastrointestinal illnesses are very common. The lack of adequate monitoring system, the rapid changes in economic activities, and the continuous movements in population make it difficult to assess the use of water resources. Available data suggests that irrigation and mining rely mostly on surface water, while households and industry on groundwater from aquifers.

Domestic water demand is increasing not only because of population growth but also because of the increase in the level of water losses, estimated to be greater than 50 per cent in all cities. Albania's water sector is plagued by a variety of problems facing the power sector, such as high consumption, wastage and misuse, illegal connections, below-cost tariffs, inadequate revenue collection, and insufficient investment in physical infrastructure. Consequently, despite Albania's abundant water resources, water supply in urban areas is intermittent and less than half of the rural population has access to piped water. The lack of reliable water supply hampers private investment and endangers public health, especially that of the poor. Without sector reform and investment in physical infrastructure, the ongoing deterioration will lead to crisis situations in many urban and rural areas. Limited resources restrict effective monitoring, and data collection on safe drinking water and sanitation remains weak in rural and suburban communities.

DONOR INTERVENTIONS AND INVESTMENTS

The World Bank funded a series of projects designed to support the rebuilding of irrigation and drainage works and the organization of WUAs. The Water Resources Management Project (2004-2009, US$ 16 million) helped increase agricultural production through the provision of reliable irrigation services; increase the financial viability of irrigation and drainage schemes through institutional strengthening; and reduce the risk of dam failures and floods through infrastructure repairs. The ***Municipal Water Project*** (2003 – 2009, US$ 16 million) improved water supply and sanitation facilities for an estimated 400,000 people in 4 towns. The project also helped improve the financial viability of 4 utilities, but the utilities did not achieve the goal of financial independence.

The World Bank-funded Integrated Water and Ecosystems Management Project (2004-2009, US$ 5 million) aimed to improve municipal wastewater services for three important tourist areas that depend heavily on a healthy coastal environment: the cities of Durres, Lezha and Saranda. The project involved building man-made wetlands for wastewater treatment and improving management of the Kune-Vain protected marshland. Project outcomes suffered from poor understanding by both the general population and many within the government about environmental management practices. The World Bank's on-going US$ 38 million Integrated Coastal Zone Management and Clean-up Project (2005-2012) includes support for water supply and sanitation projects. The project, which has the goal of reducing coastal degradation, includes activities to address soil and groundwater contamination in the former chemical plant at Porto Romano; upgrade water supply and sanitation facilities and service in two coastal municipalities; construct an EU-com pliant solid waste landfill; and develop a management plan for Albania's most important Ramsar 4 site. As of June 2010, the project had begun clean-up of the contaminated chemical plant site and construction of water supply and improvement subprojects.

WOMEN'S FOOD SECURITY FOR GENDER EQUALITY

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FOOD is a basic human right. Approximately 1.5 billion people in the world live on less than $1 a day, and every 3.6 seconds someone dies of hunger. Poverty, hunger and malnutrition silently kill the poor people and take away their ability to work and learn. So, adequate food is needed for survival, fulfilling the basic demands, ensuring constitutional human rights and achieving Millennium Development Goals (MDG).

Many rural women come to the cities for livelihood, but their bad luck follows them everywhere. They live inhuman lives, both in their villages and in cities, without food, shelter and other basic necessities. Where there is no money, there is no purchasing power. So we need effective and sustainable programmes to give women adequate food.

If we can arrange food for all, urban migration from rural areas will become less. Poor people, especially women, need a sustainable livelihood. World Food Day highlights awareness of the issues behind poverty and hunger. Despite the increases in food grain production, around half of the population of Bangladesh remains below the food-based poverty line.

Women are often the first to suffer malnutrition in the family. This has repercussions on their health, productivity, quality of life, and survival. Climate change will affect availability, accessibility, utilization and systems stability of food. Bangladesh will face a major problem in the next 40 years since production of rice will decrease by at least 8per cent and of wheat by 32per cent, while the population will increase by 50-75 million.

World Food Programme (WFP) mentioned in its report of 2009 that, in Bangladesh, 46per cent of pregnant women, 39 per cent of non-pregnant women, and 40 per cent of adolescent girls, suffer from anemia because of depleted iron stores during pregnancy and lactation, a consequence of insufficient intake of foods rich in iron and folic acid.

According to the World Bank, approximately 33 million of the 150 million people in Bangladesh cannot afford an average daily intake of more than 1,800 calories, which is the minimum standard for nutrition. For the people in most developing countries, the daily calorie average is 2,828. In Bangladesh, that average is only 2,190.

Helen Keller International (HKI)-Bangladesh has been working to ensure food security and empowerment of women through different programmes. Emily Hillenbrand is a gender specialist and programme manager of HKI-Bangladesh. She said: "Gender discrimination is an underlying, structural cause of Bangladesh's alarmingly high rates of food insecurity and malnutrition. Their malnutrition is related to their limited control over economic assets, exclusion from household decisions, and restricted mobility."

I can place here a simple example of rural women's bad luck due to lack of decision-making power. A woman in Patuakhali who wanted to have her own nose-pin repaired had to ask her husband's permission and was refused, even though the wife had saved her own money for that nose-pin repairing! (Source: HKI Bulletin, No. 5, May 2010). This proves how disadvantaged and dis-empowered the poor women of our country are!

The International Food Policy Research Institute (IFPRI) agrees that poverty is a major determinant of chronic household food insecurity. Global Hunger Index 2010 of IFPRI mentioned that malnutrition among children under two years of age is one of the leading challenges in reducing global hunger and can cause lifelong harm to health, productivity, and earning potential.

The burden of child malnutrition could be cut by 25-36 per cent by providing universal preventive health services and nutrition interventions for children under two and their mothers during pregnancy and lactation. The health of women, specifically mothers, is crucial to reducing child malnutrition. Mothers who were poorly nourished as girls tend to give birth to underweight babies, perpetuating the cycle of malnutrition. Nutrition interventions should be targeted towards girls and women throughout the life cycle, and especially as adolescents before they become pregnant, the report added.

Eradicating extreme poverty and hunger has been selected as the target of MDG One. It aims to:

- Reduce by half the proportion of people living on less than $1 a day;
- Achieve full and productive employment and decent work for all, including women and young people;
- Reduce by half the proportion of people who suffer from hunger.

In fact, MDG One is related to MDG Three: To promote gender equality and women's empowerment, and MDG Five: Women's (maternal) health.

Hunger and malnutrition increase women's dependency on men and decrease their decision making power. That is why women should raise their voice to prevent discrimination and violence against them, and to be able to make their own choices/ decisions like men.

Nobel Laureate of Bangladesh Dr. Muhammad Yunus said: "Economics has a relationship with peace." That means a poor economy is interlinked with poverty, and familial, social and political unrest. As a result, poverty hinders our development and economic growth, and creates obstacles on the road to achieving progress, prosperity, sustainable development, food security, adequate nutrition, gender equality, empowerment of women, peace and Millennium Development Goals (MDGs).

That is why we urgently need to stand up against poverty. The government, political leaders and policy makers need to be sympathetic in the real sense towards the poor and hungry; and kindly feed every hungry woman and girl an adequate diet every day. The state is committed and bound to feed the hungry at any cost.

Poor must be Food and Nutrition Secured

The national food policy of Bangladesh says that food is a basic human need and plays a crucial role in the agro-based economy of Bangladesh, where a large proportion of the income of the

population is allocated to food. The first and foremost responsibility of the state is to ensure an uninterrupted supply of food to all people at all times. According to Article-15(a) of the Constitution of Bangladesh, it shall be a fundamental responsibility of the state to provide its citizens with food. As per the government's Allocation of Business, it is the duty of the Ministry of Food and Disaster Management to establish a dependable food security system for the nation.

Hillary Rodham Clinton, US Secretary of State, wrote an article, "A new approach to global food security and hunger," on World Food Day (October 16). She sets out the five principles guiding US policy on food security. Hillary mentioned in her write-up that for one billion hungry people worldwide, the daily effort to grow, buy, or sell food is the defining struggle of their lives. This matters to all of us. Meeting the challenge of global hunger is at the heart of "food security" -- empowering the world's farmers to sow and harvest plentiful crops, effectively care for livestock and catch fish, and then ensuring that the food produced reaches those who need it.

She also added that food security represented the convergence of several issues: droughts and floods caused by climate change, swings in the global economy that affect food prices, and spikes in the price of oil -- which increase transportation costs. So food security is not only about food, but also about security.

Chronic hunger threatens individuals, governments and societies. People who are starving or undernourished and cannot care for their families are left with feelings of hopelessness and despair, which can lead to tension, conflict, and even violence. Since 2007, there have been riots over food in more than 60 countries. So, we must keep in mind that "hungry people are angry people."

Indeed, women are the main providers of meals, care and nutrition in the household, and they have a fundamental role in assuring improved nutritional status for all. Women play a key role in the socio-economic development of rural areas and in many societies they are also the main producers of food. Special attention should be given to the nutrition of women during pregnancy and lactation. All forms of discrimination, including detrimental traditional practices against women, must be eliminated in accordance with the 1979 Convention on Elimination of All Forms of Discrimination against Women (CEDAW).

Food security is defined in its most basic form as access by all people at all times to the food needed for a healthy life. Achieving food security has three dimensions. First, it is necessary to ensure a safe and nutritionally adequate food supply both at the national level and at the household level. Second, it is necessary to have a reasonable degree of stability in the supply of food both from one year to the other and during the year. Third, and most critical, is the need to ensure that each household has physical, social and economic access to enough food to meet its needs. Each household must have the knowledge and the ability to produce or procure the food that it needs on a sustainable basis.

In this context, properly balanced diets that supply all necessary nutrients and energy without leading to over-consumption or waste should be encouraged. It is also important to encourage the proper distribution of food among all members in the household without any discrimination towards women and children, especially girls.

Nobel Laureate Dr. Amartya Sen said: "Poverty is caused by the lack of exchange entitlement in a market economy. Gainful employment is the principal challenge for the poor and the main focus for poverty alleviation." Thus, strategies for poverty alleviation broadly encompass the redistribution and creation of assets in favour of the poor and give guarantee of employment at a reasonable wage and adoption of measures having direct benefit for the poor. This is possible when political leaders express their commitment to implement the program without corruption or discrimination.

Daniel Toole, Regional Director of Unicef for South Asia said: "Due to persistent and deep inequalities, children in South Asia become trapped in an unrelenting cycle of discrimination at several levels -- poor nutrition, health and sanitation and being excluded from education. This puts a child's face to chronic poverty. So, we can now design more strategic policies. 26.5 million of the 63 million children in Bangladesh live in poverty. Children's seven basic needs -- food, education, health, information, shelter, water and sanitation -- must be addressed to end their poverty. Investing in children is both a fundamental responsibility and an opportunity that, if not grabbed now, will tarnish a nation's growth." Breast-feeding is the most secure means of assuring the food security of infants and should be promoted and protected through appropriate policies and programs.

John Aylieff of World Food Program (WFP) said: "First of all, hunger and malnutrition are probably the biggest impediments to economic growth in the world today. The economic cost of hunger is immense. It is estimated that $20 to $30 billion a year are lost in the world due to hunger and malnutrition. It means that $500 billion to $10 trillion are lost in productivity and income. So, an investment in malnutrition and hunger today is an investment in tomorrow's GDP." Fao's State of Food Insecurity in the World 2008 shows that female-headed households were affected disproportionately by the food price shocks.

Bangladesh is paying a heavy toll for climate change and is facing many big problems, such as increased temperature, salinity, frequent floods, cyclones. Poverty, food insecurity and malnutrition are the three silent killers and climate change has become a severe headache for the nation. Considering those reasons, Bangladesh needs to create and maintain partnership with the rich countries, donors and international communities to feed and save the people of this country.

We should take a holistic approach, and the government and development partners should understand the situation, causes and consequences of food insecurity, hunger and malnutrition, emphasise homestead food production, provide training to more women and offer them financial and technical assistance for poultry rearing and growing vitamin A rich vegetables. The government should distribute quality seeds, fertiliser, and pesticides free of cost among these poor farmers.

As we can never deny our dependability on agriculture, so we must use modern technology to cultivate the land instead of using cows and wooden ploughs. Distribute khas lands among landless people, control population growth for planned family of not more than two children, and set up an agricultural university in Manikganj to accommodate more students for agriculture education. These are the demands of the time.

Also, make efforts to emphasize the role of mass media to raise awareness about poverty and hunger eradication, combat climate change and malnutrition, create employment of poor women, ensure sustainable agricultural and national development, and increase food production and sustainable productivity of our limited lands.

Ensure a Women-Friendly Budget

MALIHA (age 16, but not her real name) does not know what national budget is, because she is illiterate. She was married at 11 and became a mother at 13. Her rickshaw puller father died in a car accident on the day of her birth. Because of her father's death on that day, neighbours have called her *olokkhi/opoya* (unlucky) ever since. She still has to bear this name for her father's death on the same day her child Momota was born. After her husband's death, Maliha earned money working as a rice mill helper. On a rainy night, the mill owner had sex with her in exchange for one kilogram of rice as a gift and his promise to marry her. Maliha believed the man and their sexual relationship continued; she became pregnant. Upon hearing of her pregnancy, the mill owner beat her mercilessly and informed people that Maliha was a prostitute. The people also insulted Maliha, but thanked the mill owner for chasing her away. Maliha thought of killing herself but for her daughter's future, she changed her decision and cried for her bad luck.

Now, Maliha and her daughter live on the city streets without food, sometimes with a piece of bread, and eat remains of others' meals, collecting them from the drains and garbage piles. She looked for a job as a household help, but the homemakers she contacted refused to employ her for being pregnant and having a child. While I talked to Maliha on the street, Momota, malnourished, was crying for food.

The fact is there are thousands of unfortunate girls and women like Maliha in our country and we need to feed them as part of ensuring their human rights and rehabilitation from hunger. Can they not demand a women-friendly budget to help them live a dignified normal life? Of course they have the rights to demand and our constitution has given them those rights. The Constitution of Bangladesh ensures equal rights to all citizens, prohibits discrimination and inequality on the basis of sex and strives to promote social and economic equality. Specifically, with respect to women, Article 28 states "Women shall have equal rights with men in all spheres of state and public life."

Our national budget should be women-friendly to benefit vulnerable and disadvantaged women. Our budget's aim must ensure the creation of employment and shelter, food, nutrition and education security for poor girls and women. In excluding them, we cannot reach any mainstream development goals.

So, dear honourable ministers of concerned ministries: On behalf of all helpless girls and women in our country, like Maliha and her daughter Momota, I humbly request you to kindly allocate them adequate money simply for a normal life with normal daily food.

The government's national budget is a legal document passed at the national parliament. That is why every parliament member of each constituency is responsible for looking into its constituents' interests, especially poor girls and women, to fulfill their five basic needs to live:

food, cloth, shelter, education and health services. The government is accountable to them as it is to everyone. Professor Daniel Tarantola, of the University of New South Wales, Australia, has warned that global warming will indirectly affect people of developing countries, making them more vulnerable to death and severe ill health from HIV/Aids. Experts identified certain factors interrelated to climate change that can help kill more people infected with HIV/Aids.

Factors such as poverty, illiteracy, proximity, malnutrition, unemployment, slum housing, and highly mobile populations are closely related to climate change and may contribute to large number of deaths from Aids. So, the time is now to work sincerely and seriously to save the valuable lives of poor girls and women from poverty, hunger, stalking, violence and disasters. Girls and women are human beings too, and stakeholders of the state. So, poor women and children should be included in the national budget, which should be gender-sensitive. Simone de Beauvoir appropriately wrote in her book, *The Second Sex,* "One is not born a woman, one becomes one."

Address Plights of Poor Women

Historically, women have been the key to food security. But they are not secure; especially poor women die many times before their death. They receive less, but have no rights to demand more. They say less, but are bound to listen more. They eat less, but must produce more to feed others. If we analyze the lives of poor women, we become amazed at how they survive.

Nazma (not her real name), a 32-year-old woman from Patuakhali, lost her house and belongings in cyclone Sidr, which hit in November 2007. Nazma was married at the age of 14 to a 30-year-old day labourer. Nazma had 2 children, but was abandoned by her husband five years ago due to her ultimate failure to pay extra dowry. He married another woman and now lives in the town of Patuakhali, pulling a rickshaw. Nazma's parents, brother and sister died in the 1991 severe cyclone. So, Nazma has no one from whom to seek any support.

Cyclone Sidr took away 3000 lives, destroyed more than one million households, and snatched livelihoods of millions of people. Before standing up and bracing the loss, the people of the coastal belt faced another cyclone, Aila, in May 2009. Aila pushed them further back with considerable loss of lives and property. Nazma's two malnourished children survived Sidr and Aila, but then she had nothing to feed them.

Nazma received some relief material, enough to last her a few days, but after that, she found no way to save the lives of her children and herself. So Nazma and her children, like many other victims, begged a launch supervisor to give her free tickets to Dhaka. She had to digest much slang from the launch authority. After arriving in Dhaka, Nazma and her children took shelter at Sadarghat launch terminal and passed two days without having any food, and only receiving water from a local restaurant. She looked for a housemaid's job, but people refused to appoint her, as they did not know her. On the third night, two people came to Nazma and proposed to give her a 'good job.'

Nazma agreed and went with one man--the other looked after her children until she returned. Taking her to a room, the man forced her to have sex with him, paid her just Tk.20, and abandoned her. Nazma cried silently and went to reclaim her children, but she lost her way and

could not find them. She cried loudly and searched for them everywhere, but she still could not find them anywhere. Nazma became very tired searching for the children, passing her time in the city without a job, and begging to survive. After ten days, she somehow returned home to her village with the hope that maybe her children had returned there, but they were not.

In her village, she could not find work or food, but took shelter at a landlord's verandah to stay the night. Sidr and Aila affected many people in her area, so thousands of poor women and children, like Nazma and her lost children, were looking for help. There was profound regret, and wailing among many people, but too little help.

Bangladesh experiences floods, drought, cyclones and disaster more frequently now, due to climate change. Scientists forecast a further increase in natural calamities in the future. This is why we need to explore the vulnerability of poor women and linkages between gender and climate change issues, particularly in relation to enhancing women's capacities to address climate change to save millions of women like Nazma and her children.

According to the World Health Organization (Who), public health depends on safe drinking water, sufficient food, secure shelter, and good social conditions. Climate change is likely to affect all of these. Public health services and high living standards protect some populations from specific impacts; however, the health effects of a rapidly changing climate are likely to be overwhelmingly negative, particularly in the poorest communities. Among these effects:

- Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions, increasing risks of malnutrition.
- Rising sea levels increase the risk of coastal flooding, and may necessitate population displacement. More than half of the world's population now lives within 60 km of the sea. One of the most vulnerable regions is the Ganges-Brahmaputra delta of Bangladesh.

One of the participants of the Third World Climate Conference (WCC-3), organized by the World Meteorological Organization (Wmo) and held from August 31 to September 4, 2009 in Geneva, Switzerland, was our Prime Minister. The theme of the conference was Climate Prediction and Information for Decision-making. Topics covered by this climate conference included the application of climate prediction and information on societal problems to enable better adaptation to climate variability. We need better climate information for a better future.

The sorrows, tragedies and sufferings of millions of women like Nazma need to be brought in front of world leaders to help save Bangladesh and its people from the long-term problems of climate change. The United Nations secretary general said, "Climate change poses at least as big a threat to the world as war. For that reason, we have a duty to the vulnerable people who contribute least to the problem, but experience its impacts most severely. And we have a responsibility to succeeding generations. We also have a historical obligation to successfully transit to a low-carbon global economy."

In developing countries, because of women's marginalized status and dependence on local natural resources, their domestic burdens are doubly increased; they feel an even greater burden of climate change. They are also underrepresented in decision-making about climate change,

greenhouse gas emissions, and most critically, discussions and decisions about adaptation and mitigation.

So, let us empower our destitute and poor women like Nazma. Their contributions through growing crops, planting trees, producing homestead food will help the country ensure food and nutritional security, and approach climate change efforts with more than just hope and a begging bowl. The landless, poor women like Nazma are in a desperate plight, having lost all their belongings. So, the duty of national and international leaders should be to save their lives, because they, as human beings, have equal rights to stay alive, like others.

While I was talking, prominent freedom fighter Dr. Laila Parveen Banu said, "Liberation war of 1971 has made all classes of the girls and women of Bangladesh couregious, confident and encouraged to march forward. So the empowerment of women in Bangladesh, in fact, women have accomplished by themselves. But we could not still build that Bangladesh with gender equality, which we dreamt in 1971 and fought for. There is a small number of women in our country are empowered, who are well off; but unfortunately poor girls and women have been fighting to survive, most of them are disempowered. Thousands of girls are working in the garments industry and contributing a lot to earn foreign currency, moving the wheel of mainstream development; what the government is doing for them? Nothing."

Dr. Lalila added that we expected a social change and democracy in our country, but that change did not occure and democracy is not yet established. Still after 40 years of our independent, women work at the brick fields, but they do not get equal wages like men. So discrimination against girls and women exists in many sectors including in their families also, she concludes.

Experts in good governance believe that there is a close relationship between good governance and women's empowerment. Because poor systems of governance result in widespread discrimination related to sex, race, color, religion and political opinion. Looking across the world, persistent and pervasive gender disparities continue to exist. Women and men do not have an equal level of political representation, freedom of association and expression, i.e., voice. That is why good governance helps ensuring empowerment of girls and women and gender equality in many ways.

*Joanna Hoffman of Women Deliver in America nicely wrote in her recent article that what is needed now, more than ever, is a fundamental re-positioning of how girls and women are perceived, with an understanding that these changes must come from within cultures. We know that girls and women are **powerful forces of change**; that their unpaid labor contribute up to one-third of world GDP; that every year of a girl's education delays her marriage, reduces the number of children she has, and decreases her children's mortality rates by up to 10per cent; and that the world loses as much as $15 billion in productivity from maternal and newborn deaths. We need to ensure that global leaders and decision-makers are aware of these facts, understand them, and incorporate them into national policies, she concludes.*

Globally, the theme of International Women's day of March 08, this year (2012) has been selected as: 'Connecting Girls, Inspiring Futures'. So, if every International Women's Day

*event includes girls in some way, then thousands of minds will be inspired globally. United Nations has selected the theme this year: **'Empower Rural Women – End Hunger and Poverty'.***
OXFAM mentioned that globally: i) Two-thirds of all children denied school are girls; ii) Women earn only ten per cent of the world's income, yet work two-thirds of the world's working hours; iii) Domestic violence is the single biggest cause of injury and death to women worldwide; iv) Women hold only 14 per cent of the world's governmental seats.
International Food Policy Research Institute (IFPRI) launched in Febraury 27, 2012 a groundbreaking Index to Empower Women and Fight Hunger. It reveals that in the southern Bangladesh sample, more than half of women are less empowered than the men with whom they share their house, yet they are usually confident speaking in public. It further mentioned that traditionally, money and education are used as indirect signposts of women's empowerment. The new survey questions used for the Women in Agriculrure Index expose the weaknesses in these 'proxies' by showing, for example, that having money or being educated does not guarantee that women are empowered.
America-based Human Rights Watch, one of the world's leading independent organizations dedicated to defending and protecting human rights, mentioned in its world report 2012 on human rights that violence against women and girls and their discriminatory treatment in Bangladesh under personal status laws persists. New cases were reported in 2011 of beatings, isolation, and other public humiliation of girls, all imposed following religious leaders' issuance of fatwas on issues such as talking to a man, pre-marital relations, having a child outside wedlock, and adultery. Women's groups are particularly concerned that such abuses continue even though the High Court division of the Bangladesh Supreme Court ordered government authorities to take preventive measures and prosecute perpetrators.
The report added that the recruiters in the Middle East are increasingly turning to Bangladesh to hire women domestic workers as other labor-sending countries tighten their regulations or impose bans in response to widespread exploitation. The government of Bangladesh has failed to introduce minimum protection measures for these workers during training or recruitment or to ensure that embassies abroad are adequately equipped with labor attaches and shelters to respond to cases of abuse," it concludes.
Women's overall empowerment depends on their individual, familial, social and national empowerment, and includes access to food, clothing, shelter, education and treatment/ health care. Millennium Development Goal (MDG) No.3 aims to promote gender equality and empower women by 2015.
Sharmila Chakraborty, a researcher on women in char areas in Bangladesh said, "Further research needs to be conducted to accomplish the requirements necessary for the betterment of poorest segment of the society, especially women's empowerment and to stop violence against girls and women."
Men with a negative attitude towards women should immediately change their mindset to welcome girl children and recognise girls and women as human beings. And provide opportunities to them to practice their due rights pursuant to the constitution. In fact, women are

deprived in many ways and their valuable contributions are not monitored, evaluated or recognised.

So, let us come forward to stop violence against girls and women and ensure their empowerment. Because women are same human beings like we, men. They are equal to men in all respects. Nobel laureate Amartya Sen asserted, "Development is a process of expanding freedoms equally for all individuals. This view assumes that gender equality is a core goal in and of itself and that people's welfare should not be determined by their birthplace or whether or not they were born male or female."

Discrimination against Girls and Women

The United Nations General Assembly in 1999 designated 25 November as International Day for the Elimination of Violence against Women. The 16 days of activism against gender violence starts from November 25 and ends on December 10 – International Human Rights Day. These dates symbolically link violence against women and human rights, and emphasise that such violence is a human rights violation. I think, all over the world girls are treated as 'girls'. That is why they face discrimination and violence against themselves, experience disadvantages since they are in the lap. Their human rights are inhumanely denied. But boys are treated as 'human beings', so they can realise their due human rights and even they enjoy many advantages for being boys starting from their very infancy!

The UNFPA expressed concern over the high rate of early marriage in Bangladesh because it increases child and maternal mortality rates, contributes to population growth, and creates problems of gender discrimination and violence. UNFPA Executive Director Dr Babatunde Osotimehin said, "When girls are married off at early ages, they are not allowed to develop and reach their full potentials. They are also deprived of their ability to contribute to the society." Bangladesh Demographic and Health Survey, 2007 mentioned that fifty per cent of the girls are married before the age of 16. This rate has remained the same in the last 35 years. So UNFPA has urged to increase investment in girls' education. According to the UN body, population growth is a challenge for the world. "If the population growth is faster than a country's economic growth, poverty will persist."

Plan International recently launched a report, title: 'Because I am a girl'. The report points out the status of our girl children. To make a positive change in their lives and ensure equality of the girl children and women, Anwar Hossain Shikder, Acting Country Director of Plan International-Bangladesh said, "We have, of course, focused on girls in the interest of equality. In too many societies girls still face the double discrimination of being young and being female. They are pulled out of school, married early, and are more likely to be subject to violence. Equality of opportunity in health, education and in the workforce will enable girls to become active citizens; contributing powerfully, as mothers and teachers as civic and business leaders, to their families and communities.", he concludes.

In fact, over-population is a big problem for our country. People who are unaware of family planning have mainly increased the fertility rate and created this problem. Now the government and other agencies need to control the growth of population, prepare the total population as

potential human resources through free education, training, and more employment at home and abroad. In addition, unemployed people must have opportunities to be self-reliant through agriculture, homestead food production, handicrafts, business/entrepreneurship etc. There are many talented girls and boys in our country, but a large number of them are unemployed. Now the priority of the government and non-government organizations and rich people of the country must be to make profitable use of those talents of our people by involving them in productive work. Thus we shall be able to transform our population into an efficient workforce through unlocking their potentials. And then every person will be a valuable asset of each family as well as of our country.

To fulfill the plan of making Bangladesh a middle-income country and a developed one, there is no alternative to making all the people efficient human resources at any cost. Solving the problem of unemployment must be the top-priority agenda. As hungry people are always angry people, therefore, to establish peace, real democracy and to ensure sustainable development, we must find ways to feed the hungry people first to quell their anger. Then their healthy and cool brain can discover ways of being self-reliant, working towards development, peace and democracy, preventing discrimination, stalking, violence and crimes.

In Iraq, since the U.S. invasion in March 2003, as many as 5,000 women and girls have been trafficked for sex trade, according to a preliminary report released recently by the London-based Social Change through Education in the Middle East. According to the report, domestic violence, rape and other forms of gender-based violence have become a common practice among the internally displaced persons in Iraq and the large refugee communities in Syria, Jordan, Lebanon and other countries of the Middle East. Above all, we do not want war in any country anymore; rather we want peace to see women having honourable jobs to make their livelihood instead of being sex workers. This is a question all of us have to think over and decide our share of responsibility.

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ROOFTOP RAINWATER HARVESTING IN SOUTH MAHARASHTRA

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ABSTRACT

Fresh water availability is rapidly becoming scarce for environmental requirements and the human consumption such as domestic, economic, social and cultural needs. It is estimated that 3 billion people will be in the water scarcity category of 1 700 m^3 per capita per year by 2025 estimated by United Nations Environmental Programme. Technically it is possible drought proof India even at half of India's average rainfall of 1170mm which is captured on an average 1.12 hectare of land in each of India's 6,49,358 villages. About 6.57 million liters of rainwater can thus be harvested in each village. This can meet the annual cooking and drinking water needs of 1200 persons. The present study is a proof of the above mentioned statements of Sudhirendar Sharma. It has been estimated that the Revengaon village has a rooftop rain water harvesting potential of 1.86 million liters from the 46 equipped houses. The stored water will satisfy the demand of 1199 persons for 78 days or 255 persons for 1 year at rate of 22.4 liters of water per day. The rooftop water harvesting implemented for the remaining 200 houses will generate another 3.45 million liters of water which can supplements the water requirements of another sizeable population of the village.

Key wards: water, roof top rain water harvesting, water shed development,. peoples participation.

Introduction

The total usable freshwater supply for ecosystems and humans is ~200 000 km^3 of water, which is < 1per cent of all freshwater resources, and only 0.01per cent of all the water on Earth (Gleick, 1993; Shiklomanov, 1999). Groundwater represents over 90per cent of the world's readily available freshwater resource (Boswinkel, 2000). About 1.5 billion people depend upon groundwater for their drinking water supply (WRI, UNEP, UNDP, World Bank, 1998). Due to rapid population growth, the potential water availability of Earth's population decreased from 12 900 m^3 per capita per year in 1970 to 9 000 m^3 in 1990, and to less than 7 000 m^3 in 2000(UNEP, 2008). In a bid to conserve rain water and recharge ground water for drought proofing, Indian government has mounted the watershed approach to rainwater harvesting and conservation in a big way. Technically it is feasible to drought proof the entire country even half of the annual average rainfall viz.1170 mm is captured in 1.12 hectares of land in our country. 5, 87,226 villages have potential to conserve 6.57 million liters of rainwater. This collected water in this

village can be meet the annual demand of water required for cooking and drinking (Sharma 5:1). Rainwater harvesting through rooftops is an optimistic method of water resource conservation and Indian government has adopt this as the part of watershed management programme. While people participation is the community centered development has remained largely stuck in the 'youth participate in my programme' mode as a result of lack of community ownership the impact of investment in rural development and natural resources generation has not been effective and long lasting. But somewhere it achieves the goals of rural development in sustainable way. Present study is conducted in Revengaon village of Khanapur tehsil, Maharashtra state. This area has been copes with pains of drought since from longer time because of scanty rainfall.

Revengaon village is now became a success model of watershed development programme carried out by Sangli district administrative in drought prone situation in year 2001 to 2003. Rainwater harvesting via rooftop is an one of the water harvesting technology in this programme applied in drought prone situation in 2001-2003.The rooftop rain water harvesting and watershed development programme have been carried out in Revengaon village with the great deal of enthusiasm because of active peoples participation and social activist and leader Mr. Babasaheb Mulik. The study region is falls under the rain shadow region. On the other hand scanty availability of water leads to over use of surface water as well as sub surface water. Due to which water resource has get urgent attention for future development of this region. Out of total 730 villages in Sangli district, drought situation is same in 494 villages (67per cent) in feminine period occurred in year 2003 (Jalja: 2005: P: 7)[3]. Revengaon village became recognize as a successful model of watershed development where the programmes of water conservation are carried out with sustainable views. The people's participation remained isolated for bringing goals of such developmental work. Present study is conducted in Revangaon village with following objectives.

Objective of the Study

1) *To study rainwater harvesting potential of Revengaon village.*
2) *To suggest remedies for sustainability of rain water harvesting model*
3) *To carry out rain water harvesting potential of pucca (well built) houses for both with roof top rain water harvesting and without rooftop rainwater harvesting.*

Methodology

A general village survey was carried out to assess the roof top area of houses. The primary data have been collected through the Village Panchayat records, the information pertaining to the geographical location, agriculture and water management have been collected through Indian Meteorological Department, Pune, Maharashtra as well as from district collector's records, district census hand book and Socio-Economic review. For making study more reliable the focus group discussion and key informant's interviews have been conducted to collect qualitative data.

Rain Water Harvesting Structure:

ROOF TOP RAIN WATER HARVESTING AND STORING FOR COMMUNITY USE-

This is quite new and improved method for rain water harvesting. This model is suggested by the K. Gopichand and Indersen, Engineer of IIT, Kanpur in year 1983. The rain water collected in roof and stores it in clean tank. The 5ft. radius and 3 ft. depth well constructed tank is build for this purpose. The collected rain water carries towards tanks through PVC pipes. First two rains of early monsoon are not favorable for storing because it having high contaminants. This is much modern method for harvesting rain water in urban areas and now Revengaon Village Panchayat adopt and applied this method for rural areas of Maharashtra.

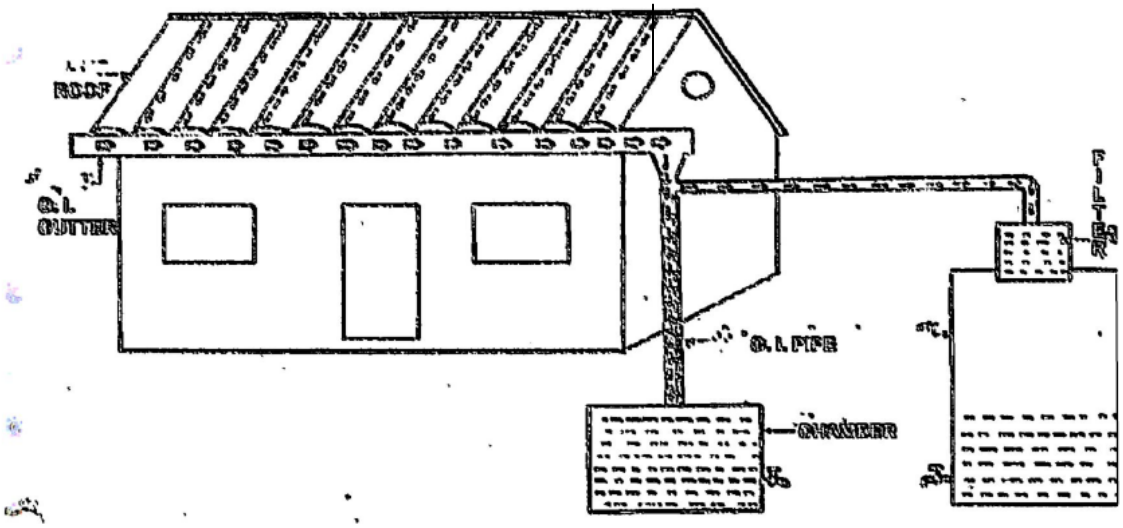

Figure 1 Roof top rain water harvesting and storing structure.

Rainfall Data:

The rainfall data (year 2000-2006) has been collected from Indian Meteorological Department, Pune, Maharashtra. The study village Revengaon came in Khanapur tehasil of Sangli district of Maharashtra. The annual average rainfall (last from 33year) of this region is ranging between 550 to 560 mm.

Coefficient of Runoff:

The coefficient of runoff (Cr) for any catchment's is defined as the ratio of the volume of water that turn off to the volume of rain that fall on the surface (Gould and Nissen, 1999)

$$Cr = \frac{\text{Volume of runoff Cr}}{\text{Volume of rain water that fall on the surface}}$$

The runoff coefficient (Cr) of Revangaon village has been taken 0.8 which is taken as standard for the designing of pucca roof catch system.

The Potential of Water Supply:

It is calculated by using formula given below (Gould and Nissen, 1999**)**

$$S = R \times A \times Cr$$

Where, R= annual rainfall in mm,

A= catchments area in m^2,

Cr= coefficient of Runoff.

Background of Study

Eastern part of Sangli district, including regions of Tasgaon, Kavathemahankal, Atpadi, Khanapur, Kadegaon thasils fall in the semi arid tract of country and which having semi arid climate (Sankpal S:S: 2003 P :29)[4.] Study region forms south part Maharashtra state as it stretches between the altitudes of 16°45'N to 17°33'S and 73°41'East to 75°41'W longitudes. The Eastern part of Sangli district facing extreme weather conditions. In winter season usually last from November to February, whereas summer starts from March and continue up to June with maximum temperature ranging between 30 to 43°C. The precipitation obtained from South-West monsoon continues between July to September end. The average annual rainfall is 460mm, it is sufficient for rainfed agriculture condition but constant variation in rainfall is recorded in study region. The average number of rainy days in year is forty. The average ground water level is 6 meters and only 17 per cent of area of district is under irrigation. Out of the total irrigated area about 70 per cent area is irrigated by well and tube well (Sankpal S. 2003:19)[5]

Revengaon village was highly rich in ground water as well as surface water. Variation in monsoon rainfall and exploitation of ground water at alarming rate falls the ground water level in this region. Conditions are more severe in famine occurred in a year 2001 to 2003. The Revengaon village has been twenty five open wells, two large tanks, 57 bore wells in 678.19 hector. (Village Panchyat Office Record, 2006)[6]. Study village having typical geographical condition to harness huge quantity of water in Revengaon catchment's area.

Mass Participation in Roof Top Rain Water Harvesting in Revangaon Village

In the some recent decade the planners, government stock holder and donor agencies have perceived that the goal of social development can not be achieved unless the beneficiaries participation in the entire process of preparation, implementation and follow up of the development, plans and programme (Chamber's Robert,1994)[7]. Getting people participation in any social development programme is not easy task, people participation in a broader sense means their total involvement with development agencies in deciding the programme and activities, fixing up of priorities, taking initiatives and carrying out the programme as partners by the contribution of their ideas, interest, material, money, labor and time. However the term participation emerged long ago in the vision and actions of Tagore and Gandhi in India. In this context the success story of roof top rain water harvesting in Revengaon village came in lime light during our study visits in month of February, 2006. During our field work our research team recorded that people of this village actively engaged in water management programme.

The social activist Mr. Babasaheb Mulik is initiator of people centered watershed development programme. During our field work he expressed several philosophical views. The part of Deccan platue is very dry and it is came under rain shadow region. Where annual average rainfall of over 4000 mm in wettest part while in the dry areas of the rain shadow zone receives rainfall barely

500 mm, this making geographical conditions quite favorable to rainfed agriculture. In the feminine period Mulik and his organization *`Shreyas Charitable Trust'* offer 10 lakh rupees for de-silted lakes viz. from the village tanks. Further mass movement in this village bringing the goals of sustainable water supply in reality. In this study region roof top rainwater harvesting programme have been carried out for 45 houses out of 278 houses. Participatory approach of people in Revangaon village shows an example of mass participation and it is essential for the success of social development and development of natural resource.

RESULT AND DISCUSSION:

A) The Houses with Roof Top Water Harvesting Model:

Mean annual rainfall of Khanapur tehasil is 460mm. Survey revealed that the village has 278 houses having total population 1199. Of the total houses, 248 houses are pucca (well built) houses and rooftop rain water harvesting model have been implemented for 46 (18per cent) houses. From the result it is revealed that 13 pucca houses (28per cent) having roof top area more than 60 m^2, 11 (23.91 per cent) household having area between 40 to 50 m^2, 8 (17.39 per cent) household having area between 30 to 40 m^2, 3 (6.52 per cent) household having area between 20 to30 m^2, 1 (2.17 per cent) household having area below 20 m^2 and 8 (2.17 per cent) numbers of houses with different rooftop areas were calculated.

Table 1: Tehsil wise Rain fall data in mm. of Sangmli district from 2000-2006.

Years	*Miraj*	*Kavathe mahankal*	*Tasgaon*	*Jath*	*Khanapur*	*Atpadi*	*Kadegaon*	*District Average mm.*
2000	521	535	560	550	**656**	300	250	533.14
2001	471.4	653.4	577	637	**747**	372	747	600.57
2002	478.9	407.9	329	284.6	**356**	226	356	348
2003	252.9	431.8	240	265.5	**294**	193	340	287.85
2004	477.8	450	390	370	**547**	31	210	394.92
2005	565	470	547	390	**560**	325	650	501
2006	650	510	590	410	**750**	180	760	550
Total	**487**	**493**	**461**	**415**	**558**	**273.28**	**544**	**459**

Source- Jalja, Sangli Zilla Watershed Programme, 2005.

The potential of rain water storage were calculated for each category, total potential of rain water and stored water were calculated for each category. Total potential of rooftop rainwater of all household having an rooftop rainwater harvesting model is analyzed as 1.86 million liters. According to United Nation report, it is assumed that 20 liters/capita/day water is essential for rural communities in the developing countries. If the total rain water i.e. approximately 18,60,000 litters stored in tanks. If this is calculated with 20 litters/capita/day for domestic use, then stored water made available for nearly 78 days (approximately for 2-3 months). The

problem of sever water scarcity is observed in March and continue at June. Though it is suggested that the conserved rooftop rainwater is use in this period.

***Table 2 : Rainwater Harvesting In Watershed Structures In Revengaon Village*.**

Sr. No	Type of work	Number	Scheme	Expenditure in Rs	Water Budget (TCM)	Increased area under irrigation (Hect.)
1	Soil nalla bunding	4	EGS			
2	Farm ponds	5	EGS			
3	Continues counter trenches	70 Hect	EGS			
4	Desiltation	1	Peoples participation and co-operative credit society	29.08 Lakhs	134.97	135
5	Roof top rain water harvesting	46	SPPY			
6	Cement nalla bunding	4	SGRY			
7	Well recharge	22	DN			

***Source :- Jalja, Sangli Zilla Watershed Programme, 2005*.**

EGS :- Employment Guaranty Scheme :-Schemes implemented by Govt. of India SGRY :-Sompurna Grammin Rijgar Yojana :- Schemes implemented by Govt. of India

SPPY :- Shivkalin Panipurawatha Yojana:-Both Schemes implemented by Govt. of DN:- DuShkal Nidhi

B) Houses Without Rain Water Harvesting Structures in Revengaon Village:

In the total 278 households, 208 pucca household having traditional roofs which without rooftop rainwater harvesting model. These houses have a potential to implement a rooftop rain water harvesting system. The result showed that, 53 household having rooftop area above 60 m^2, 31 (15.5 per cent) houses having roof top area between 50 to 60 m^2, 43 (21.5 per cent) house hold having roof top area between 40 to 50 m^2 , 27 (13.5 per cent) house hold having roof top area between 40 to 30 m^2 and 25 (12.5) house hold having roof top area between 30 to20 m^2 and 21 (10.5 per cent) house hold area is less than 20 m^2. The total potential of rain water harvesting has been calculated for this category also the total potential of rainwater harvesting for this category is 2.24 million liters. If the total rainwater i.e. approximately 22,40,000 liter stored in storage tank and if we assume 20 liters/capita/day for domestic use, then approximately 101 day i.e. for 3 ½ months in scarcity condition

C) Total Potential of Rainwater Harvesting in Revengaon Village.

It is found that total potential of rooftop rainwater harvesting of Revangaon village is 41, 00,000 liters. If the rooftop rain water harvesting programme has been carried out for remaining houses, the total water stored is 41, 00,000 liters. That will satisfies the demand of water for 171 days of Revangaon village population for approximately for six months.

D) Rain Water Harvesting Through Watershed Development.

The water shed development programme has been carried out in the village campus. In the Revengaon village watershed structure having huge potential conservation of water resources which is explained in following table From table it is clear that, water budget of Revangaon village is 134.97 TCM. Due to water shed development programme increased irrigated area is 135 hectare.

CONCLUSION:

Eastern part of Sangli district is absolute water stressed. While mean annual rainfall is 460 mm. From the analysis rainfall in the Sangli district (last six years) revealed that mean annual rainfall of district is 292 mm with 70 per cent probability. Before rain water harvesting and watershed development programme water obtained from rain immediately flow away towards nearest channels and finally out side watershed area. During present study it is found that, Revengaon village is become a successful model of watershed development. Because of watershed programme and rooftop rainwater harvesting implemented in this village with equity, reliability and adequacy in that case rainwater harvesting is effective alternative where scientific knowledge has been integrated with traditional one for water resource development. Rainwater harvesting and watershed development satisfies the demand of water not only for the domestic purpose but also for agriculture which has been proved by Revangaon village. This model is highly practicable for other villages from country where that region copes with similar conditions.

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Table 3: *Rooftop Rainwater Harvesting Potential in Revengaon Village*

Sr. No.	*Rooftop area(m^2)*	*No. of houses*	*Total rooftop area*	*Potential of rainwater (m^2) (Mean avg. rainfall x catchments area x Cr)*	*Water Storage*	*Total stored water in million liters*	*No. of days@20 lits/day*
Houses with rooftop rain water harvesting structure (based on rainfall in a year 2006)							
1	*60*	*13*	*780*	*0.527x780x0.80= 328.848*	*0.32*	*1.86*	*78*
2	*50*	*10*	*500*	*210.8*	*0.21*		
3	*40*	*11*	*440*	*185.5*	*0.18*		
4	*30*	*8*	*240*	*101.18*	*0.1*		
5	*20*	*3*	*60*	*25.29*	*0.25*		
6	*<20*	*1*	*20*	*0.08*	*0.08*		
Total		*46*					
Houses without rooftop rain water harvesting structure (based on rainfall in a year 2006)							
1	*60*	*53*	*3180*	*0.527x3180x0.80=328.848*	*1.3*	*3.41*	*118*
2	*50*	*31*	*1550*	*210.8*	*0.65*		
3	*40*	*43*	*1720*	*185.5*	*0.72*		
4	*30*	*27*	*810*	*101.18*	*0.34*		
5	*20*	*25*	*500*	*25.29*	*0.21*		
6	*<20*	*21*	*460*	*0.08*	*0.19*		
Total		*200*					

WILD EDIBLE PLANTS OF AN ARID REGION KACHCHH, INDIA: ASSOCIATED INDIGENOUS KNOWLEDGE AND IMPLICATIONS TO FOOD SECURITY

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Abstract

This article describes the indigenous knowledge of local communities on the wild edible plants in Kachchh. Kachchh, the second largest district of India, shows great diversity in floristic pattern. An extensive survey of various wild growing plants was carried out in the district with a view to recording the plant species that are used for edible purposes in emergencies or otherwise. A total of 144 individuals, from 65 villages across the district were interviewed using structured questionnaire survey method. All the major communities across wide range of age groups ranging from 8 years to above 60 years have been covered. Respondents listed a total of 73 plant species. Of these, 73 species, viz. Capparis cartilaginea, Ceropegia bulbosa, Citrullus colocynthis, Prosopis cineraria and Salvadora oleoides are used widely. Three species are used in times of scarcity.

Introduction

The food yielding plants are of predominant importance- a chief group in plant kingdom in the human life (Thacker, Ismail master, Jain, Jain and Sinha, King, Srivastav). The Kachchh flora contains a variety of recipes fulfilling therapeutic, nutritive, health promoting and preventive. This flora provides a large numbers of plants whose fruits, seeds, tubers, gum, leaves, etc. make an important contribution to the diet of the local rural people. These plants not only provide inexpensive food but several other useful products like fibre, fodder, dyes, small timber and musical instruments etc. they also provide useful genes for crop improvement. The study of wild edible plants is important not only to identify the potential sources, which could be utilized as alternative food or in times of scarcity, but also to select promising types for domestication (Arora).

In the very remote and rural area, the local people generally prefer wild plants/ plant parts for edible purposes. According to many elderly people, the local markets used to be predominated by wild edible plants both in quantity and number of species. Though some of these plants are available, nowadays also, the number and quantity of the species are much less than in earlier period. Markets have long played an important role in local economy interaction and exchange

of plant and other products. Usually, commodities are still bartered in some inaccessible areas. Some of the wild edible plants are gathered exclusively for sale and many wild edible plants are carried to nearby urban and/or semi-urban markets for getting higher returns. In the semi- urban areas, a number of introduced plants are replacing this vast number of wild plants.

Study Area

Kachchh district stretches between 22^0 to 24^0 and 68^0 to 71^0 E. It is the second largest district of the country and spreads over 45,652 km^2. It falls in arid tract of Gujarat state and covers about 73per cent of total arid land of the state. The average annual rainfall of Kachchh is 370 ml. It experiences extremes of the weather conditions. The wide range of landscape diversity of the region has supported ecosystem diversity. Several major types of ecosystems are evident in this region, such as grassland and savannah, thorn forest and scrub forest, saline marshlands including great Rann and little Rann of Kachchh, rivers and wastelands and croplands and orchards. In the coastal zone mangrove forests, mudflats and sandy beaches are frequently recorded. These different ecosystems provide habitats to various kinds of plants and animals, including rare and endangered ones, in district Kachchh.

From socio-cultural point of view, district Kachchh exhibits great ethnic and cultural diversity. According to 2001 provisional census the total human population of the district is about 15 lakhs. More than 70per cent of the population belongs to Hindu community, followed by Muslims, Jains and others. Among the Hindus, Rajput, Brahmin, Lohana, Baniya, Bhatiya, Ahir, Kanbi, Lohar and Charan are the chief castes while among Muslims, Sangar, Sodha, Haliputra, Rasiputra are major clans. Around 19per cent of the total population belonged to socio-economically weaker section of the society, including scheduled castes (12per cent), mainly represented by Meghwals and scheduled tribes (7per cent) represented by Koli, Paradhi and Bhils. Animal husbandry, dry land agriculture, fishing, mining and daily wage labour are major income sources for the locals.

Methodology

The present article is outcome of authors' PhD study on the Ecology and Ethnobiology in district Kachchh. Structured questionnaire survey method was employed to document the traditional knowledge of local communities in district Kachchh. During field studies, a total of about 65 villages were surveyed from different parts of district Kachchh. The villages were selected based on the broad socio-economic setup, topographical variation and cultural diversity. In each of the selected villages, 10 per cent households were randomly interviewed to document the ethnodietetic aspect. However, a care was taken to represent all the communities and occupation group within the selected village. In such a manner a total of 204 respondents were interviewed using structured questionnaires. The respondents consisted of all age groups, ranging from 8 years to above 60 years.

Results

Plants under Edible Use

Local people reported a total of 73 species under edible use, which includes 13 domesticated species. While species of all the habits were providing different edible materials, herb, shrub and tree species were most commonly used. Among the plant parts, fruits, leaves and seeds were commonly used for edible purpose. These 73 species are discussed below under 2 sub-edible categories.

Plant/ Plant parts eaten as Fruits and Vegetables

A total of 72 species were reported used as fruits and vegetables (**Table 2**). Out of 72 species, 62 were wild in nature and 10 were cultivated. Among the 72 species, 35 were woody (tree, shrub, undershrub), 4 were grasses and 8 were climbers. It is clearly evident that, Kachchh being arid area, people tend to depend on more frequently available species for their day to day requirements. Out of all, 41 species were available frequently in the area while, 31 species were occasionally available. So the local people use to preserve these plant species for their consumption for whole year.

Ceropegia bulbosa, a twiner with underground bulb was one of the most frequently used edible species. The entire plant along with bulb, branches, leaves, flowers, fruits and buds was used for edible purpose. The bulbs of a grass species- *Cyperus sp*. (locally known as '*Khed*') were mostly reported by rural children as they use to eat them as fruit. The receptacles (*Pipu*) of *Ficus religiosa* are boiled and used for making vegetable. The unripe fruits of *Phoenix dactilyfera* are used for making '*Sabji*'.

Fruits of *Citrullus colocynthis, 'Tusda'*, are covered with gunny bag and bury under the ground and after decaying, it is dig out and then the seeds are eaten. A local sweet dish '*Khir*' is made up of seeds of *Ocimum americanum* (*Tukmariya*) and *Nymphaea pubescens* ('Ghiya', the seeds smell like- '*Ghee*') during some occasions and fasting days. The person, who is taking treatment for fracture, use to drink spores of *Agaricus sp*. with milk to gain more calcium.

Parts of some species, which are not available throughout the year, are preserved and used. Species like *Cucumis callosus* fruits are sliced, salted and sun dried, which is known as '*Kachari*'. Pods of *Cyamopsis tetragonoloba*, *Prosopis cineraria* (*Sangari*) and fruits of *Salvadora oleoides* (*Kokadi*) are dried and preserved for daily consumption during the off-season. The seeds of *Ipomoea pes-tigridis*, locally known as *fadfota* are eaten (mainly in absence of water) by *Maldhari* children.

Some famine resistant species, which occurs widely in the wild, are used during drought period. During severe drought period, the flour of dry fruits of *Capparis decidua* are used to prepare *chapatti*, locally known as '*Mani*'. Further the grains of *Eleusine indica* and *Eragrostis ciliaris* (*Chinchani*) were also used during drought.

Traditional Pickles

There are varieties of pickle recipes in Kachchh. Eighteen plant species, including five domesticated ones, were reportedly used for making pickles (**Table 2**). 12 woody (i.e. trees and

shrubs), 5 herbs and one climber were used in pickle making. Fruits were most commonly used in local pickles. Out of 18 species, 14 were frequently available while, 4 were less available. Pod of *Cassia fistula* (*Garmal*) are boiled and used in pickle making after removing the upper coat. Earlier Fishermen and mainly the camel herders (locally known as *Maldhari*), who graze their camels in mangrove habitat use seeds of *Avicennia marina* to make pickle. Nowadays, these groups are settled in small hamlets and getting substitutes of this coastal species, from their surroundings, so this pickle is not in common use today. *Capparis cartilaginea* is the most important species in pickle making. Its aerial parts (tender twigs) along with leaves and fruits are used for this purpose. Moreover, it is not only important for its taste but daily consumption is believed to help in curing arthritis.

Conclusion

The present paper gives detailed information on 73 species used as edible purposes for traditional pickles making as well as vegetable use in Kachchh. The data indicate that there is great importance of indigenous knowledge in ethnodietetic aspect. The local indigenous knowledge of famine/ scarcity food is also very significant. Conservation of such plants is very important in terms of food security in wild and remote areas.

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KALPAVALLI WIND ENERGY GENERATION PROJECT: LANDGRABBING AND RESOURCE GRABBING ISSUE

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The Kalpavalli forest is developed as common resource on the revenue land (common property) with the community participation and equal efforts by Timbactu Collective organization. Common resources are resources of and for the common people. The eco restoration process becomes meaningful when common and natural resources become peoples resources, owned and managed by the common people. During the British time, the whole landscape was lush green but after some period of time, the area experienced a drastic deforestation which leads to degradation. Land cannot be managed well unless sound agricultural practices are followed. Sound agricultural practices are dependent on forests as only a sound ecosystem can support sustainable agriculture. Twenty years ago ecorestoration work was initiated and currently Kalpavalli forest has very rich biodiversity and healthy resources. There is no any detail ecological study done earlier in the area, the present study aimed to understand the biodiversity of the area and the increased productivity scenario. The preliminary survey has clearly indicated that the valleys of Kalpavalli are very important not only supporting the life of Kalpavalli region but also the nearby Guttur Reserve Forest.

Study Area

The study area is located in Anantapur District, part of the Rayalseema belt of Andhra Pradesh and lies between $13^{o}41'$ and $15^{o}14'$ northern latitude and $76^{o}47'$ and $78^{o}26'$eastern longitude. Over 10 per cent of the geographical area of the district is covered with hills. The important rivers in the district are Pennar, Chitravathi and Vedavathi or Hagari River. Apart from these there are also a number of streams that flow in this region. Anantapur is the second most drought affected district in India and is characterized by harsh environmental conditions, such as very low rainfall, intense solar radiation, high temperature during summer and high wind. Temperatures normally soar up to $45^{o}C$ and wind velocity reaches 50 to 60 km.
The average rainfall in the district is around 520 mm per annum ranging from 120 mm in some parts to 650 mm in some other parts of the district. Being equidistant from the east and the west coast, the district does not enjoy the benefit of both the south-west and the north-east monsoon. Therefore the district is deprived of timely and sufficient precipitation and is subjected to recurring droughts. On an average six droughts occur every ten years. The geological formations in Anantapur District can be broadly classified into two distinct and well marked groups-an older group of archaean rocks and a younger one of sedimentary rocks. Minerals and metals like gold, diamonds, iron, copper, steatite, calcite, corundum and asbestos are known to occur in this region. Gold bearing quartz veins near Ramagiri in Dharmavaram taluk were mined from 1909 to 1997. There is also evidence of heavy sand casting in a few places pointing towards desertification. The area is notified as an arid zone.

Kalpavalli forest area, geologically, is a ridge running northeast to south. The region is at the South edge of Deccan Plateau. The land is highly undulating with a number of small hills. The green cover of 7000 acr. comprising different landuse patterns i.e. forestland, agriculture land, pastureland, tanks, habitation, windfarms, etc.. The region falls into two large contiguous watersheds (Mustikovila and Kogira). There are seven villages in the Kalpavalli protected forest area - Mustikovila, Subbrayanpalli and Guvvalagondipalli, of Chennekothapalli mandal and Shyapuram, Kogira, Kambalpalli and Bedanpalli of Roddam mandal.

The patches of forest in Kalpavalli can be broadly classified into tropical dry deciduous and open scrub (Champion and Seth, 1968). The plant species that dominate the vegetation in this forest are *Acacia* species, *Balanites roxburghii*, *Cordia myxa*, *Capparis* spp., *Prosopis* spp., *Azadirachta indica*, *Cassia fistula*, *Carrisa carandas*, and *Phoenix sylvestris*, etc. Grasses of the ecoregion include *Chrysopogon fulvus*, *Heteropogon contortus*, *Eremopogon foveolatus*, *Aristida setacea*, and *Dactyloctenium* spp., etc.

Methodology

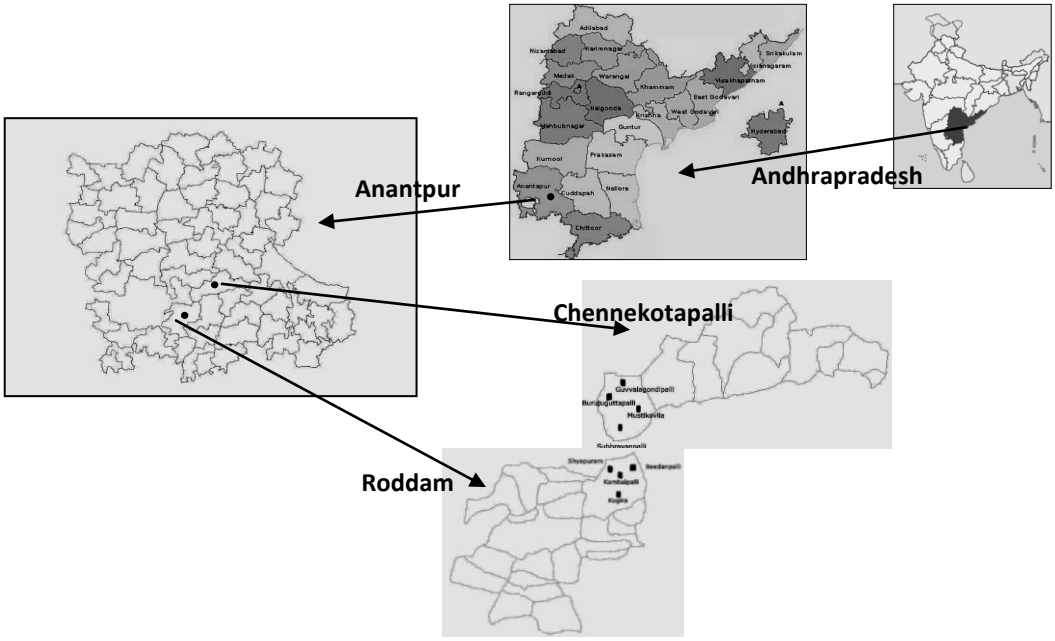
Line transects were laid in different habitats like wetland, valley, hilltops, sacred groves, paddy fields, wind farms and Gold mine dumps of Kalpavalli and adjoining Reserve Forest and other open areas. Trees, shrubs, herbs, grasses, climbers were reported and specimen collected for herbarium. Threats, pressure on resources, community dependency on the forest, interlinkages between the forests, agriculture, pasture lands, windfarms were also studied to understand the status of the forest. Information on the historical profile of the area was collected from local community of Kalpavalli and members of Timbactu Collective.

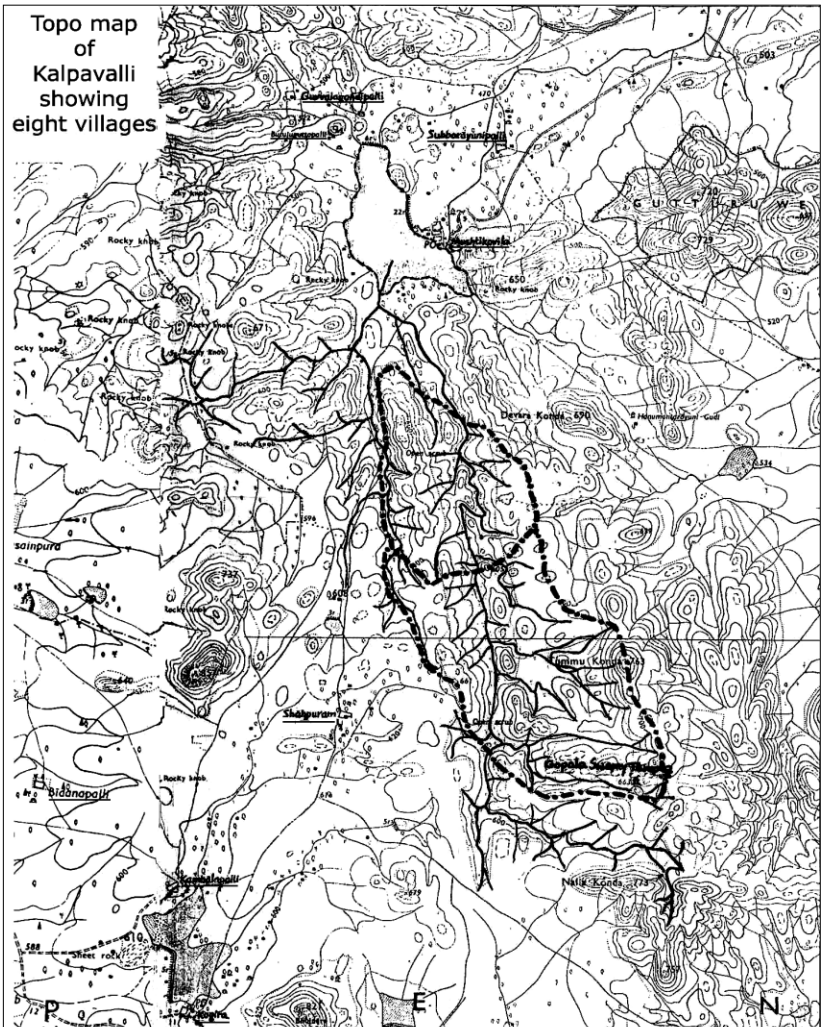
Findings

Kalpavalli Ecosystem

- **Characteristics of Kalpavalli biotope are as follows:**
- **Presence of dry mixed deciduous forest on hill slopes.**
- **Presence of evergreen species along streams.**
- **Presence of Eastern Ghats biotic elements.**
- **Presence of many arboreal faunal species.**
- **Presence of Date Palm groves.**
- **Presence of perennial water sources.**
- **Presence of Sacred Groves**
- **Presence of a layer of soil of varying depth on hill slopes**
- **Presence of traditional water storage Tanks and kuntas**
- **Flow of water and soil deposition towards tank channel.**
- Presence of Mushtikovila tank environ as ‘Corridor’ between Kalpavalli and Guttur Reserve Forest

Map 1: Location of Kalpavalli





BIODIVERSITY OF KALPAVALLI

Biodiversity may sound like an abstract concept, but in reality it touches almost every aspect of our life. Kalpavalli has an enormous variety of plants and animals, both domesticated and wild, as also a wide array of habitats and ecosystems. This diversity meets the food, medicine, shelter, spiritual as well as the recreational needs of local people in and around the Kalpavalli region. It also ensures that ecological functions such as the supply of clean water, nutrient cycling and soil protection are maintained (soil erosion started due to irresponsible, illegal and unsystematic Windmill operations).

The diversity and richness of genes, species, habitats and ecosystems are the real wealth, far more important than money. Perhaps the most important value of biodiversity, particularly in a region like Anantpur, is that it meets the basic survival needs of a vast number of people. A large number of traditional communities depend, wholly or partially, on the surrounding natural resources for their daily needs of food, shelter, clothing, household goods, medicines, fertilizers, religious customs, economy, etc.

FLORA (WILD):

Kalpavalli is quite rich in plant diversity including Cryptogamous plants (lower plants) and Angiosperms (higher plants). In the preliminary survey a total of 387 species were reported from Kalpavalli forest, pasture patches, sacred groves, agriculture fields, Guttur RF F fringe area (border area) and other outside areas of Kalpavalli.

Out of 387 species, 3 belong to Cryptogamous group and 384 species belong to angiosperms.

The detail of each group of plant kingdom is as follows:

Cryptogamous (Lower) Plants

Thallophyta (algae, fungi, bacteria and lichens), Bryophyta and Pteridophyta are the Cryptogamous or lower plant forms. Plants of this group generally need a cool and moist micro-climate to survive. Few such localities are available in Kalpavalli, like dense valleys, which provide micro-climate to lower plants. A brief description of members of these groups, seen in and around Kalpavalli are as under:

Since extensive network of streams and tanks are available in Kalpavalli (see map of tank network), enormous growth of blue green algae and algae diversity can be seen easily. Many unidentified Algae species were seen down stream and in Mushtikovila tank. . Due to time and resource limitations, justification could not be done with this taxa.

Moist, cool and shady places are available in Kalpavalli dense valley areas, which harbour Bryophytes. Mosses like *Riccia* spp. was identified and reported on vertical rocks.

During the study few Pteridophytes (fern) were reported. *Actinopteris radiata*, a xerophytic fern was seen in vertical cut surface on ground floor of moist area, enduring high intensity of radiant energy. *Azolla* sp, was reported as free floating aquatic (hydrophytic) fern. Both these ferns are sun loving (heliophilous) in nature. Crown contact and crown overlapping stages can be seen in the dense valley of the main stream of Kalpavalli, which make the ground floor quite shady. This is a perfect habitat for bryophytes and pteridophytes. Detailed study is required to understand the diversity and richness of mosses and ferns.

Angiosperms (Higher Plants)

All the life forms of higher plants like tree, shrub, herb, climber, liana, parasite, tuberous plant can be seen in Kalpavalli region. A total of 384 angiospermic species are reported till

date from the field (Annexure 1). Of these, about 298 plant species were recorded from inside the line transects while the rest 86 (including 52 agriculture crop varieties) were recorded from the cultivated fields. Other than these, there are still more plant specimens, which are unidentified and unconfirmed and need timely exploration (in different seasons) for their identification. In view of this, the plant diversity of Kalpavalli is expected to be well over 500 plant species, including cultivated and ornamental plants. However, the taxonomic analysis presented here is based on the 332 plant species excluding agriculture varieties (52 nos). The detail of agriculture diversity is given in "Agro-diversity" in this chapter.

Among Angiosperms, 261 (79per cent) were dicots while the rest 71 (21per cent) were monocots. Around 43per cent of total plants were recorded under herb category (143) followed by trees (63), shrub (37), under shrub (10) and climbers and twiners (25). Of the total listing of plants about 45 species of grasses and 9 species of sedge were recorded from the study area.

All the reported 332 species belong to 79 families. Poaceae family is the most dominant family with 45 species followed by Fabaceae (39), Asteraceae (15), Euphorbiaceae (15), Amaranthaceae (14), Mimosaceae (11), Caesalpiniaceae (11). Collectively the leguminous group (Fabaceae, Mimosaceae, Caesalpiniaceae) is richer with 61 species, which helps to rejuvenate the health of soil by nitrogen fixation. The sedge family (Cyperaceae) is reported from wetlands and tanks with 9 species. The dominance of Poaceae family is because of the rich grasslands everywhere in the hillocks in Kalpavalli. Major species were reported from the sacred groves.

The region has range of micro habitats and some of the species reported from specific habitats, are explained here:

A very dense Kewra grove (*Pandanus fascicularis*) was reported in moist and marshy part of the Mushtikovila tank near the temple. A dense grove of *Borassus flabellifer* (Toddy tree) was reported from the *Marima Gudi* Sacred grove area. Among others,

Riparian species: *Syzygium heyneanum*

Forest outskirts: *Cordia dichotoma*

Aquatic and semi aquatic: *Bacopa monneri, Typha angustata, Saccarum spontaneum*

Valleys: *Tecomella undulate, Phoenix sylvestris, Desmostachya bipinnata*

Foot hills*: Barleria prionitis, Tectona grandis, Gmelina arborea, Gloriosa superba*

Along streams: *Vitex negundo*

Moist open and fields: *Digera muricata*

Gravelly rock area: *Pupalia lappacea, Aristida adscensionis, Melanocenchris jacquemontii*

Moist, shady places: *Commelina benghalensis*

Hill slopes: *Apluda mutica, Heteropogon contortus*

Agro fields: *Urochloa panicoides*

Three parasitic species *Dendrophthoe falcate*, *Cassytha filiformis* (stem parasites) and *Santalum album* (root hemi-parasite) were also reported. In the Kailashkona area, *Dendrophthoe falcate* is very dominant parasite species. Seed dispersal of parasitic plants

mainly depends on avian activities. Parasitic plants are indicator of good forest and rich avifauna.

Other than this, three major invasive species were reported form Kalpavalli. *Prosopis juliflora* is the most dominant invader followed by *Lantana camara* and *Parthenium hysterophorus*. Their increasing population is harmful for the indigenous vegetation especially in the valley areas.

FAUNA (WILD):

Fauna diversity is dependent on the flora of the area. The rich vegetation of Kalpavalli supports a range of non-chordate and chordate fauna diversity. A total of 123 fauna species were recorded from the area (Annexure- 2).

Non-chordate Fauna:

Non-chordate is a very big group of animals i.e. Protozoa, Prolifera, Coelenterata, Helminthes, Nnnelida, Arthropoda (Crustacea, Arachnida, Insecta, Myriapoda) Mollusca. Due to time and resource limitations, only macro forms of non-chordate of Kalpavalli could be studied. So far, no scientific work has been done on the non-chordates of Anantpur district. Hence, this will be a pioneer effort in this field.

Earthworms (Annelids) are common in the wet areas of fields, which are well known for well being of soil health. There are many spider species existing in the area but only four species were identified. Spiders are considered biological pest controllers. Red velvet mite (*Mutella occidentolis*), a symbol of monsoon is seen during early rains; they are not parasite like ticks but are free living. Ticks were not identified.

Varied form of habitat are available in Kalpavalli like forests, patches of grasslands, agricultural fields, streams, wells, human settlements etc. which harbour high numbers and varied forms of insect life. Since winters are not severe here, insects can be seen throughout the year but during and after rains their number increases up to maximum level.

The members of insect group reported from Kalpavalli are Mantis, Grasshopper, Crickets, Dragonfly, Damselfly, Ant, Beetle, Honey Bee, Flies, Moths and Butterflies, Water bugs and Water skaters. Dragonflies and Damselflies (Odonates group) play a very crucial role in ecosystem (indicators of quality of the biotope). Being very specific about breeding habitat, they are sensitive indicators of the health of wetland and its landscape. Odonates, being predators both at larval and adult stages, play a significant role in the wetland ecosystem. Adult odonates feed on mosquitoes, flies and other blood-sucking flies and act as an important biological pest-control agent of these harmful insects. They are also known as 'Conservation Soldiers'.

Class Myriapoda is represented by two orders - Chilopoda (Centipedes) and Chilognatha (Millipedes). Among millipedes only *Julus* sp. is identified.

Among Mollusca, many fresh water and land Snail species are seen in Kalpavalli. Snails play an important ecological role in the forests. They feed on litters, fungi, dead plants and animals and help in their decomposition thereby enriching the soil. They are therefore often called as 'Soil engineers'.

Chordate Fauna:

The water bodies of Kalpavalli have good fish diversity, which support fishing activity. No identification done of fish species available in the tanks. Fishes of streams and tanks provide food to many birds like, River Tern (*Sterna aurantia*), Little Grebe (*Techybaptus ruficollis*), Little Egret (*Egretta garzetta*), Indian Pond Heron, (*Ardeola grayii*), Little Heron (*Butorides straitas*) etc.

Amphibian members are also seen in the area but only Indian bull Frog is identified. Identification of many other species of frogs and toads are yet to be done. During the study some reptiles were seen in the area. The detailed study on fish, amphibian and reptiles is essential to understand their role in food web.

During the study, Avifauna (birds) species were recorded from all the habitats mentioned above. Family Ardeidae, Phasianidae, Campephagidae, Laniidae, Muscicapidae are well represented in Kalpavalli and surrounding areas of RF. The Mushtikovila tank is the biggest open surface water body in the area and supports big flocks of aquatic birds, can be considered an IBA (Important Birds Area). Cattle Egrets tap many foraging grounds. They follow cattle in fields and congregate in streams and tanks. Flocks of Cattle Egret can be seen following ploughing farmers in the paddy fields of tank-command areas. They roost near human habitations. The dense bed of *Typha augustata* was seen in the stream area between Ramagiri and Mushtikovila village attracts many birds.

A group of Egyptian Vulture (16 members) was seen while roosting on the open ground area near Anjana Swami Gudi Sacred grove. There is a site near to this ground where the local people throw dead cattles and these vultures feed on carcass of the cattle. Hence, they help in environment cleaning. Also three Egyptian Vultures were seen hovering in the sky near the Mushtikovila tank.

During the night transects, *Caprimulgus indicus* (Indian Nightjar) was sited two times in Kalpavalli (night transect- Kogira forest part). They roost and lay their eggs on the ground without building any kind of nest during breeding season. Nightjars prefer open areas during summer season, especially during moonlit nights. Therefore the population of Nightjars is an indicator of good status of the ground of the forest.

One species of Bee-eater (*Merops orientalis)*, two species of Rollers and one species of Hoopoe were seen in Kalpavalli. A beautiful bird Indian Grey Hornbill (*Ocyceros briostris*) was seen near Guttiwala Kunta, on the tree near Mushtikovila tank and Gopalswami Gudi Sacred grove. White-napped Tit is an endemic species in India and it prefers thorn-scrub forest. It was seen at the end of the transect near National Highway 7. Nests of Baya Weaver were recorded on Date trees in the valleys of Kalpavalli. Crested Bunting was seen in the Guttur RF periphery area near Mushtikovila.

Kalpavalli is a hard-effort-gifted natural forest worth visiting from biotic resource point of view. Since varied habitats are available over here, it is rich in mammalian fauna too. Due to the excellent network of the water bodies, drinking water is not a problem for wild animals. Big and small mammals are present in the area. Bats were seen in Kalpavalli but not in Ramagiri Wind Farm area (this aspect is covered in next Chapter). The luxuriant vegetation is suitable for bats. Bats are helping the forest in terms of seed dispersal. The species identification is not done and needs detailed study on Bat population, their habitat and habitat assessment, food habit and food niche, impacts of recent developments on their population.

Rhesus Macaque *(Macaca mulatta)* is a common primate in Kalpavalli region. Small troops were recorded in the way to Ramagiri near the tank. A big troop of this primate resides in the Kailash Kona temple area near water stream. They help in seed dispersal of many wild plant species.Asiatic Jackal and Indian Fox are two main canids of Kalpavalli. Indian Fox is identified from Jackal by more bushy tail and long ears. Its tail tip is of black colour like that of Jackal. Jackal is a nocturnal animal and sited three times during night transects. The Indian Fox was recorded from the Canal area behind Timbaktu and near Guttur RF (two Foxes on the dead cow).

Grey Mongoose (*Herpestes edwardsii*) is common in fields and human habitations in Kalpavalli. Also they were seen dead in road trampling near Mushtikovila, on the way to Kailash Kona, on the road between railway-crossing to Kailash Kona. It is important to notice that the local villagers use bullock carts, cycles and other small vehicles of low speeds for transportation. All these incidents are reported on

the roads, which are in use by big and heavy vehicles for Windmill operations. Not only this, three snakes, hare, squirrel and dogs were also reported in road trampling.

According to the local people Leopard is there in the area. During the study, no direct or indirect evidences were seen of Leopard. But presence of Leopard in Guttur RF is sure. There is a corridor between the RF and Kalpavalli they visit Kalpavalli areas too (according to the local villagers) for food as the grasslands of Kalpavalli supports population of Deer. A good number of Deer herds were recorded from Kalpavalli in Kogira forest area, on the grassland on the hills near Kailash Kona and Anjaneyswami Gudi Sacred groves. The Indian Wild Boar also exists in the area. Calls of a big group of Wild Boar were reported in Marima Gudi Sacred grove area.

Indian Hare was recorded from many parts of Kalpavalli and the outskirts of Timbaktu. Among the Rodentia, Five stripped palm squirrel, mice and Porcupine were recorded. The Five stripped palm squirrel is common everywhere in the area. Indian Porcupine (*Hystrix indica*) is a nocturnal animal and the biggest rodent of Kalpavalli. Indirect evidences collected from many parts of the area.

Relation of Kalpavalli with Guttur Reserve Forest:

Kalpavalli supports rich biodiversity evidenced by this preliminary study. Large numbers of local and migratory birds and animals are indicators of good habitat and food security in Kalpavalli. The Mushtikovila tank and adjoining plains are playing a role of corridor for the wildlife of Guttur Reserve Forest. Therefore it is very important to understand the strong connection between Kalpavalli and Guttur RF.

It was observed that the tree cover was providing a large range of food and roosting and safe habitat for various animals and birds in summer season also where the surrounding other patches are barren.

The corridor not only provides food and safe habitat but also provides to and fro safe route to the game animals. Many animals, Bats, members of Avifauna and odonates need open surface water and the tanks of Kalpavalli are an ideal water source for them. The corridor area consists different habitats like open ground, grassland, agriculture fields and small height hills. Small and big herbivore have good food-covered path for movements. Three transects were laid in the corridor to understand the movements of animals and birds.

There is a site in this corridor area where the local people discard dead bodies and thus it is a food zone for vultures, small and big carnivore animals and scavengers. In an easy language one can say that the Kalpavalli tanks and valleys provide food and water whereas Guttur RF provides safe hiding for animals.

It is also important to notice that the part of Guttur RF adjoining Kalpavalli do not face noise and air pollution as there are no such disturbing activities in Kalpavalli villages. Another part of Guttur RF, which is connected to National Highway 7, faces such pollution and disturbances. But for last eight months the Windmill operations going on in Kalpavalli and during these operations frequent landblasts done to remove hill tops have increased disturbances to the wild animals and birds. This is detailed in the next chapter. Six Windmills are under construction in the corridor area which will increase threats to the wild life of Guttur RF (This needs detailed observation and analysis).

Agro-Diversity and Agriculture:

As mentioned earlier, Kalpavalli region has good stream and tank network, agriculture is comparatively good. The tank system detail is given in this chapter later. A total of 86 plant species including 34 main crops and 52 crop varieties were recorded from agriculture fields (Annexure- 3.). Rice has maximum varieties (15) including indigenous and hybrids. Low water requirement, local Paddy seeds are also under cultivation in the fields.

Millets are the second staple food after Rice and under cultivation with six species and 19 varieties. Four varieties of Finger Millet and nine varieties of Great Millet were recorded. Among others, the oil yielding crop Groundnut has six varieties, 16 varieties belong to pulses followed by vegetables (18), spices and condiments (8) and fruit crops (4). The main source from agriculture field is food but the crop diversity provides good amount of fodder and feed for poultry.

Grass Lands and Animal Husbandry

Success of the regeneration is visible in the abundance of fodder that is available today for grazing. Villagers from the natural regeneration region alone are allowed to graze their livestock and that too in demarcated plots. Due to the regular regeneration efforts fodder is now available throughout the year.

Until rains in 2004 broke it, Rayalaseema was going through a 3 year long drought. By 2003, villagers everywhere were selling their cattle to slaughterers. But not the 8 villages where the Kalpavalli Samakhya has a unit. They had more fodder than they could use. From the 8,000 acres on the Kalpavalli under regeneration, close to 7,000 cart loads of fodder were carried away by 3,000 farmers in 40 villages of Roddam, Ramagiri, Chennakothapalli and Penukonda mandals. Farmers even came from Thirumali of neighbouring Karnataka State. Additionally, the hills welcomed around 40,000 sheep from 23 villages. The regenerating hills had yielded Rs 27.50 lakhs of produce, and over 34,000 work-days of employment.

The availability of fodder supports a great genetic diversity of cattle and small ruminents (Annexure-4). Cows and Bullocks are having six different breeds with different characteristics, namely, Alikeri, Desapu, Jersey, Kwadi, Nati, Ongole.

Ongole[8] bulls (photo) look majestic, royal, attractive and alert. The Ongoles are fine, docile and suitable for heavy draught. Ongole cattle perform under varying environmental conditions (high temperature) due to their adaptability and are unique triple purpose cattle that serve as draught cattle, milk and meat animals.

The shepherds graze small ruminents in the pasture patches of Kalpavalli. During summers they set fire to the old and dry standing grass (unpalatable) so that new fresh grass will come on the ground. Because of this practice, some times large tracts of hills and grounds get burnt. Not only the dry and unpalatable grass, other herbs, climbers, regeneration of trees and shrubs also get burnt.

Poultry:

Country poultry is also an important source of livelihood in Kalpavalli. Villagers keep domestic fowls as pets. There are 11 different breeds of domestic fowls present in the area. Hence, the area has rich gene pool. The breeds of domestic fowl include Asali, Bedasalu, Ceetikodi, Dega, Girraju, Kakinemalli, Natikodi, Padakodi, Paramkodi, Pigali, Selam

FUEL WOOD:

Fuel wood to meet the household needs is also available easily in Kalpavalli for the villagers (especially women) saving them from the trouble of going long distances in its search. Dry and dead wood are mainly used for fuel.

[8] Ongole bulls have gone as far as America, Holland, Malaysia, Brazil, Argentina, Columbia, Mexico, Paraguay, Indonesia, West Indies, Australia, Fiji, Mauritius, Indo china & Philippines. The Brahmana bull in America is an off-breed of the Ongole. An Island in Malaysia where there are many Ongoles is named as Ongole Island. The population of Ongole off-breed in Brazil is said to be around several millions.

The mascot of the 2002 Indian National Games was *Veera*, an Ongole Bull.

***MINOR FOREST PRODUCE*:**

Dates:

One of the most useful assets created by the regeneration process at Kalpavalli is the Date palm tree. The main stream that runs through Kalpavalli is dotted with thousands of Date palms and they have begun to benefit the poorest of the poor. While the VSC have been reaping benefits from the sale of Date palm fronds to basket and mat makers and from commission received from toddy trappers, the poor have been benefiting from dates, which they collect and sell to local markets in summer months. Norms are laid for the collection of dates. Only the ripened fruits can be collected and not the entire branch cut. 160 families selling Date palm fruits earn Rs 16,000 each in three months (all economic data by Timbaktu Collective)

Date Palm Fronds:

These are collected for making baskets. Blocks or areas which contain date palms are allocated to individuals by the VSC of the village at a specified rate to the highest bidder who pays the amount as advance. Collection of fronds can be done only from the blocks specified and only trees that are more than five feet tall are marked out. All fronds from one tree cannot be removed but some at the top should be left for allowing the tree to grow. Local people are given preference.

Toddy:

Collection of toddy from the date palms is another source of income for the poor villagers. Again norms are specified and adhered to. Local people are given preference. Tapping is allowed only on those palms that are more than five feet in height. The VSC member goes with the toddy tapper and indicates the trees from which he can tap toddy for a period of three months only. Toddy tappers are required to pay an advance to the VSC and are instructed to be extremely careful while carrying out tapping. If carelessly done the tree can be subjected to an attack of insects which can kill it. Also for every hundred trees, if the tapper injures more than five, he is required to pay a fine. In addition a fine is levied if the tapper taps more trees than he had been allocated. The activities of the tapper are closely monitored by the watchers on a regular basis.

Grass for Brooms:

Brooms made from the 'bodha grass' *(Cymbopogon coloratus*) are locally used as well as sold in the market in the surrounding towns. In this case it was women who took the initiative. They collected grass, cleaned the same and took it to the market for selling thereby getting an income and encouraging others to do the same. 240 families earn Rs 18,000 each in four months by making and selling brooms which are made from grass.

Fibre Collection from Agave Leaves for Rope Making:

Leaves of *Agave americana* are used for rope making. Agave Americana grows on hedge of agriculture fields and near water bodies. Local farmers grow this species as biological fence.

Fibre collection is the livelihood of some, mainly land less people. Usually farmers give contract to cut leaves. The leaves were cut from the body of the plant. Care used to be taken that roots do not get damaged. So that in few months leaves grow again. The fibre collectors now use machine to obtain fibre from leaves, which does the work fast and fine. One truck of green leaves costs Rs. 2000 to 3000 and the obtained product-fibre (photo), costs around Rs. 5000 per truck, which is ready material for making rope and is transported outside Kalpavalli.

There are 90 more plants which are currently used as medicinal plants and 79 plant species collected as MFP for domestic and economic use.

SACRED GROVES

Temples called 'Gudi' are very religious and sacred places, present in each village especially in valley areas. Good forest cover is seen in the vicinity of such sacred places (map and photo). Sacred groves around valley are rich from floral and avifauna diversity point of view. Anjaneyswami Gudi, Gopalswami Gudi, Marima Gudi and Karima Gudi,Virannapadaluswami Gudi, Shri Kailasham are such sacred groves. Among all the sacred groves, some deities are male gods and some are female gods.

In olden days, Gudi (temple) were simple and open structure (like Marima Gudi, Virannapadaluswami Gudi) but now they are covered-room like (Anjaneyswami Gudi, Gopalswami Gudi).

Forest around a temple is generally protected. Since most of temples are present inside the Kalpavalli forest area, hence, boundaries of a sacred grove remain obscure. When a Gudi is present outside the forest, a small grove of trees is seen around the deity.

Idol or symbolic idol of a deity is never placed in open area. It is generally placed under shade of stones or naturally growing trees. Once a tree is dedicated to some diety such trees are always respected and protected by the community.

WINDMILL INTERVENTION WITHOUT PROPER PERSPECTIVE

Kalpavalli is facing a problem from development of Windmills in catchment areas of regenerated forest. Large patches and roads are developed by removal of vegetation in the upper ridges which causes the area to suffer massive soil erosion. The forest cover is the main factor against soil erosion and supports rainwater recharge in streams and tanks. If this forest cover gets harmed, it will affect the whole watershed channel including stream, tanks, small water bodies and wells.

Proper, systematic and local life-sensitive methods should be developed and utilised for area screening of prospective sites for wind power development. Wind speeds at the height of a wind turbine depend strongly on terrain elevation, exposure, slope, and orientation to prevailing winds, all these factors are professionally important for companies; but there are other factors, more important to consider during wind site suitability, such as the distance to nearby transmission lines, proximity to protected areas or reserve forest, type of vegetation cover, local life support systems including natural resource dependent livelihoods, watershed and water catchment aspects, habitat diversity, use of local resources in the power generation etc. These factors are not considered in selection of Kalpavalli region for wind power generation.

During the study, three transects done outside areas of Kalpavalli, which are not forest and also not under ecorestoration and hence are fallow areas. These areas are having similar topography and may have potential for Wind energy projects. Kalpavalli regenerated area is in continuation to Ramagiri Wind farms area. Fallow areas could be more suitable than the green and dense cover of Kalpavalli destroyed for energy generation. A variety of considerations need to be taken into about during micro-siting like, habitat and vegetation surveys, soil surveys, geotechnical assessment, hydrology, etc. but according to the crying face of Kalpavalli, all these are completely ignored. It is important to notice that the environment sensitive methods were not applied for the site selection of Kalpavalli and there is no concrete mechanism for environment protection, habitat restoration, ground risk assessment, waste management, local resource use (especially roads and water) and all these details are not discussed with the local community with transparency.

The face of Kalpavalli has completely changed in the past one year after Enercon's entry. The company has permission to install 48 windmills, and the state government has allotted 28 hectares (ha) of land at a cost Rs. 25,000 an acre (0.4 ha). Apart from the allotted land, the company has used 79.3 ha (more than 190 acres) of land for road construction without any legal permission.

The company got permission from the district administration, to set up the windmills after the Non-conventional Energy Development Corporation of Andhra Pradesh (NEDCAP) sanctioned the project in 2004. According to the company wind monitoring studies have been undertaken by the NEDCAP, and Ministry of Non-conventional Energy sources notified the location "as a proven windy site to encourage investment in the private sector".

The result has been devastating. Almost all the hillocks in Kalpavalli (all in catchment areas) are bearing the brunt of wind energy production. Vegetation cover has been removed and hilltops are being cut for windmill installation. Deep cuts of about 3 to 4 metre have been made on the slopes to develop roads, but without any retaining walls which has led to massive soil erosion. The company has so far developed 40 km of road, ranging 10m to 50m in width. The deep cuts have heavily damaged pasture routes, making it impossible for cattle to climb up the hills.

Clean Energy, Dirty Business: Clean Energy Generation by Destroying Existing Green Energy!

Despite the area then being covered by forests, both the government as well as the company ignored this and referred to obsolete revenue records which showed the area as "wastelands". Subsequently, the company and the government entered into purchase agreements for one acre plots at 48 strategic locations at throw away prices. Despite the introduction of Part IX in the Constitution of India dealing with the Panchayats (The smallest unit of Governance comprising of a group of villages) and powers given to the Gram Sabha (A meeting where all members of the village above voting age are eligible to attend and give their opinion) and Panchayats, neither the state government nor the company thought it fit to discuss the setting up of windmills in the Gram Sabhas and thereafter in the Panchayats. Meetings were held with government officials and with elected representatives and occasionally with some of the Sarpanch's (Elected Head of the Panchayat). The State Government and the elected representatives were most keen to promote windmills as the investments were considerable and certain benefits would accrue to these officials personally.

The cutting of top of the hill to create a flat area for the construction of the windmill, the making of the roads, the incessant heavy traffic up and down the hills and through the villages by trucks carrying the massive parts of the windmills, all created heavy dust pollution which settled on the trees and on the agricultural fields causing tremendous inconvenience to the people, the rise of temperature in the area, and the decline of agriculture. As road building required the mountains to be cut, the internal water aquifers were also cut and destroyed leading to a drastic decline in water availability through traditional sources. Even the main streams of the villages began to slowly dry up.

The Kalpavalli area was widely known for the abundance of grass that grew on the hill slopes which was more suitable for sheep and goats. Even during the drought periods Kalpavalli was one area where the grass grew in abundance and animals could graze and survive. The livelihood of the people of Kalpavalli depended, in no small measure, on these pasture lands which brought them livelihood and income. With the making of the roads, the cutting of the mountains, the destruction of the groundwater sources, the cutting of the trees for the construction activity, and the erection of 48 huge steel structures reaching high into the sky; the grass of Kalpavalli began to mysteriously diminish and now, in many parts, has disappeared altogether. The cattle are unable to graze on the mountains because the slopes of the mountains have been disrupted by the making of massive roads and by deep cuts made in the mountain side which make it impossible for the cattle to climb up. Grazing of cattle has therefore come to an end completely and with that a major source of livelihood for the people of Kalpavalli.

The construction work also caused huge amount of debris to spill into the adjacent fields and to fall into the tanks and water bodies thus destroying the water bodies wholly or partially and affecting livestock. The putting up of the windmills resulted in plastic and metal debris spread all over the area. Cattle ate this debris and died. To make matters worse the construction activity needed a huge amount of water and even afterwards windmills need a constant supply of water for the cooling of windmills. This water was taken by the company from the traditional water bodies of the villages without bothering to take permission and most often without payment and occasionally on the payment of some paltry amount. Water was also taken by the excessive drawing of water from the tube wells on private lands which depleted the water table even further.

Low Benefit-Huge Negative Impact

Yet, Enercon has submitted this windmill project at the UNFCCC to receive Carbon credits under the UN offsetting scheme Clean Development Mechanism (CDM). Under this scheme, projects can receive Carbon credits if they reduce emissions and contribute to sustainable development. If approved, the project will receive about 360,000 Carbon credits. Compared to other CDM projects, a relatively small amount.

Despite serious concerns explained above, the Indian government has confirmed that the project contributes to the social, environmental, economic and technological well-being in the region. This without any Environment Impact Assessment (EIA) being done in the area.

Moreover, the UN approval process requires a thorough stakeholder consultation process, including a local stakeholder consultation where local communities are consulted about the project. This was not done in the case of Kalpavalli. It was only when the roads needed to be constructed that a process of involving the community was followed by making many promises with the idea of dividing them. When concern was raised about the effect on the cattle grazing near by the project after 4 to 5 years down the line from the commencement of project, villagers were assured that the project would not have any impact on grazing.

From the above it is clear that windmills have a cost to the local community apart from diminishing valuable biodiversity. The study done by the author, documents more than 500 flora and fauna species in the region, including a number of rare and endangered ones. The study also shows that the region is acting as a corridor to the nearby Guttur Reserve Forest, which is the only wilderness area in the region.

The following needs to be done.

1. Restoration of the damage caused by the construction of roads.
2. Compensation for the loss of the livelihood potential due to the restricted grazing access and loss of other livelihoods from Non Timber Forest Produce.
3. Consideration of the local community as the primary stakeholder for the preservation of the biodiversity which includes many rare and endangered species having world wide significance.
4. Providing a mandatory provision of Environment Impact Assessment (EIA) and Social Impact Assessment (SIA) for the construction of windmills which would ensure that there is a proper assessment of the potential damage before giving permission to the windmill company.
5. Rejection of the request for registration as CDM project by the UNFCCC Executive board due to breach of local stakeholder consultation rules.

Windmills are being promoted as an alternative to thermal power and big dams that are considered destructive of the environment besides causing huge displacement of people. The use of windmills is an age old practice, however the way in which wind power projects are being implemented under CDM without a proper EIA and SIA process is defeating the purpose for which it is intended. The Kalpavalli

case study of the CDM project: Clean Energy generation from wind energy in the State of Andhra Pradesh shows that wind is part of a larger energy system. Indiscriminate tampering with this, results in destruction of other forms of energy. The impact on the life support systems of the local people have therefore to be considered as an integral part of any project and must be factored into the assessment of the benefits and costs.

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ANNEXURE 1: FLORAL DIVERSITY OF KALPAVALLI REGION

Sr	Scientific name	Telugu name	Family	Life form
1	*Abelmoschus esculentus* (L.) Monench.		Malvaceae	Under Shrub
2	*Abrus precatorius* L		Fabaceae	Twiner
3	*Abutilon indicum* (L..) Sweet subsp. *indicum*		Malvaceae	Under Shrub
4	*Acacia catechu* (L. f.) Willd.	Nalla sundra	Mimosaceae	Tree
5	*Acacia chundra (*Roxb. ex Rottler.) Willd.		Mimosaceae	Tree
6	*Acacia farnesiana (L.)* Willd.	Kasturi/Kamou tumma/Arimidamu/Murki tumma	Mimosaceae	Tree
7	*Acacia ferruginea* DC.	Vanni sundra/Inupu tumma/An-sandra/Val-sandra	Mimosaceae	Tree
8	*Acacia leucophloea* (Roxb.) Willd.		Mimosaceae	Tree
9	*Acacia nilotica* (L.) Willd. ex Del.	Nalla tumma	Mimosaceae	Tree
10	*Acalypha alnifolia* Willd.		Euphorbiaceae	Herb
11	*Acalypha indica* L.		Euphorbiaceae	Herb
12	*Acanthosperum hispidum* DC.		Asteraceae	Herb
13	*Achyranthes aspera* L. var. *aspera*		Amaranthaceae	Under Shrub
14	*Aegle marmelos (*L.) Corr.	Bilvamu/Sriphalamu/Maredu	Rutaceae	Tree
15	*Aerva javanica* (Burm.f.) Juss. ex Schult.		Amaranthaceae	Herb
16	*Aerva lanata* (L.) Juss. ex Schult.		Amaranthaceae	Herb
17	*Agave americana* L.	Kala bandha	Agavaceae	Herb
18	*Ageratum conyzoids* L.		Asteraceae	Herb
19	*Ailanthus excelsa* Roxb.	Pedda manu/Pedda vepa	Simaroubaceae	Tree
20	*Alangium salvifolium* (L. f.) Wangerin	Uduga/Ooduga/Urgu/Nalladuga/Ankolamu	Alangiaceae	Shrub
21	*Albizia lebbeck* (L.) Benth.	Dirisinam/Pedda dirisanam/Sirisamu	Mimosaceae	Tree
22	*Albizia procera* (Roxb.) Benth.		Mimosaceae	Tree

23	*Allium cepa* L.		Liliaceae	Herb
24	*Allium sativum* L.		Liliaceae	Herb
25	*Allmania nodiflora* (L.) R.Br.ex Wt.	Gurugu koora	Amaranthaceae	Herb
26	*Alloteropsis cimicina* (L.) Stspf		Poaceae	Grass
27	*Aloe vera* (L.) Burm.		Liliaceae	Herb
28	*Alternanthera pungens* Kunth		Amaranthaceae	Herb
29	*Alternanthera sessilis* (L.) R. ex DC.		Amaranthaceae	Herb
30	*Alysicarpus bupleurifolius* (L.) DC.		Fabaceae	Herb
31	*Alysicarpus hamosus* Edgew.		Fabaceae	Herb
32	*Alysicarpus heterophyllus* (Baker) Jafri and Ali		Fabaceae	Herb
33	*Alysicarpus rugosus* (Willd.) DC. var. *rugosus*		Fabaceae	Herb
34	*Alysicarpus vaginalis* (L.) DC.		Fabaceae	Herb
35	*Amaranthus spinosus* L.		Amaranthaceae	Herb
36	*Amaranthus viridis* L.		Amaranthaceae	Herb
37	*Ammannia baccifera* L.		Lythraceae	Herb
38	*Andrographis paniculata* (Burm. f.) Wall. ex Nees		Acanthaceae	Under Shrub
39	*Andropogon pumilus* Roxb.		Poaceae	Grass
40	*Anethum graveolens* L.		Apiaceae	Herb
41	*Anisomeles malabarica* (L.) R. Br. ex Sims		Lamiaceae	Shrub
42	*Annona squamosa* L.	Sitaphalamu/Ganda gathram/Sitapandu	Annonaceae	Tree
43	*Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. and Perr.	Elama/Tiruman/Chiru manu	Combretaceae	Tree
44	*Apluda mutica* L.		Poaceae	Grass
45	*Arachis hypogaea* L.		Fabaceae	Herb
46	*Arachis hypogaea* L.		Fabaceae	Herb
47	*Argemone mexicana* L. f.		Papaveraceae	Herb
48	*Aristida adscensionis* L. var. *adscensionis*		Poaceae	Grass

49	*Aristida hystrix* L. f.		Poaceae	Grass
50	*Aristida mutabilis* Trin. and Rupr.		Poaceae	Grass
51	*Aristida setacea* Retz.		Poaceae	Grass
52	*Arundinella setosa* Trin.		Poaceae	Grass
53	*Asparagus racemosus* Willd.	Shantavari/Pilli teegalu/Pilli gaddalu/Challa gadda	Liliaceae	Under Shrub
54	*Azadirachta indica* A. Juss.	Yapa/Vepa/Vemu	Meliaceae	Tree
55	*Bacopa monnieri* (L.) Wettst.		Scrophulariaceae	Herb
56	*Balanites aegyptiaca* (L.) Del.	Gara	Balanitaceae	Tree
57	*Barleria prionitis* L. subsp. *prionitis* var. *prionitis*		Acanthaceae	Under Shrub
58	*Basella rubra* L.		Basellaceae	Twiner
59	*Bauhinia racemosa* Lam.	Ari	Caesalpiniaceae	Tree
60	*Beta vulgaris* L.		Amaranthaceae	Herb
61	*Bidens biternata* (Lour.) Merr. and Sherff ex Sherff		Asteraceae	Herb
62	*Biophytum sensitivum* (L.) DC.		Oxalidaceae	Herb
63	*Blainvillea acmella* (L.) Philipson		Asteraceae	Herb
64	*Blepharis repens* (Vahl) Roth		Acanthaceae	Herb
65	*Blumea obliqua* (L.) Druce		Asteraceae	Herb
66	*Boerhavia chinensis (Linn.) Aschers. and Schweinf.*		Nyctaginaceae	Herb
67	*Boerhavia diffusa* L.		Nyctaginaceae	Herb
68	*Boerhavia erecta* L.		Nyctaginaceae	Herb
69	*Bombax ceiba* L.	Buruga	Bombacaceae	Tree
70	*Borassus flabellifer* L.	Tati/Karatalamu/Trynarajamu/Tadi	Palmaeceae	Tree
71	*Borreria articularis* (L. f.) Mill.		Rubiaceae	Herb
72	*Borreria pusilla* (Wall.) DC.		Rubiaceae	Herb

73	*Boswellia serrata* Roxb. ex Cocls.	Dhupam/Guggilam/Anduga	Burseraceae	Tree
74	*Bothriochloa ischaemum* (L.) Keng.		Poaceae	Grass
75	*Bougainvillea glabra* Choisy		Nyctaginaceae	Climber
76	*Bougainvillea spectabilis* Willd.		Nyctaginaceae	Climber
77	*Brachiaria ramosa* (L.) Stapf var. *ramosa*		Poaceae	Grass
78	*Brachiaria reptans* (L.) Gard. and Hubb.		Poaceae	Grass
79	*Bulbostylis barbata* (Rottb.) Clarke		Cyperaceae	Sedge
80	*Butea monosperma* (Lam.) Taub.	Moduga chettu	Fabaceae	Tree
81	*Cadaba fruticosa* (L.) Druce		Capparaceae	Shrub
82	*Caesalpinia pulcherrima* (L.) Swartz.		Caesalpiniaceae	Shrub
83	*Cajanus cajan* (L.) Millsp.		Fabaceae	Herb
84	*Calotropis gigantea (*L.) R. Br.		Asclepiadaceae	Shrub
85	*Calotropis procera* (Ait.) Ait.f. subsp. *Hamiltonii* (Wight) Ali		Asclepiadaceae	Shrub
86	*Canavalia ensiformis* (L.) DC.		Fabaceae	Twiner
87	*Canna indica* L.		Cannaceae	Herb
88	*Canscora diffusa* (Vahl) R. Br.		Gentianaceae	Herb
89	*Canthium dicoccum* (Gaertn.) Teys. and Binn.		Rubiaceae	Shrub
90	*Capparis decidua* (Forsk.) Edgew.		Capparaceae	Tree
91	*Capparis divaricata* Lamk.	Budareni	Capparaceae	Shrub
92	*Capparis sepiaria* L. var. *sepiaria*		Capparaceae	Shrub
93	*Capsicum annuum* L.		Solanaceae	Herb
94	*Cardiospermum halicacabum* L.		Sapindaceae	Twiner
95	*Carica papaya* L.	Paringi/Boppai	Caricaceae	Tree

96	*Carissa congesta* Wight.	Kalivi	Apocynaceae	Shrub
97	*Carissa spinarum* L.		Apocynaceae	Shrub
98	*Cassia absus* L.		Caesalpiniaceae	Herb
99	*Cassia auriculata* L.	Tangedu/Merka tangedu	Caesalpiniaceae	Shrub
100	*Cassia fistula* L.	Rela	Caesalpiniaceae	Tree
101	*Cassia occdentails* L.		Caesalpiniaceae	Under Shrub
102	*Cassia pumila* Lam.		Caesalpiniaceae	Herb
103	*Cassia siamea* Lam.	Seema tabgedu/Niala tangedu	Caesalpiniaceae	Tree
104	*Cassia spp.*		Caesalpiniaceae	Tree
105	*Cassytha filiformis* L.		Lauraceae	Shrub
106	*Casuarina equisetifolia* L.	Sarugugdu/Chavuka	Casuarinaceae	Tree
107	*Catharanthus pusillus* (Murr.) G. Don		Apocynaceae	Herb
108	*Catharanthus roseus* (L.) G. Don		Apocynaceae	Herb
109	*Catunaregam spinosa* (Thunb.) Tirveng.		Rubiaceae	Tree
110	*Celosia argentea* L.		Amaranthaceae	Herb
111	*Cenchrus biflorus* Roxb		Poaceae	Grass
112	*Cenchrus ciliaris* L.		Poaceae	Grass
113	*Ceratophyllum demersum* L.		Ceratophyllaceae	Herb
114	*Chloris barbata* Sw.		Poaceae	Grass
115	*Chloris virgata* Sw.		Poaceae	Grass
116	*Chrozophora rottleri* (Geis.) A. Juss. ex Spreng.		Euphorbiaceae	Herb
117	*Chrysopogon fulvus* (Spreng.) Chiov.		Poaceae	Grass
118	*Cissampelos pareira* L. var.*hirsuta* (Buch.- Ham. ex DC.) Forman		Menispermaceae	Twiner
119	*Cissus pallida* (Wt. andArn.) Nan.		Vitaceae	Shrub
120	*Citrullus colocynthis* (L.) Schrad.		Cucurbitaceae	Climber
121	*Cleome aspera* DC.		Cleomaceae	Herb
122	*Cleome gynadra* L. var. *gynandra*		Cleomaceae	Herb
123	*Cleome viscosa* L.		Cleomaceae	Herb

124	*Clerodendrum inerme* (L.) Gaertn.		Verbenaceae	Shrub
125	*Clitoria ternatea* L.		Fabaceae	Twiner
126	*Cocculus hirsutus* (L.) Diels		Menispermaceae	Shrub
127	*Cocos nucifera* L.		Arecaceae	Tree
128	*Coldenia procumbens* L.		Boraginaceae	Herb
129	*Combretum ovalifolium* Roxb.		Combretaceae	Shrub
130	*Commelina benghalensis* L.		Commelinaceae	Herb
131	*Commelina diffusa* Burm. f.		Commelinaceae	Herb
132	*Commelina paludosa* Blume		Commelinaceae	Herb
133	*Convolvulus arvensis* L.		Convolvulaceae	Twiner
134	*Convolvulus prastratus* Forsk.		Convolvulaceae	Herb
135	*Corallocarpus epigaeus (*Rottl. and Willd.) Hook. f.		Cucurbitaceae	Climber
136	*Corchorus aestuans* L.		Tiliaceae	Herb
137	*Corchorus fascicularis* Lam.		Tiliaceae	Herb
138	*Corchorus trilocularis* L.		Tiliaceae	Herb
139	*Cordia dichotoma* Forst. f.	Banka nakkera/Chinna nakkera/Botgiri/Iriki/Pedda Iriki/Botuku	Ehretiaceae	Tree
140	*Coriandrum sativum* L.		Apiaceae	Herb
141	*Crotalaria medicaginea* Lam.		Fabaceae	Herb
142	*Croton bonplandianum* Baill.		Euphorbiaceae	Herb
143	*Cryptostegia gradiflora* R. Br.		Periplocaceae	Shrub
144	*Cucumis prophetarum* L.		Cucurbitaceae	Climber
145	*Cyamopsis tetragonoloba* (L.) Taubert		Fabaceae	Herb
146	*Cymbopogon martinii* (Roxb.) Watson	Bodha grass	Poaceae	Grass
147	*Cynodon dactylon* (L.) Pers.		Poaceae	Grass
148	*Cyperus compressus* L.		Cyperaceae	Sedge

149	*Cyperus iria* L. var. *iria*		Cyperaceae	Sedge
150	*Cyperus nutans* Vahl subsp. *nutans*		Cyperaceae	Sedge
151	*Cyperus rotundus* L.		Cyperaceae	Sedge
152	*Dactyloctenium aegyptium* (L.) Willd.		Poaceae	Grass
153	*Dalbergia latifolia* Roxb.	Pacchari/Jittegi/Zitregi/Virugudi cheva/Iridi/Irigudi	Fabaceae	Tree
154	*Dalbergia paniculata* Roxb.	Sopera/Pachari/Palsaru/Porla patchari	Fabaceae	Tree
155	*Dalbergia sissoo* Roxb.	Sissoo	Fabaceae	Tree
156	*Datura innoxia* Mill.		Solanaceae	Under Shrub
157	*Daucas carota* L.		Apiaceae	Herb
158	*Dendrocalamus strictus* (Roxb.) Nees	Veduru	Poaceae	Grass
159	*Dendrophthoe falcata* (L. f.) Etting.		Loranthaceae	Shrub
160	*Desmodium gangeticum* (L.) DC.		Fabaceae	Under Shrub
161	*Desmostachya bipinnata* (L.) Stapf		Poaceae	Grass
162	*Dichanthium spp.*		Poaceae	Grass
163	*Dicoma tomentosa* Cass.		Asteraceae	Herb
164	*Digera muricata* (L.) Mart.		Amaranthaceae	Herb
165	*Digitaria ciliaris* (Retz.) Koel.		Poaceae	Grass
166	*Dodonaea viscosa* (L.) Jacq.	Bandaru/Puli vailu/ Bandam/Golla pulledu/ Bandedu/Bandhari	Sapindaceae	Shrub
167	*Dolichandrone atrovirens* (Heyne ex Roth) Sprague		Bignoniaceae	Tree
168	*Dolichandrone falcata* (Wall. ex DC.) Seem.		Bignoniaceae	Tree
169	*Dolichos Biflorus* L.		Fabaceae	Herb
170	*Dolichos lablab* L.		Fabaceae	Herb
171	*Echinochloa colona* (L.) Link		Poaceae	Grass
172	*Echinops echinatus* Roxb.		Asteraceae	Herb
173	*Eclipta alba* (L.) Hassk.		Asteraceae	Herb

174	*Ehretia pubscens* Benth.		Ehretiaceae	Tree
175	*Eleusine coracana* (L.) Gaertn.		Poaceae	Grass
176	*Enicostema axillare* (Lam.) Raynal		Gentianaceae	Herb
177	*Eragrostiella bifaria* (Vahl) Bor		Poaceae	Grass
178	*Eragrostis aspera (*Jacq.) Nees		Poaceae	Grass
179	*Eragrostis tenella* (L.) P.Beauv. ex Roem. and Schult. var. *insularis* C.E. Hubbard		Poaceae	Grass
180	*Eragrostis tenuifolia* Hochst. ex Steud.		Poaceae	Grass
181	*Eranthemum roseum* (Vahl) R. Br.		Acanthaceae	Herb
182	*Eremopogon foveolatus* (Delile) Stapf.		Poaceae	Grass
183	*Erythrina suberosa* Roxb.	Mulla moduga /Vanjiram/ Barijama/Muni moduga	Fabaceae	Tree
184	*Eucalyptus globulus* Labill.		Myrtaceae	Tree
185	*Euphorbia antiquorum* L.		Euphorbiaceae	Shrub
186	*Euphorbia caducifolia* Haines		Euphorbiaceae	Shrub
187	*Euphorbia cristata* Roth.		Euphorbiaceae	Herb
188	*Euphorbia heterophylla* L.		Euphorbiaceae	Herb
189	*Euphorbia heyneana* Spreng.		Euphorbiaceae	Herb
190	*Euphorbia hirta* L.		Euphorbiaceae	Herb
191	*Euphorbia trucalli* L.		Euphorbiaceae	Tree
192	*Evolvulus alsinoids* (L.) L.		Convolvulaceae	Herb
193	*Exacum pedunculatum* L.		Gentianaceae	Herb
194	*Fagonia indica* Burm. f. var. *indica*		Zygophyllaceae	Shrub
195	*Feronia limonia* (L.) Swingle	Velga/Yelakaya	Rutaceae	Tree
196	*Ficus benghalensis* L.	Marri	Moraceae	Tree
197	*Ficus religiosa* L.	Ravi	Moraceae	Tree
198	*Fimbristylis complanata* (Retz.) Link		Cyperaceae	Sedge

199	*Fimbristylis cymosa* R.Br.		Cyperaceae	Sedge
200	*Fimbristylis sieberiana* Kunth		Cyperaceae	Sedge
201	*Fimbristylis tenera* Schult. var. *tenera*		Cyperaceae	Sedge
202	*Gisekia pharnaceoides* L. var. *pharnaceoides*		Molluginaceae	Herb
203	*Glinus lotoides* L.		Molluginaceae	Herb
204	*Glinus oppositifolius* (L.) DC.		Molluginaceae	Herb
205	*Gloriosa superba* L.		Liliaceae	Herb
206	*Glossocardia bosvallea* (L. f.) DC.		Asteraceae	Herb
207	*Gmelina arborea* Roxb.	Gummudu	Verbenaceae	Tree
208	*Gomphrena globosa* L.		Amaranthaceae	Herb
209	*Goniogyna hirta* (Willd.) Ali		Fabaceae	Herb
210	*Gymnema sylvestre* (Retz.) R. Br. ex Schult.		Asclepiadaceae	Twiner
211	*Hackelochola granularis* (L.) Ktze.		Poaceae	Grass
212	*Hardwickia binata* Roxb.	Nara yepi/ Yepi	Caesalpiniaceae	Tree
213	*Heliotropium indicum* L.		Boraginaceae	Herb
214	*Heliotropium marifolium* Retz.		Boraginaceae	Herb
215	*Heliotropium strigosum* Willd *subsp. striogosum*		Boraginaceae	Herb
216	*Hemidesmus indicus* (L.) R. var. *indicus.*		Periplocaceae	Shrub
217	*Heteropogon contortus* (L.) P. Beauv. ex Roem. and Schult.		Poaceae	Grass
218	*Hibiscus ovalifolius* (Forssk.) Vahl.		Malvaceae	Under Shrub
219	*Hibiscus rosa-sinensis* L.		Malvaceae	Shrub
220	*Holoptelia intergrifolia* (Roxb.) Planch.	Thapasi/Nemali/Nauli/ Pulari/Nevili	Ulmaceae	Tree
221	*Hyptis suaveolens* (L.) Point.		Lamiaceae	Herb
222	*Indigofera caerulea* Roxb. var. *monosperma* (Sant.) Sant.		Fabaceae	Herb

223	*Indigofera cordifolia* Heyne ex Roth		Fabaceae	Herb
224	*Indigofera glabra* L.		Fabaceae	Herb
225	*Indigofera hirsuta* L.		Fabaceae	Herb
226	*Indigofera linifolia* (Lf.) Retz.		Fabaceae	Herb
227	*Indigofera tinctoria* L.		Fabaceae	Herb
228	*Indigofera trifoliata* L.		Fabaceae	Herb
229	*Indigofera wightii* Wt. andArn.		Fabaceae	Herb
230	*Indoneesiella echioids* (L.) Sreemadh.		Acanthaceae	Herb
231	*Ipomoea eriocarpa* R. Br.		Convolvulaceae	Twiner
232	*Ipomoea pes-tigridis* L.		Convolvulaceae	Twiner
233	*Jasminum spp.*		Oleaceae	Shrub
234	*Jatropha curcas* L.	Nepalamu/Adavi Amudamu/Kondamudamu	Euphorbiaceae	Tree
235	*Kickxia ramosissima* (Wall.) Janchen		Scrophulariaceae	Twiner
236	*Lantana camara* L.		Verbenaceae	Shrub
237	*Launaea procumbens* (Roxb.) Ramayya and Rajagobal		Asteraceae	Herb
238	*Lawsonia inermis* L.	Gorantaku	Lythraceae	Shrub
239	*Lepidagathis cristata* Willd.		Acanthaceae	Herb
240	*Leucas aspera* (Willd.) Link		Lamiaceae	Herb
241	*Leucas urticaefolia* (Vahl) R. Br.		Lamiaceae	Herb
242	*Lindenbergia indica* (L.) Vatke		Scrophulariaceae	Herb
243	*Luffa acutangula* L.		Cucurbitaceae	Climber
244	*Luffa tuberosa* Roxb.		Cucurbitaceae	Climber
245	*Lycopersicon esculentum* L.		Solanaceae	Herb
246	*Maerua oblongifolia* (Forss.) A.Rich		Capparaceae	Climber
247	*Mangifera indica* L.		Anacardiaceae	Tree

248	*Manilkara sapota* (L.) P. Royen		Sapotaceae	Tree
249	*Melanocenchris jacquemontii* Jaub. and Spach.		Poaceae	Grass
250	*Merremia emarginata* (Burm. f.) Hall. f.		Convolvulaceae	Herb
251	*Merremia tridentata* (L.) Hall. f.		Convolvulaceae	Herb
252	*Mollugo pentaphylla* L.		Molluginaceae	Herb
253	*Momordica charantia* L.		Cucurbitaceae	Climber
254	*Morinda pubescens* Roxb.		Rubiaceae	Tree
255	*Moringa oleifera* Lam.	Munaga/Mulaga	Moringaceae	Tree
256	*Murraya koenigii* (L.) Spreng.		Rutaceae	Shrub
257	*Musa paradisiaca* L.		Musaceae	Herb
258	*Nymphaea pubescens* Willd.		Nymphaeaceae	Herb
259	*Ocimum basilicum* L.		Lamiaceae	Herb
260	*Ocimum sanctum* L.		Lamiaceae	Herb
261	*Opuntia elatior* Mill.		Cactaceae	Shrub
262	*Oryza sativa* L.		Poaceae	Grass
263	*Pandanus fascicularis* Lam.	Kewara	Pandanaceae	Shrub
264	*Panicum miliare* Lam.		Poaceae	Grass
265	*Parthenium hysterophorus* L.		Asteraceae	Herb
266	*Paspalum scrobiculatum* L.		Poaceae	Grass
267	Pennisetum typhodium		Poaceae	Grass
268	*Pergularia daemia* (Forsk.) Chiov.		Asclepiadaceae	Twiner
269	*Phaseolus aureus* Roxb.		Fabaceae	Herb
270	*Phoenix sylvestris* (L.) Roxb.	Eetha	Arecaceae	Tree
271	*Phyllanthus virgatus* Fors.f.		Euphorbiaceae	Herb
272	*Pithecellobium dulce* (Roxb.) Benth.		Mimosaceae	Tree
273	*Plectranthus amboinicus* (Lour.) Spreng.	Karpurvalli	Lamiaceae	Shrub

274	*Polycarpaea corymbosa* (L.) Lam.		Caryophyllaceae	Herb
275	*Polygala arvensis* Willd.		Polygalaceae	Herb
276	*Polygala erioptera* DC.		Polygalaceae	Herb
277	*Pongamia pinnata* (L.) Pierre	Kanuga	Fabaceae	Tree
278	*Portulaca oleracea* L.		Portulacaceae	Herb
279	*Portulaca quadrifida* L.		Portulacaceae	Herb
280	*Prosopis cineraria* (L.) Druce		Mimosaceae	Tree
281	*Prosopis juliflora* (Swartz) DC.	Seema Jali /Mulla thumma/ Jali chettu	Mimosaceae	Tree
282	*Pterocarpus marsupium* Roxb.	Yegisa/Ponna	Fabaceae	Tree
283	*Pulicaria wightiana* (DC.) Clarke		Asteraceae	Herb
284	*Punica granulata* L.		Punicaceae	Shrub
285	*Pupalia lappacea* (L.) Juss. var. *lappacea*		Amaranthaceae	Herb
286	*Raphanus sativus* L.		Brassicaceae	Herb
287	*Rhynchosia capitata* (Heyne ex Roth) DC.		Fabaceae	Climber
288	*Rhynchosia minima* (L.) DC.		Fabaceae	Climber
289	*Rivea hypocrateriformis* (Desr.) Choisy		Convolvulaceae	Climber
290	*Saccharum spontaneum* L.		Poaceae	Grass
291	*Santalum album* L.	Tella chandanam /Srigandham /Chandanamu /Malayajamu/ Sreechandanamu/Harichandanamu/Krishnachandanamu	Santalaceae	Tree
292	*Sapindus emarginatus* Vahl	Kunkudu	Sapindaceae	Tree
293	*Securinega leucopyrus* (Willd.) Muell.-Arg.		Euphorbiaceae	Shrub
294	*Sehima nervosum* (Rottl.) Stapf		Poaceae	Grass
295	*Setaria intermedia* Roem. and Schult.		Poaceae	Grass
296	*Setaria italica* (L.) P.		Poaceae	Grass

	Beauv.			
297	*Sida cordata* (Burm. f.) Borssum		Malvaceae	Herb
298	*Solanum melongena* L.		Solanaceae	Herb
299	*Solanum surattense* Berm.f.		Solanaceae	Herb
300	*Solanum tuberosum* L.		Solanaceae	Herb
301	*Solanum virginianum* L.		Solanaceae	Herb
302	*Sopubia delphinifolia* (L.) G.Don		Scrophulariaceae	Herb
303	*Sorghum bicolor* (L.) Moench.		Poaceae	Grass
304	*Striga angustifolia* (D.Don) Sald.		Scrophulariaceae	Herb
305	*Striga gesneroides* (Willd.) Vatke		Scrophulariaceae	Herb
306	*Syzygium cumini* (L.) Skeels	Neredu	Myrtaceae	Tree
307	*Syzygium heyneanum* (Duthie) Wall. ex Gamble	Alla neredu	Myrtaceae	Tree
308	*Tagetes patula* L.		Asteraceae	Herb
309	*Tamarindus indica* L.	Chinta	Caesalpiniaceae	Tree
310	*Tectona grandis* L. f.	Teku	Verbenaceae	Tree
311	*Tephrosia purpurea* (L.) Pers.		Fabaceae	Herb
312	*Terminalia catappa* L.	Badamu	Combretaceae	Tree
313	*Trachys muricata* (L.) Pers.		Poaceae	Grass
314	*Tragia involucrata* L.		Euphorbiaceae	Shrub
315	*Tragus spp*.		Poaceae	Grass
316	*Trianthema portulacastrum* L.		Aizoaceae	Herb
317	*Tribulus terrestris* L.		Zygophyllaceae	Herb
318	*Trichodesma indicum* (L.) Lehman.		Boraginaceae	Herb
319	*Trichosanthes anguina* L.		Cucurbitaceae	Climber
320	*Trichurus monsoniae* (L.f.) C.C.Towns.	Ferrapindi	Amaranthaceae	Herb
321	*Tridax procumbens* L.		Asteraceae	Herb
322	*Typha angusta* Bory and Chaub.		Typhaceae	Herb

323	*Urochloa panicoides* P. Beauv. var. *panicoides*		Poaceae	Grass
324	*Vernonia cinerea* (L.) Less.		Asteraceae	Herb
325	*Vicia faba* L.		Fabaceae	Herb
326	*Vigna unguiculata* (L.) Walp.		Fabaceae	Herb
327	*Vitex negundo* L.		Verbenaceae	Shrub
328	*Zingiber officinale* Rosc.		Zingiberaceae	Herb
329	*Ziziphus mauritiana* Lam.	Reni/Regu/Badari	Rhamnaceae	Tree
330	*Ziziphus oenoplia* (L.) Miller	Pariki/Banka	Rhamnaceae	Shrub
331	*Ziziphus xylopyrus* (Retz.) Willd.	Gol/Gotiki	Rhamnaceae	Tree
332	*Zornia gibbosa* Span.		Fabaceae	Herb
333	*Riccia spp*.		Ricciaceae	Herb
334	*Actinopteris radiata* (SW) Link		Actinopteridaceae	Herb
335	*Azolla spp.*		Salviniaceae	Herb

ANNEXURE 2: FAUNAL DIVERSITY OF KALPAVALLI REGION

Sr	***Latin name***	***Common name***	***Family***
1	…	Land snail	
2	*Gongylus gongyloides*	Mantis	Mantidae
3	*Argiope arecuata*	Speckled Band Fourleg	Araneidae
4	*Crosspriza lyoni*	Box Longleg Spider	Pholcidae
5	*Plexippus paykullii*	Zebra Jumper	Salticidae
6	*Stegodyphus pacificus*	Pocock	Eresidae
7	*Poecilocerus pictus*	Common Painted Grasshopper	Arcridiidae
8	*Teratodes monticollis*	Hooded Grasshopper	Arcridiidae
9	*Gryllodes domesticus*	House Cricket	Gryllidae
10	*Acheta domestica* Linn.	Black Field Cricket	Gryllidae
11	...	Termite	Fermitidae
12	*Apis dorsata*	Rock Bee	Apidae
13	*Apis indica*	Indian Bee	Apidae
14	*Holcomyrmex scabriceps*	Granary Ant	Formicidae
15	*Luciola* sp.	Fire-fly	Malacodermidae
16	*Sternocera chrysis* (Fabr.)	Jewel Beetle	Baprestidae
17	*Mylabris phalerata*	Blister Beetles	Cantharidae
18	*Diplacodes lefebvrei*	Black Ground Skimmer	Libellulidae
19	*Orthetrum triangulare*	Blue tailed Forest Hawk	Libellulidae

20	*Aethriamanta brevipennis*	Scarlet Marsh Hawk	Libellulidae
21	*Crocothemis servilia*	Ruddy Marsh Skimmer	Libellulidae
22	*Hyblaea puera*	Teak defoliator	Noctuidae
23	*Pyrausta machaeralis*	Teak Leaf Skeletonizer	Pyralidae
24	*Papilio polytes*	Common Mormon	Papilionidae
25	*Pathysa nomius*	Spot Swordtail	Papilionidae
26	*Princeps demoleus*	Lime Butterfly	Papilionidae
27	*Anapheis aurota*	Pioneer	Pierinae
28	*Catopsilia Pomona*	Common Emigrant	Pierinae
29	*Cepora nerissa*	Common Gull	Pierinae
30	*Eurema hecabe*	Common Grass Yellow	Pierinae
31	*Ixias pyrene*	Yellow Orange Tip	Pierinae
32	*Cynthia cardui*	Painted Lady	Nymphalinae
33	*Danaus chrysippus*	Plain Tiger	Nymphalinae
34	*Danaus gnutia*	Striped Tiger	Nymphalinae
35	*Euploea core*	Common Crow	Nymphalinae
36	*Hypolimnas misippus*	Danaid Eggfly	Nymphalinae
37	*Junonia hierta*	Yellow Pansy	Nymphalinae
38	*Junonia orithya*	Blue Pansy	Nymphalinae
39	*Melanitis leda*	Common Evening Brown	Nymphalinae
40	*Tirumala limniace*	Blue Tiger	Nymphalinae
41	*Ypthima ceylonica*	Common Four-ring	Nymphalinae
42	*Musca domestica*	Common House-fly	Muscidae
43	*Gerris sp.*	Water skater	Gerridae
44	*Hydrometra vittata*	Water bug	Hydrometridae
45	…	Centipedes	Chilopoda
46	*Julus* sp.	Millipedes	Chilognatha
47	*Hoplobatrachus tigrinus*	Indian Bull Frog	Ranidae
48	*Calotes versicolor*	Indian Garden Lizard	Agamidae
49	*Mabuya sp.*	Skink	Scincidae
50	*Varanus bengalensis*	Common Indian Monitor	Lacertidae
51	*Daboia russelii*	Russell's Viper	Viperidae
52	*Egretta garzetta*	Little Egret	Ardeidae
53	*Bubulcus ibis*	Cattle Egret	Ardeidae
54	*Ardea cinerea*	Grey Heron	Ardeidae
55	*Ardeola grayii*	Indian Pond Heron	Ardeidae
56	*Threskiornis melanocephalus*	Black-headed Ibis	Threskiornithidae
57	*Pseudibis papillosa*	Black Ibis	Threskiornithidae
58	*Elanus caeruleus*	Black-shouldered Kite	Accipitridae

59	*Accipter badius*	Shikra	Accipitridae
60	*Neophron percnopterus*	Egyptian Vulture	Accipitridae
61	*Coturnix coturnix*	Common Quail	Phasieanidae
62	*Francolinus pondicerianus*	Grey Francolin	Phasieanidae
63	*Pavo cristatus*	Indian Peafowl	Phasieanidae
64	*Francolinus pictus*	Painted Francolin	Phasieanidae
65	*Coturnix coromandelica*	Rain Quail	Phasieanidae
66	*Perdicula asiatica*	Jungle Bush Quail	Phasieanidae
67	*Vanellus indicus*	Red-wattled Lapwing	Charadriidae
68	*Vanellus malabaricus*	Yellow-wattled Lapwing	Charadriidae
69	*Columba livia*	Blue Rock Pigeon	Columbidae
70	*Streptopelia decaocto*	Ring Dove	Columbidae
71	*Psittacula krameri*	Rose-ringed Parakeet	Psittacidae
72	*Centropus sinensis*	Greater Coucal	Cuculidae
73	*Eudynamys scolopaceus*	Koel	Cuculidae
74	*Athene brama*	Spotted Owlet	Strigidae
75	*Tephrodornis pondicerianus*	Common Woodshrike	Campephagidae
76	*Pericrocotus cinnamomeus*	Small Minivet	Campephagidae
77	*Caprimulgus indicus*	Indian Nightjar	Campephagidae
78	*Cypsiurus balasiensis*	Asian Palm Swift	Campephagidae
79	*Apus affinis*	House Swift	Campephagidae
80	*Alcedo atthis*	Common Kingfisher	Alcedinidae
81	*Merops orientalis*	Green Bee-eater	Alcedinidae
82	*Coracias garrulous*	European Roller	Coraciidae
83	*Coracias benghalensis*	Indian Roller	Coraciidae
84	*Upupa epops*	Common Hoopoe	Upupidae
85	*Ocyceros birostris*	Indian Grey Hornbill	Bucerotidae
86	*Dinopium benghalense*	Black-rumped Flameback	Picidae
87	*Chrysocolaptes festivus*	White-naped Woodpecker	Picidae
88	*Hirundo smithii*	Wire-tailed Swallow	Hirundinidae
89	*Lanius meridionalis*	Southern Grey Shrike	Laniidae
90	*Lanius schach*	Long-tailed Shrike	Laniidae
91	*Dicrurus macrocercus*	Black Drongo	Dicruridae
92	*Corvus splendens*	House Crow	Corvidae
93	*Corvus macrorhynchos*	Jungle Crow	Corvidae
94	*Dendrocitta vagabunda*	Rufous Treepie	Corvidae
95	*Acridotheres ginginianus*	Bank Myna	Sturnidae
96	*Acridotheres tristis*	Common Myna	Sturnidae

97	*Sturnus pagodarum*	Brahminy Starling	Sturnidae
98	*Pycnonotus cafer*	Red-vented Bulbul	Pycnonotidae
99	*Parus nuchalis*	White-naped Tit	Paridae
100	*Turdoides caudate*	Common Babbler	Muscicapidae
101	*Turdoides malcolmi*	Large Grey Babbler	Muscicapidae
102	*Turdoides striata*	Jungle Babbler	Muscicapidae
103	*Cercomela fusca*	Brown Rock Chat	Muscicapidae
104	*Saxicoloides fulicata*	Indian Robin	Muscicapidae
105	*Copsychus saularis*	Magpie Robin	Muscicapidae
106	*Prinia socialis*	Ashy Prinia	Muscicapidae
107	*Prinia inornata*	Plain Prinia	Muscicapidae
108	*Orthotomus sutorius*	Common Tailorbird	Muscicapidae
109	*Nectarinia asiatica*	Purple Sunbird	Nectariniidae
110	*Passer domesticus*	House Sparrow	Passeridae
111	*Ploceus philippinus*	Baya Weaver	Passeridae
112	*Melophus lathami*	Crested Bunting	Emberizidae
113	*Axis axis*	Spotted deer	Cervidae
114	*Sus scrofa*	Indian wild boar	Suidae
115	*Canis aureus*	Jackal	Canidae
116	*Vulpes bengalensis*	Indian fox	Canidae
117	*Herpestes edwardsii*	Grey mongoose	Herpestidae
118	*Lepus nigricollis*	Indian hare	Leporidae
119	*Macaca mulatta*	Rhesus Macaque	Cercopithecidae
120	*Mus booduga*	Indian field mouse	Muridae
121	*Mus musculus*	House mouse	Muridae
122	*Funambulus pennanti*	Five stripped palm squirrel	Sciuridae
123	*Hystrix indica*	Porcupine	Hystricidae

ANNEXURE 3: AGRO DIVERSITY OF KALPAVALLI

Sr	***Group***	***Scientific name***	***Common name***	***Varieties***
1	Cereal	*Oryza sativa* L.	Paddy (Vadlu)	Ankursonam
				Bapatla
				Basma
				Bavani
				Dilhibogalu
				Hamsa
				Jagityalu
				Javakodlu
				Masura
				Palubbulu

				Picchivadlu
				R.N.R
				Sannodlu
				Sonamasura
				Superfine
2	Milet	*Eleusine coracana* (L.) Gaertn.	Finger millet (Ragulu)	Hibrid ragi
				Kalayaniragi
				Muddaragi
				Yerra ragulu
		Panicum miliare Lam.	Little millet (Samalu)	Samalu
		Paspalum scrobiculatum L.	Kodo millet (Arikalu)	Arikalu
		Pennisetum typhodium	Pearl millet (Sajjalu)	Nati sajja
				Pedda sajja
		Setaria italica (L.) P. Beauv.	Foxtail millet (Korralu)	Jada korralu
				Nati korralu
		Sorghum bicolor (L.) Moench.	Great millet (Jonnalu)	Chitta jonnalu
				Hibrid jonna
				Kakimarujonna
				Muddajonna
				Mukkajonna
				Musukujonna
				Muthyaljonna
				Pasurujonna
				Swarna jonna
3	Oil	*Arachis hypogaea* L.	Ground Nut (Veruchanaga)	K.6
				Kadiri modu
				Nati kaya
				Peddakaya(J.L
				Samrat
				Thiga kaya
4	Pulses	*Cajanus cajan* (L.) Millsp.	Redgram (Kandulu)	Hibrid Kandi
				Jadakandulu
				Nati kandulu
				Thellakandulu
				Yerrakandulu
		Dolichos Biflorus L.	Horse gram (Ulavalu)	Hibrid ulavalu
				Nati ulavalu
				Thiga ulava
		Dolichos lablab L.	Field bean (Anumulu)	Chikkudu
				Nati anumulu
				Pedda anumulu

		Phaseolus aureus Roxb.	Green gram (Pesalu)	Chinna pesalu
				Pedda pesalu
		Vigna unguiculata (L.) Walp.	Cow pea (Alasandulu)	Nati alasandulu
				Pedda alasandulu
				Yerra alasandulu
5	Spice and condiment	*Allium cepa* L.	Onion	Yerragadda
		Allium sativum L.	Garlic	Thella gadda
		Capsicum annuum L.	Green chilly	Bajji mirapa
				Balapuram
				Kaddi mirapa
				Nati mirapa
		Coriandrum sativum L.	Coriander	Kothumeeri
		Zingiber officinale Rosc.	Ginger (Allam)	
6	Vegetable	*Abelmoschus esculentus* (L.) Monench.	Ladies finger	Hibrid benda
				Nati benda
		Beta vulgaris L.	Beetroot	
		Cyamopsis tetragonoloba (L.) Taubert	Cluster bean	
		Daucas carota L.	Carrot	
		Luffa acutangula L.	Ridge gourd (Beera)	
		Lycopersicon Esculentum L.	Tomato	Bangalore tomata
				Nati tomata
		Momordica charantia L.	Bitter gourd (Kakara kaya)	Pedda kakara
				Thella kakara
		Raphanus sativus L.	Raddish (Mullangi)	
		Solanum melongena L.	Brinjal	Gutti vankaya
				Mullavankaya
				Nallvankaya
		Solanum tuberosum L.	Potato	Bangaala dumpa
		Trichosanthes anguina L.	Snack gourd	
		Vicia faba L.	Indian Broad Beans (Chikkada kayalu)	Nati chikkada
				Pedda chikkada
7	Fruit	Carica papaya L.	Papaya	
		Cocos nucifera L.	Coconut	
		Musa paradisiaca L.	Banana	
		Punica granulata L.	Pomegranate	

ANNEXURE 4: DOMESTIC ANIMALS DIVERSITY OF KALPAVALLI

Animal	***Sc name***	***Purpose of rearing***	***Breed***
Domestic fowl	*Gallus sp.*	Flesh, eggs	Asali
			Bedasalu
			Ceeti kodi
			Dega
			Girraju
			Kakinemalli
			Nati kodi
			Padakodi
			Param kodi
			Pigali
			Selam
Cow	*Bos indicus*	Milk, leather, dung	Alikeri Avulu
			Desapu Avulu
			Jersey Avulu
			Kwadi Avulu
			Nati Avulu
			Ongolu Avulu
Bullock		Dung, in agriculture and transport	Alikeri Eddulu
			Desapu Eddulu
			Jersey eddulu
			Kwadi Eddulu
			Nati Eddulu
			Ongolu Eddulu
Buffalo	*Bubalus spp*	Milk, dung	Natti Buffalo
			Seema Buffalo (Murrah)
Goat	*Capra aegagrus hircus*	Milk, leather, flesh	
Sheep	*Ovis ammo aries*	Milk, leather, flesh, wool	
Dog	*Canis familiaris*	Protection of house and agriculture	

IMPACT OF CLIMATE CHANGE ON WATER, ENERGY AND FOOD PRODUCTION IN INDIA

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INTRODUCTION

The inter-linkage between water and energy is well known. Water is required to sustain life and energy is required for human development and welfare. At the same time to produce hydro-or thermal energy, water is essential. On the other hand with increasing demand for water for various uses and the corresponding shortfall in supply of water, energy is required to pump out water from the aquifers. In developing countries which are primarily agriculture based, this issue becomes more important because of demand for water by the agricultural sector and its impact on food production and food security. Compounding this inter-linkage is the impact of climate variability and change on rainfall patterns, weather and humidity which again impacts food production. India is primarily an agriculture based economy, despite the recent developments in the industry and tertiary sectors. The share of agriculture sector to GDP during 2009-10 was 14.6 per cent and provides livelihood to almost 55 per cent of the population. As such it is very important to study the impact of climate change on the demand and supply of water and energy and its consequence on food production. The present paper analyses these inter linkages in the context of India.

METHODS

The analysis will be based on secondary statistical data on variables like rainfall, temperature, weather patterns, demand for water for different uses, demand for water by the major sectors of the economy, supply of water; demand for energy, energy production and changes/trend of these variables. Other variables like changes in cropping pattern and in crop production, availability of food per capita, nutritional intake, measurement of climate change vulnerability may also be included.

RESULTS

Studies have shown that there is a deviation from the set rainfall patterns which results considerable impact on the agricultural sector and food production. Due to continuous drought conditions in some districts the dependence on groundwater for irrigation and drinking purposes has increased. This leads to increased demand for energy. In coastal regions, for example in south Gujarat, severe pumping out of water has led to sea water ingress leading to salinity and degradation of land. In other states like Punjab and Andhra Pradesh, using groundwater has led to drying up aquifers and its consequent adverse impact. Of late the impact of change in climatic conditions has led to changes in temperature and moisture leading to erratic rainfall conditions and changes in food production.

As regards production and supply of energy, India has been making efforts to match the supply with the demand. As per the Economic Survey 2010-11, total Thermal power generation in India is about 640.876Billion KWh i.e. per cent growth of 3.03 per cent and hydroelectric power production is 106.680KWh which is a growth of 8.14 per cent over 2008-2009. Despite major power sector reforms in

India, regulation, distribution and tariff rates needs to be properly monitored and reforms needs to be in place to monitor demand for energy in various sectors and also to control adverse impact on climatic conditions.

Table-1 Decadal Mean (Per Cent Departure from Normal), Frequency of Drought and Flood Years

DECADE	Decadal mean Per cent departure from normal	Freq. of Deficient year	Freq. of Excess year
1941-50	**3 .3**	**1**	**1**
1951-60	**2.5**	**1**	**3**
1961-70	**-0.1**	**2**	**1**
1971-80	**-0.8**	**3**	**1**
1981-90	**-0.3**	**2**	**2**
1991-2000	**0.6**	**0**	**1**
2001-2003	**-5.9**	**1**	**0**

Source; Trends in the rainfall pattern over India by P. Guhathakurta and M. Rajeevan; National Climate Centre India Meteorological Department [Research Report No: 2/2006]

DISCUSSION AND CONCLUSIONS

The interaction and inter linkages between climate change , water demands and energy has important and wide ranging implications especially in the context of food production and food security as well as environmental implications due to over use of water and erratic rainfall pattern. The full length paper will come up with the policy suggestions based on the detailed analysis of data.

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NEED FOR PROPER MANAGEMENT OF WATER FOR FOOD SECURITY

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ABSTRACT

The state of Punjab, in common parlance, known as 'Food Basket' of the country, is the largest surplus state in terms of food grains. With only 1.5 per cent of geographical area of the country, the state produced 18.77 per cent of wheat, 12.61 per cent of rice and 8.35 per cent of cotton of their respective national production in 2009-10, thus, has played a pivotal role in sustaining national food security. But this increase in agricultural production has been at the cost of sustainable use of resources especially water. The dominance of paddy-wheat crop rotation has led to over-exploitation of ground water resulting in rapid decline of water table in the state. The overall contribution of rainfall to state's annual replenishable ground water resource is 30 per cent and the share of other sources taken together is 70 per cent. Keeping 2.33 billion cubic metre (bcm) for natural discharge, the net ground water available for utilization for the entire state is 21.44 bcm. The annual ground water draft is 31.16 bcm out of which 30.34 is for irrigation use and 0.83 bcm for domestic and industrial use. In general, the irrigation sector remains the main consumer of ground water (97.36 per cent of total annual ground water draft for all uses). The stage of ground water development computed as the ratio of ground water draft to total replenishable resource, works out as about 145 per cent for the State as a whole which implies that the average annual ground water consumption is more than average annual water recharge. Adoption of efficient water use technologies can save lot of water in the state without adversely affecting the crop production and productivity. Micro innovative methods of irrigation like drip and micro sprinkler irrigation systems, use of tensiometers need to be taken up on a large scale for conserving the depleting water resources. Continuation of rice wheat cropping system may exaggerate the problem of groundwater depletion and therefore changes in cropping pattern in favour of low water consuming crops needs to be encouraged. Strict regulation for exploiting groundwater and conjunctive use of surface water need to be introduced at the earliest. Supply of free electricity to agriculture particularly for irrigation purposes has led to injudicious use of irrigation water. A proper price policy for electricity use backed with proper information dissemination regarding optimum use of irrigation water needs to be introduced in the state. Timely transplanting is one of the effective strategies to arrest the falling water table in the state. Farmer is the ultimate use of water so he should be made aware of the griming situation of water resources and the techniques of water conservation should be explained and demonstrated to him by organizing awareness camps.

NUTRITIONAL SECURITY OF PUNJAB CULTIVATORS: ROLE OF TECHNOLOGY ADOPTION

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Abstract

The threat to food security arises from purchasing power of the population groups. Mere availability of food does not guarantee nutritional security to all. Punjab has witnessed tremendous increase in production and productivity of cereal crops in the wake of adoption of new technology. The impact of technology adoption was evident on income from farm cultivation across the three categories. It is found to be maximum on mechanized farms and least in case of non-mechanized farms. However, net returns were found to be positive in all the three categories under study, though in case of bullock operated farms, maximum proportion of total income was accruing to non-farm sources. Food has emerged as the main component of domestic expenditure in all the three categories, though its proportion decreased at higher level of mechanization. Within food segment, milk and milk products, wheat and sugar have shown a higher share in total food expenditure. The value of food items furnished by the farm itself was found to be higher on semi-mechanized farms and mechanized farms as compared to non-mechanized farms. Incase of wheat consumption, the main staple diet of Punjab 91 per cent was self produced in all the categories. The nutritional status of selected cultivators when compared with Recommended Dietary Allowances (RDA) depicted a same pattern across the categories with a bias towards high energy food items like cereals, milk and fats, but is deficit in proteineous and protective food materials like fish, meat, eggs etc.

BIOTECHNOLOGY TO COMBAT FOOD SECURITY AS WELL AS CLIMATE CHANGE ISSUES

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Climate change will affect all four dimensions of food security, namely food availability (i.e., production and trade), access to food, stability of food supplies, and food utilization. The importance of the various dimensions and the overall impact of climate change on food security will differ across regions and over time and, most importantly, will depend on the overall socio-economic status that a country has accomplished as the effects of climate change set in. By 2050, the global population will surpass 9 billion

and require nearly a double of agricultural output to provide an adequate food supply. At the same time, the world's agricultural system will be continuously challenged by water scarcity and climate change; raising the risk of production shortfalls in a world where over more than 800 million people are already undernourished. A challenge like this can be met out through biotechnology, innovation appropriate agricultural development and trade policies. We have to encourage countries to think proactively about the use of biotechnology that can play role in addressing food security, mitigating climate change and its strong potential as an engine for economic growth. Biotechnology has created an array of tools to improve agricultural productivity, efficiency and nutrition over the last decade, from tissue culture to marker-assisted selection to genetic engineering. It offers great potential to help developing countries in reducing crop losses due to pests and disease, increasing the nutrient content of crops and mitigate the effects of climate change. This is particularly relevant in all developing countries, where agriculture models have indicated that by 2050 average yield of rice, wheat and maize will decline by up to 14 per cent, 22 per cent and 5 per cent respectively, as a result of climate change. The establishment of a regional biotechnology framework for every susceptible area that is transparent, predictable and science-based will demonstrate their openness for investment while protecting people and the environment. As biotechnology is expensive, at the international level efforts should be made to create and utilize central laboratory facilities where expensive equipment and reagents may be utilized in an economic manner.

LIGNINOLYTIC ENZYMES PRODUCED BY TRAMETES VERSICOLOR AND SCHIZOPHYLLUM COMMUNE DURING BIOPULPING OF OIL PALM TRUNK CHIPS AND THEIR USE IN BIOTECHNOLOGY

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Abstract

There has been an enormous expansion of oil palm plantation all through Malaysia in the last five decades. The growth of oil palm as a commercial crop generates lignocellulosic residues in the form of empty fruit bunches fronds and trunks. To minimize this agriculture waste from the field, an alternative could be its utilization as pulp material. Biopulping using 2 white rot fungi *Trametes versicolor* and *Schizophyllum commune* was studied and determined by the lignolytic enzymes produced and degree of decay each of the fungi causes on oil palm biomass. The production process was further improved by optimizing a number of parameters such as incubation time, pH, temperature, inoculums size and nutritional factors. By optimization of dissimilar parameters, the maximum activities of enzymes synthesized by *T. versicolor* and *S. commune* were observed as 715 and 412 IU/ml for laccase, 120.5 and 80.75 IU/ml for manganese peroxidase (MnP) and 221.85 and 189.35IU/ml for peroxidase (LiP) after 8 days incubation at pH 4.5 and 28°C temperature with 3 ml inoculums size, 55 per cent moisture content, 20:1 C:N ratio. The selective degradation was observed through Scanning Electron

Microscope. The ligninolytic enzymes produced by the fungus implies its potential for commercial scale production of these enzymes for industrial applications.

Key words: Biopulping, *Trametes versicolor, Schizophyllum commune*, Laccase, Manganese peroxidase, Lignin peroxidase

IMPACT OF RESETTLEMENT ON WOODY PLANT SPECIES AND LOCAL LIVELIHOOD: THE CASE OF GURAFERDA WOREDA IN BENCH MAJI ZONE, SOUTH WESTERN PART OF ETHIOPIA

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Abstract

The study was carried out at Guraferda woreda in Bench Maji zone, south western part of Ethiopia with aimed at analyzing the impacts of resettlement on woody plant species and local livelihood.A total of 64 plots, 20mx20m (400m^2) plots at 300m intervals within sixteen transect line were laid and taken to identify woody tree and shrubs species composition on both Intact and disturbed area. Subplots having equal size of 2mx2m (4m^2) at the four corners and the center within each main plot were laid out to collect seedlings and saplings from the two study sites Also a total of 120 household heads were interviewed on resettlement and its impact in Guraferda out of which 53 Natives and 67resettlers.The SPSS version 13 was used for data analysis. Focus Group Discussion (FGD) with Native, resettlers, Developmental agents (DAs) and official's people were conducted to get information on their perception towards resettlement. Results from the woody vegetation, socio-economic survey analyses and the summary of the focus group discussions showed that a total of fifty-six woody tree and shrub species belonging to 28 families were recorded in the study sites. Forty-seven woody species were recorded in intact site belonging to 26 families, whereas forty –two woody species belonging to 24 families were recorded in disturbed area.Diversity index value showed that intact area (H'=3.3270050) and evenness value (E= 0.8641241) and (H'=3.3203220) and evenness value (E=0.8883401) of the disturbed area i.e.; the two sites had high diversity indexes that indicate the species richness of the area. Regeneration status of the two study sites showed inverted 'J' shaped distribution which is the sign of good regeneration status. In addition the socio-economic assessment result showed that out of the total respondents 56.0 Per cent of them have 2ha farmland and 15.0 and 18.3 per cents of the respondent have 3ha and 4ha respectively. Again the household's with land holding of greater than 5ha were 10.0 per cent this result was

found from household survey. This is actually above the minimum requirement standard of 2ha per head for farm land.The majority 51.0 per cent of the native people gets their fire wood demand from farm land as a source of house hold energy, while 35.8 per cent of the resettlers respondents use wood from both natural vegetation and farm land as a source of household energy but the rest respondents from Natural vegetation. All in all about 85 per cent of the native people opposed resettlement because it has influence on their livelihood. The current study shows the area is in problem of deforestation the intact forest and needs immediate attention from all concerned bodies and implements land use on the natives' need.Agro forestry and farmland tree planting will also help to reduce the pressure on the natural vegetation. To this end protect and preserve the existing intact forests; planting valuable tree species and rehabilitation programme is needed to the study area.

Keywords: Resettlement, Guraferda, Species diversity, Perception

SEWAGE SLUDGE AS FERTILIZER SUPPLEMENT: MORPHOLOGICAL, PHYSIOLOGICAL, BIOCHEMICAL AND YIELD RESPONSES OF TRITICUM AESTIVAM PLANTS

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Abstract

The present study was conducted to assess the suitability of sewage sludge amendment for wheat (*Triticum aestivam* L. var. Malviya 234) by evaluating the morphological, physiological, biochemical and yield responses of plants grown at 6, 9, 12 kg m^{-2} sludge amendment (SSA) rates. Root length of wheat decreased, whereas shoot length, number of leaves and leaf area increased significantly due to SSA. Total plant biomass also increased significantly at all the SSA rates, maximum increase (58 per cent) was recorded at 12 kg m^{-2} SSA at 50 days after sowing. Lipid peroxidation, protein content and antioxidant levels increased, whereas thiol and phenol contents decreased in plants grown at different SSA Yield increased by 54, 86 and 70 per cent at 6, 9 and 12 kg m^{-2} SSA, respectively as compared to unamended controls. Heavy metal concentrations in soil and different plant parts increased at increasing SSA rates. Heavy metal concentrations in soil and different plant parts increased at increasing SSA rates. Heavy metal concentration in wheat grains was found to be above the save limits of human consumption for Ni, Pb and Cd above 6 kg m^{-2} SSA.

The study suggests that SSA upto 6 kg m^{-2} may be recommended for land application due to significant increment in yield. Higher sludge amendment rates though increased the yield but caused risk of food chain contamination

Keywords: Wheat; Sewage sludge; Heavy metals; Yield; Root length; Shoot length; Lipid peroxidation.

A SNAPSHOT OF INNOVATIVE APPROACHES IN WATER USE FOR AGRICULTURE: CASE STUDY OF PERUMATTI PANCHAYATH, KERALA

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Water is critical to food security and a prerequisite for energy, health and human security. Agriculture is by far the biggest user of the world's freshwater resources, accounting for nearly 70 per cent of all withdrawals, and up to 95 per cent in developing countries. The substantial increase in the demand for food and other agricultural needs coupled with more irregular rainfall pattern and higher temperature due to climate change are the key challenges for increasing water efficiency in all aspects food production. Adopting innovative water management technologies in agriculture are essential for food security, poverty alleviation and ensuring water security. The present paper is a case study of 20 farmers of Perumatti Panchayath of Palakkad District in Kerala adopted Precision farming and drip irrigation in their agriculture as sustainable water management for food production. The study assess the biophysical and technical aspects of the resource use in agriculture and how it is contributed to global food security as a local action for global challenge .

Key Words: *Water security, Food security, Sustainable water management, precision farming*

EFFECT OF DIFFERENT PALM OIL MILL EFFLUENT (POME) CONCENTRATIONS ON SEED GERMINATION, SEEDLING GROWTH AND PHYSIOLOGICAL RESPONSE OF KIDNEY BEAN PLANT.

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ABSTRACT

Study was carried out to evaluate the effect of Palm Oil Mill Effluent (POME) on seed germination, seedling growth, total chlorophyll, carotenoid, proline and thiol content of Kidney bean plant. Kidney bean seeds were raised in petriplates irrigated with different concentrations of POME (0 (control), 25, 50, 75 and 100 per cent). At lower dilutions, Kidney bean plant showed a favourable effect on seed germination, seedling growth and total chlorophyll content but at higher they showed the inhibitory effects. It was reported that at pure POME (100 per cent) the seed germination was minimum. The carotenoid contents increased with increasing POME ratios and being highest at 100 per cent POME.

The present study suggests that the effluent can be used safely for kidney bean cultivation, only after proper treatment and dilution.

Key words: Palm Oil Mill Effluent; Kidney bean; Germination per centage; Total chlorophyll content; Carotenoid content, Proline content