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सत्यमेव जयते

Ministry of Earth Science,  
Government of India,  
New Delhi



**3<sup>rd</sup> IDSAsr**

*International Seminar*

# *Final Report*

## *Water Security and Climate Change: Challenges and Strategies*

*Venue*

*Conference Hall,  
Guru Nanak Bhawan  
Guru Nanak Dev University  
Amritsar-143005*

*November 4-6, 2011*

***Guru Arjan Dev***

***Institute of Development Studies***

***14-Preet Avenue, Majitha Road, PO Naushera, Amritsar-1430008***

*(Under the aegis of Guru Arjan Dev Institute of Development Studies Society)*

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**CSIR**



# ***WATER SECURITY AND CLIMATE CHANGE: CHALLENGES AND STRATEGIES***

*{Compiled and finalized jointly by Dr Gursharan Singh Kainth and Dr Archana Sinha from Indian Social Institute New Delhi; with inputs from Shri Sanjay Soni and Dr. K. Subramaniam, Managers from National Bank for Agricultural and Rural Development Regional offices of Uttar Pradesh, Lucknow and Haryana, Chandigarh respectively}*

Global warming and the subsequent climatic change over the Himalayas, South Asia's major water source is a topic of intense debate and scientific researches as it has huge ramifications for both security and socio economic scenario in future. With global warming altering weather patterns and affecting fresh water availability, it has been often stressed that the next war will be fought not over oil but over water. As the world gears up for the next round of United Nations climate-change negotiations in Durban, South Africa, in November, Guru Arjan Dev Institute of Development Studies called for its **3<sup>rd</sup> IDSAsr International Seminar** to provide much needed



scientific exposure about water stress and water security concerns and provide a road map for



better water resources in the future. The seminar was jointly sponsored by Government of India through its Ministry of Earth Science; Indian Council of Social Sciences Research; Council for Scientific and Industrial Research and National Bank for Agricultural and Rural Development. Guru Arjan Dev Institute of Development Studies is a centre for advanced research and training in multi-disciplinary areas under the aegis of Guru Arjan Dev Institute of Development Studies Society Amritsar. The main objectives of this seminar has been to contribute to the understanding of the development processes and problems related to water security and climate change; to focus on studies relating to this problem of the by-passed section and regions; and to provide a forum for dialogue on the subject.

Food production and social development has depended heavily on access to the water needed to grow crops or rear livestock. In the past, balance between water supplies and human need has come under increasing threat from growing populations, urbanization and climate change. The likely increase in rainfall variability could have devastating effects on food production and rural livelihoods. Even a short dry spell during the growing season where farmers rely almost entirely on rainfall to water their crops, can devastate food supplies. Freshwater fit for human consumption is a scarce resource. Discussions about freshwater availability increasingly focus on water security, which refers to people's access to enough safe and affordable water to satisfy their needs for household use, food production and livelihoods.

Water insecurity and scarcity already affect large parts of the developing world. An additional threat to water security comes from climate change. Climate change has already affected water resources across the world. Agriculture accounts for more than 70 per cent of water use in the world. Addressing water scarcity will inevitably imply revising agricultural practices and policies worldwide to ensure their sustainability. Inadequate knowledge of policy framework and its poor implementation of water management process are proving to be the root cause of many water related problems. Hence, it is felt necessary to deliberate these issues both scientifically and socially with policy makers, international and national water experts. The seminar endeavors to share latest as well as traditional water knowledge and best practices on this issue, and discuss the possible options available for integrated water resource management. This seminar has provided a space for discussion, interaction, dissemination of information to policy-makers, water managers, academics, students and the public in general.



**Dr Rajinder Singh Bawa**, Chairman Research Advisory Council of the institute while delivering



his welcome address reflected on the main purpose of holding the seminar. He welcomed Dr Gurdev Singh Khush, the chief guest to inaugurate the seminar, who is one of the global leaders on crop breeding and a major brain behind the development of productive rice varieties and the Green Revolution in plant breeding and contributed to food security. He also welcomed Dr. Ashok Gulati, Chairman, Commission for Agriculture Cost and Prices, Government of India for presiding over the

seminar. He expressed his appreciation for Dr. Gulati as one of India's sharpest and most respected agricultural economists, besides his wide publications in national and international research journals, rendering policy advice to the Government of India. Dr. Bawa also welcomed all the distinguished representatives from government and non-governmental organizations present in the seminar. He stated that in terms of water, India stands among those most challenged, because with 16 per cent of world population, India has just 4 per cent of its available fresh water. At the end, he commended the efforts of Dr. Gursharan Singh Kainth and his team for the untiring efforts in organizing the seminar.

**Dr Gursharan Singh Kainth** Seminar Director delivered his introductory remarks on the theme



of the Seminar. While welcoming all the key speakers, session chairpersons, distinguished guests and participants stated that this periodic seminar aims at providing a platform for the exchange of ideas and presentation of viewpoints related to sustainable management of water resources. Dr. Kainth said that freshwater is a scare resource and issues about freshwater availability increasingly focuses on water security, which refers to people's access to enough safe and



affordable water to satisfy their needs for household use, food production and livelihoods.

Water insecurity and scarcity already affected large parts of the developing world. Further, last century has seen a six fold increase in global water demand. India currently has among the world's most destructive approaches to water consumption and where 85 per cent of the country's water goes each year to agriculture sector. Domestic consumption accounts for just 7 per cent of the total, and industry, energy generation, and other uses the remainder. Dr. Kainth highlighted the need to 'fix' irresponsible usage, theft and leakage of water. India's long standing emphasis on water—intensive crops such as grains and even sugarcane needs also to be re-assessed and planned afresh for if our equal need for water is to be responded to appropriately. This will acquire a greater urgency now, given the government's commitment to the Food Security Act. At the end, Dr. Kainth re-emphasized upon this periodic seminar aiming at providing a platform for the exchange of ideas and presentation of the viewpoint's related to the sustainable management of water resources. He concluded by stating that the time has come for us to draw deep from this tradition and launch India and its billion people on a path of ecologically sustainable development.

In his Inaugural Address, **Dr. Gurdev Singh Khush** FRS Member US National Academy of



Sciences, Adjunct Professor University of California, Davis, and Former Head Department of Plant Breeding Genetics and Biotechnology, IRRI, Philippines complemented Guru Arjan Dev Institute of Development Studies for organizing this conference on climate change and water security. Water is earth's most vital resource. He stated that climate change shall affect our lives mainly by impacting water supplies for agriculture, as emphasized in '**Gurbani**' the three most important things that sustain humans are air, water and earth (**Pawan Guru, Pani Pita and Mata Dharat**). Also

from our worldly entrance in a burst of amniotic fluid to the ritual washing of the dead, water flows through our lives; and, more than 75 per cent of our bodies are water.



Climate change has raised the earth's temperature by  $0.74^{\circ}\text{C}$  or  $1.3^{\circ}\text{F}$  during last 50 years. Water is the visible face of climate and therefore climate change: shifting rain patterns, floods in some regions and drying in others as nature demonstrates a grave physics lesson. The Tibetan plateau is heating up as a whole twice as fast as the global average of  $1.3^{\circ}\text{F}$  during the last century and in some places even faster. These warming rates are merciless on the glaciers. For thousands of years these glaciers have formed Asia's freshwater source. The Himalayan glaciers are water towers for our rivers. Glacial melt plays most vital role before and after rainy season when it supplies a greater portion of the flow in every river from Indus system to Gangetic basin. But, over the past half century this balance has been lost. Approximately 210 million hectares of land in the world is irrigated. Half of this is in India and China alone, e.g., 50 million hectares in China and 55 million hectares in India. That is why China and India have been able to feed their huge populations.

The major impact of climate change is on our water resources and food production. Nonetheless, water insecurity is already a reality in some parts of our country due to over exploitation of and misuse of our water resources, which is leading to an alarming decline of ground water tables. There are serious concerns about changes in water quality due to the exploitation of lower strata of aquifers in some areas of Malwa region. Perhaps the single most important reason for the groundwater depletion trends of last 30 years is the homogenization of crops planted in the Punjab. Over the last several decades crop selection has shifted from being diversified to a





seasonal monoculture, e.g., rice in summer and wheat in winter. Further compounding inefficient water use problems is the fact that the central and state governments provide incentives that specifically encourage planting of rice, the major cause of depleting water tables. These incentives include full economic offsets for the electricity costs used in extraction of groundwater, which, unsurprisingly, exacerbates groundwater withdrawals. Stressing on the solutions on the present scenario, Dr. Khush suggested several interventions that can be employed to stabilize and improve the groundwater levels in Punjab: Firstly, crop diversification, is the single most important intervention would be to reduce the area planted to rice from 2.7 million to about 1.5 million hectares. Alternate crops should be as remunerative as rice. Hybrid maize and legumes such as soybean with price support would be good possibilities. Some area should be devoted to fruits and vegetables. Contract farming should be promoted for surplus value creation, with systems set up so that the surplus value is split between the farmer and private sector.

Secondly, precision agriculture is an option that includes the introduction of a variety of water saving technologies. Direct seeding of rice uses 30 per cent less water, and laser leveled fields can save 20-30 per cent irrigation water. Existing irrigation techniques also involve flooding the fields, with only a fraction of water and applied fertilizers effectively used by plants. In recent decades, a suite of precision irrigation techniques have been developed. These include drip irrigation where water is dripped on root zones of plant providing water just where needed.

Thirdly, minimum support price can be one way to promote crop diversification is to introduce price support for alternate crops such as maize and soybean. Price support for soybean will increase its production and help reduce the import bill.

Breeding crops with lower water requirements are also opportunities to economize water use through genetic interventions. Lastly, pricing of electricity at full cost perhaps have been good reasons for implementing the policy of free electricity for agriculture. However, this also led to excessive pumping of water from the aquifers and lowering of water tables.

At the end Dr. Khush emphasized that government must start charging farmers for the use of electricity, besides the above interventions strategies. Discussion of water security interventions inevitably leads to concerns about their impact on the nation's food security. Better management interventions for wheat in Uttar Pradesh and for rice in West Bengal, Tamil Nadu, Orissa and



Andhra Pradesh should help increase their productivity. Thus, water security constitutes one of the great challenges facing our state, at the same time there is an unprecedented opportunity to develop and apply new forms of knowledge and interventions thereby, turn this crisis into an opportunity.

**Dr. Ashok Gulati Chairman,** Commission for Agricultural Costs and Prices, Government of



India while delivering the Presidential Address, appreciated the perseverance of Dr. Gursharan Singh throughout and also Dr. Khush, whose research is known the world over. Dr. Gulati looks at water security in the backdrop of climate change as a threat to food security. He reflected upon the subject primarily from the food security perspective. He said that climate change has its implications on the melting of glaciers and changes in the water run-off. He said that the rising temperatures are likely to benefit the

agriculture of cold temperate regions, especially Europe since warmer conditions will allow their single crop zones to become two, or even three crop zones. Asia and especially India are likely to face major challenges in terms of their agricultural production potential. Rising temperatures are likely to impact wheat in India much more than rice. The northwest belt of India which is the wheat bowl of the country will be adversely affected and therefore has to be under alert as to how to cope up with these effects of climate change. He highlighted that agriculture being the lifeline of a populous country like India, will bear the worst brunt of climate change, so, food security emerges as a serious issue.

With regard to water security Dr. Gulati said that today, the competition for water resources is much more intense. The per capita availability of water is going to reduce very fast while the demand for water from the increasing urbanization, industrialization and more protein based diets is going to increase. Further, in order to avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industry and cities have to find ways to use water more efficiently. Overexploitation of the resource has sharply lowered the water table in many parts of the country, making them increasingly vulnerable to adverse impacts of climate change. Due to over exploitation of ground water, largely in an unregulated





manner, safeguarding our water aquifers on a long term sustainable basis has become a major challenge. There are pockets where there is a much faster depletion and cannot be recharged by the natural cycle of rains. There are some estimates which show that in next 30 years or so if this unabated exploitation of ground water aquifers continues, the region will fast move towards desertification inflicting a major loss to the food basket of the country. Dr. Gulati stressed that this should be a wake call for the policy makers who care for the long term sustainability of Indian production system.

With regard to the dynamics of change in rice and sugarcane, Dr. Gulati stated that these two crops are the most water-guzzling crops in Indian agriculture. At the level of the Central government there is a clear thinking that at least one million hectares of rice cultivation area should be shifted from north west belt to Eastern India (East Uttar Pradesh, Bihar, Orissa, Chhattisgarh etc.), where water is relatively in plenty. It is only under this situation the ground water situation of the North West India can improve.

Dr. Gulati stressed upon the significance of supplementing ground water. Ground water alone cannot be relied upon for the growth of Indian agriculture. There is a need to tap major and medium irrigation schemes. There is also a proposal of linking rivers where an additional 35



million hectares can be brought under irrigation. Irrigation potential can be increased but to meet this, it costs quite a bit more. Investment in irrigation has to increase four to five times if we need to ensure long term sustainability of food security.

Currently the country is spending a lot of money through MNREGA (Rs 40,000 crores) per year and at least half of this is going on water and soil related conservation projects. Water harvesting has to be done with a view to recharge the ground water at a much bigger scale than what is currently being done. At the end he emphasized that supply management alone will not help solve the problem of water security. A lot will have to be done on the demand side of the management. He felt that challenge is more on the political front. It is hoped that Indian Policy makers will rise to the occasion and take a bold decision well in time for the long term benefit and sustainability of India's production systems.

**Dr Manmohan Singh Gill** Trustee of the society extended his heart-felt thanks to the



Chairperson Dr. Gurdev Singh Khush, World Renowned Agronomist, and Dr. Ashok Gulati, Chairman Commission for Agriculture Cost and Prices, Government of India. He stated that sustainable water management has acquired a new urgency in the face of challenges posed by population growth, urbanization and greater hydrological variability caused by climate change. Further, crucial task now include controlling the effects of industrial and other related activities on the environment within the ecological carrying

capacity and using finite resources as efficiently as possible. Presently the burden on the resource consumption and environment is above 40 per cent of sustainable levels. In this regard he said that the need for action is understandable. At the end, Dr. Gill while welcoming expressed his thanks to the dignitaries for making this seminar a success and with the hope that this seminar would be able to bring about some concrete results pertaining to the global issue of water security

The afternoon session was chaired and conducted by Dr Gurdev Singh Khush from Davis, US, in



which three technical papers were read. Dr Archana Sinha from Indian Social Institute Delhi acted as a Rapporteur of this technical Session. **Dr R C Bhattacharjee**, Dean National Institute



of Technology, Kurukeshtra delivered his key note address. He delivered his address on ***Water for Life –Some Issues and Concerns*** – a subject which is of concern to scientists and policy makers alike. He said that water is used for the purpose of drinking, irrigation and agriculture. India is 9<sup>th</sup> largest economy of the world and its growth rate is 8 to 9 per cent which is a good sign for nation. It is hoped that India will overtake other countries. And that after China, US, India will be third largest

economy in the world in 2050. Hence this time is important for us now. India's growth will be constant for some time and will gradually improve. With regards to the issue of climate change, he stated that it cannot be controlled, but must be given due attention. He said at present 70 per cent of water is used for agriculture and only 8 per cent for domestic purpose. He elaborated upon the drinking water consumption using facts and figures. This scenario in India, shows that there is indiscriminate extraction of water without due regards to the recharging capacities of aquifers. This challenge lies in increasing supply of water; maximize its yield and minimize its waste. Hence there is a strong need for a change in approach to water management; need for political leadership on water' and need for water to become everybody's. At the end he suggested some measure for water security. He also suggested that drinking water must be a

component in all programmes.



**Er. R K Khanna** former Chief Engineer, Environmental Management, Central Water Commission Government of India said that Climate change is at our door steps. As Climate Change is likely to affect water sector most, prudence demands that water professionals plan the necessary adaptive measures, keeping in mind the lessons from the past experience. The issue is somewhat



controversial and his paper attempts to clear of all controversies and focus on the possible impact of Climate Change on water resources and adaptive measures.

Demand for water has been growing rapidly due to rise in population, industrialization, urbanization and change in life style. While the earlier concern was water quantity, now there is equal concern for water quality. Growing concern about impact of CC on water resources has thrown a new challenge. Urgent steps are required to be taken to meet all eventualities. The paper provided an overview of the recent events and lists components of an adaptive strategy from policy framework to planning. Designing, installing O and M and safety for existing and proposed utilize/facilities in water sector. All water sector viz., irrigation, drinking water, domestic, industrial; hydropower and energy, navigation, recreation etc and water users viz. farmers, women and religious and social needs were considered/ covered.

**Dr Mahendra Pal Singh** Professor of Agronomy from Govind Ballabh Pant University of



Agriculture and Technology, Pantnagar in his key paper touches the issues like major land-use distribution in Himalayan regions. Data and figures on National Water Resources at a glance; gaps between ultimate potential created potential utilizable potential; district wise and block wise rainfall pattern, cropped area and irrigated area; irrigation sources in IHP; ground water exploitation pattern and its utilization pattern.

Dr Pal clarify that ground water table is decreasing very fast even in Tarri region; Ionic concentration in of ground water in IHR and total water use in various sectors. Besides these, his presentation also highlighted upon the major challenges in IHR including soil and water erosion, pollution of fresh water, landslides dying of springs, ponds, lakes, floods, poor crop productivity, deforestation of migration climate change etc. How to tap ground water for drinking purposes and how to increase agriculture potential?



The sessions of second day were chaired by Dr. Rais Ahmad from Department of Agricultural Economics and Business Management, Aligarh Muslim University, Aligarh and Rapporteur for



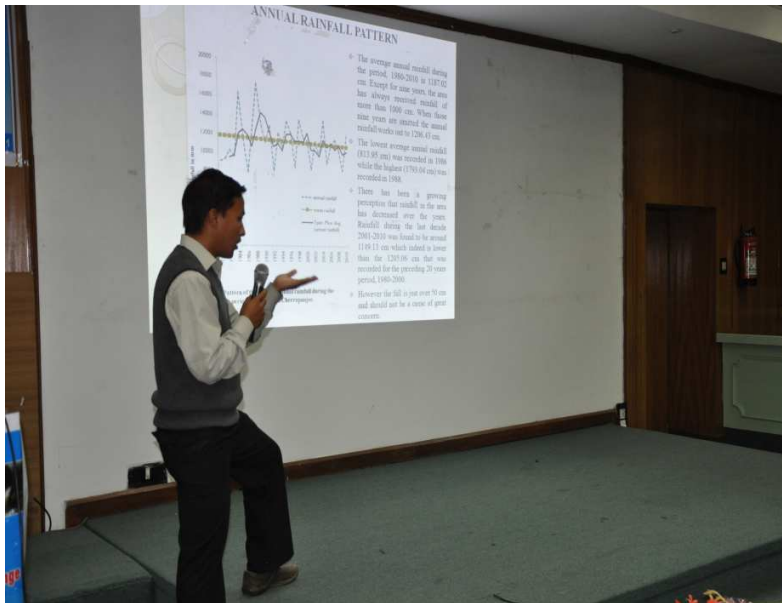
both the sessions was Dr. K. Subramaniam, Manager Haryana Regional office of NABARD at Chandigarh. Some papers could not be presented due to time constraints and non availability of the presenters. Hence all papers received were deemed as read.

Over the years, India has experimented with several social security schemes/programs aimed at reaching out and supporting the deserving citizens. The paper, ***“Towards Linking Livelihood and Rural Water***

***Security- An Assessment”*** by Dr. R. P. S. Malik from International Water Management Institute reveals that a majority of the permissible works being undertaken as part of the livelihood security program, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), relate to building of assets aimed at enhancing rural water security. The present study attempts to assess how durable these assets have been and how effective MGNREGS has been in helping improve rural water security. The results based on a case study in the state of Madhya Pradesh show that despite the restrictions imposed on non- use of any machinery for construction of structures and several other limitations, the water structures that have been built are of a reasonably good quality and hold a great promise to improve rural water security. There are however some problems in transforming available water in these structures into utilizable water. Successful mediation through appropriate intervention strategies can not only enable beneficiary farmers to use the available water more productively, it can also enhance more productive utilization of MGNREGS money invested in asset creation. It is envisaged that execution of these works under MGNREGA over a period of time would help provide water security to large parts of rural areas, especially to the marginalized sections of the society, on a sustainable basis. Much however would depend upon the nature and quality of works that are undertaken and durability of the assets that are being created under the program. With reasonably good quality water structures being built in rural areas, the MGNREGS holds a great promise for improving water security in rural India.



Shri Bhogtoram Mawroh, a research Scholar of Department of Geography, N-E Hill University



Shillong deliberated on “*Seasonal and Spatial Variations in the Availability of Domestic Water in the Sohra Syiemship of the Cherrapunjee Area*”. In his study, the region was divided into three geomorphological zones viz. - *Plateau, Mild slope and Valley*. He observed that all the zones have domestic water scarcity problem due different geo

environmental and socio economic factors.

Dr. Krishan K. Boora from School of Management Studies, BPS Mahila Vishwavidyalaya, Women University), Khanpur Kalan, Sonipat, and Dr. Jagdeep Singla from Institute of Management Studies and Research (IMSAR), Maharshi Dayanand University, Rohtak, in their paper *Privatization and Commoditization of Water in India: An Economic Appraisal* reveals that the headlong rush toward private markets has failed to address some of the most important issues and concerns about water. In particular, water has vital social, cultural and ecological roles to play that cannot be protected by purely market forces. In addition, certain management goals and social values require direct and strong government support and protection, yet privatization efforts are increasing rapidly in regions where strong governments do not exist. We strongly recommend that any efforts to privatize or commodify water be accompanied by formal guarantees to respect certain principles and support specific social objectives. Among these are the need to provide for basic human and ecosystem water requirements as a top priority, independent monitoring and enforcement of water quality standards, equitable access to water for poor populations, inclusion of all affected parties in decision making, and increased reliance on water-use efficiency and productivity improvements. Openness, transparency, and strong public regulatory oversight are fundamental requirements in any efforts to share the public responsibility for providing clean water to private entities. Water is both an economic and social



good. As a result, unregulated private market forces can never completely and equitably satisfy social objectives. Nonetheless, the driving forces toward, and potential advantages of, globalization and privatization of fresh water supply will continue to play an important role in future water supply and planning. Given the legitimate concerns about the risks of this “new economy of water,” efforts to capture the positive characteristics of the private sector must be balanced with efforts to address its flaws, gaps, and omissions. Water corporations, through world bodies such as the World Bank and IMF, are influencing national governments to push privatization and commodification of water as “the chosen” alternative to manage the growth in water consumption and the severe water scarcity. However, the growth in water consumption is highest in the agricultural and industrial areas, where the resources to buy water are readily available with rich farmers and industries. This increase in consumption will be satisfied through the market dynamics often at the cost of the poor who cannot afford the increased water tariffs. Furthermore, due to the nature of this sector, water privatization, instead of bringing in healthy competition, results in a monopoly sanctioned by the government agencies. Numerous case studies around the world highlight the other ills of water privatization such as poor quality of water, unsustainable water mining and lack of transparency and accountability. From the various studies outlined here, we consider the proposed privatization of water as a violation of basic rights of Citizens of India and oppose any means to privatize water in India.

Better and socially responsible alternatives can be found by investing in community based participatory approaches to water management that ensures equitable and sustainable use of this precious natural resource. All over the world, alternate models such as rain water harvesting, check dam and bund building, holistic watershed management, integrated river basin management and irrigation efficiency improvement have all been demonstrated as low cost successful alternatives to privatization.

A paper on “***Virtual Water Scarcity in Agriculture***” was presented by Mr. Surinder Singh Mor, from Ch. Devi Lal University, Sirsa. He has pointed out that global warming has many effects on water resources like; it changes the rainfall pattern, temperature, occurrence of frequent floods, etc. He also presented the virtual water requirements for various crop production processes, which is getting scarcer and scarcer day by day. He suggested the following measures to mitigate the water scarcity in Agriculture. i. Cultivate the less water intensive crop, ii. Adopt water saving devices and iii. Use better water management techniques for the improvement in WUE.



The paper ***“Conservation and Management of Water Resources for Sustained Development of Pondicherry Agricultural Economy”*** is authored by Dr K.S. Velmurugan from Department of Economics, Pondicherry; Dr Rajarajeswari Parisot , Doctorate de Etat (France) and Economist Conferenciere , Strasbourg, France, and Dr E.M.Rajan, Dr Pramod Kumar and Kanchi Mamunivar from Centre for Post Graduate Studies , Lawspet, Pondicherry. The objectives of the paper are - to develop a broad and compendious account of water resources available at present at all India level and at Pondicherry and to give suggestions, ways and means of conserving these resources in future. The paper calls for broad-based agriculture, community and national initiatives in ground water and surface water projects from the national government. Further, larger projects on the basis of private corporate initiatives are required in the present juncture. It includes all kinds of structural reforms and second generation reforms in banking, finance, and in communications - to allow these private corporate sectors, to build up and operate dams across the rivers for hydro-electric power and for irrigation. Above all, it calls for a new National Water Policy, to be consistently followed by all the state governments and Union Territories and above everything, it call for a sense of National Federalism in the sharing of waters between the states and within the states.

The paper, ***“Water Scarcity across the Regions in Maharashtra”*** by Prof Sanjay Rode from Somaiya College, University of Mumbai, Mumbai states that the demand for water is increasing in Maharashtra because of urbanization, population growth, changing cropping pattern etc. The rainfall is not equally distributed in the region due to physical feature of state. Due to high industrialization, government tried to give first preference in water supply to industry but it was unsuccessful. The drinking water has to be provided to all villages, municipal councils and corporations in the state on 24/7 basis. It further adds to the stress on water demand. The work of NREGA is good in water storage through check dams but there are no laws for water use. In order to reduce the water stress in the state government should allow industry to do their own arrangement for water. Similarly check dams, farm ponds and compulsory rain water harvesting for each household in each village will reduce the water scarcity. Such steps are urgently required for an economically well developed state in India. First part of the paper explains about the rainfall pattern in the state. The water is stored in various projects in Maharashtra. The surface and ground water is used for irrigation, drinking and industry. The allocation of water for



agriculture is explained in third section of paper. In the second last sector drinking water is issue is discussed. The last section of paper explains about the policies and conclusion.

Water is more important than any other resource for the uninterrupted existence of mankind. Dr Bimaldeep Singh and Dr R P Singh from Guru Nanak Dev University, Amritsar in their paper on **"Legal Issues with Water Security"** made a brief presentation on institutional and legal frameworks available for water security in India. He emphasized that all the water bodies including the dirtiest water are to be preserved. They sought that though water is mainly a state subject, the Central Government should have sufficient provisions to regulate the water resources in a better manner at National level. Now, the existing Acts are having provisions for the Central govt. to have control over the surface water only. Hence, there is a need for amending the Act so that the ground water can also be regulated by Central Govt. They informed that Industries in our country are also biggest water users and they use mostly ground water. Hence, they may be advised to use the surface water, even if it is required to invest to bring the water to their Industry, to avoid excess burden on ground water resources.

Another paper entitled **"Prevention and Control of Water Pollution in India: Issues and Challenges"** by Prof Mukesh Kumar jointly with Naresh Lata Singla from the Department of Law, Ch. Devi Lal University, Sirsa reveals that water is useful for the survival of the mankind. It is used for the industrial, agricultural and for drinking purposes. For the purpose of drinking, clean water is required. It is not only the human right of a person to get clean water for drinking but also the part of fundamental right under Article 21 of the Indian constitution. There are many causes which pollute the clean water sources. Parliament has enacted the *Water (Prevention and Control of Pollution) Act* in 1974 for controlling and removing the causes of water pollution. Indian judiciary is also well acquainted with the problem of water pollution. It can be observed from the decisions of the various courts. But this problem can be removed only when general public will be determined to control the water pollution. Thus, the present study examines the significance of the clean water for the survival of the mankind and the causes of the water pollution. It also examines legal provisions applicable in case of water pollution in India and it reveals that there is need for strong implementation of the provisions of The *Water (Prevention and Control of Pollution) Act*, 1974. The study asserts that right to clean water is the human right of every person and it should be inserted as a separate right in the chapter of fundamental rights in the Constitution of India. The study lays stress on awareness of the people regarding the



consequences of water pollution and the culprits may be penalized and people should be made aware that how to control the water pollution.

The paper entitled ***“Water Saving in Rice Cultivation in Climate Change Scenario”*** by Dr. Subhash Chand, Dr. S. Sheraz Mahdi, and Dr. Badrul Hasan from Sher Kashmir University of Agricultural Sciences, Srinagar reveals that water is an important component of any production system. Indian farming community is facing challenges of water for agricultural purposes with limited rains during monsoon and canal water irrigation system. Rice is the staple food of about 3 billion people and demand is expected to continue to grow as population increases. However, the appalling paucity of water threatens the sustainability of the irrigated rice ecosystem these days. Such water shortage in many rice growing areas is prompting a search for production systems that use less water to produce rice. Although there are several water saving strategies such as alternate wetting and drying, continuous soil saturation, ground cover system and system of rice intensification are being pursued to save water in irrigated rice ecosystem. Water losses still hang on high since all those systems use prolonged periods of flooding. Aerobic rice systems, wherein the crop is established via direct seeding in unpuddled, non flooded fields and managed intensively as an upland crop are among the most promising approaches of water saving particularly in water short areas with less compromise on yield. In this paper, an intensive report has been given on prospects and problems of aerobic rice system with some future strategies to promote this technology over large areas without considering yield penalty and other shortcomings. The objectives of present study are to review - rice ecosystems from traditional (anaerobic) to aerobics and need of shift from anaerobic to aerobic rice ecosystems; the concepts and comparative performance of different water saving rice production methods including aerobic rice; and the ways, means and strategies to improve aerobic rice systems. The paper suggests that yield penalty and yield stability of aerobic rice have to be considered before promoting this water-saving technology. But at the same time rice can be highly productive in aerobic soils under optimum management for improved genotypes adapted to aerobic soil. Aerobic rice is a good strategy for coping with the increasing water shortage and ensuring rice food security particularly in tropical/arid/semi-arid regions.

Shri Anthony Imoudu of Nigeria presented a paper on ***“Modeling Soil water characteristics of Inland valley bottom soil of a derived Savanah in SW Nigeria”***. He explained SOILWAT software to study the soil water requirement and other soil characteristics of various soil types.



Paper entitled “*Judicious Use Of Irrigation Water in Paddy: Some Improved Management Practices*” by Dr. Gurjit Singh Matharu, Meharban Singh and Bhupinder Singh Dhillon from Punjab Agricultural University, Ludhiana reveals Water is an essential ingredient in modern agriculture and industry. Agriculture sector is the largest user of water which consumes more than 80 per cent of the country’s exploitable water resources. Rice-wheat crop rotation practiced on 2.5 m hectare area in Punjab has caused abundant removal of underground water without proper replenishment and for the last many years, the ground water table has shown an alarming decline. With rapidly depleting groundwater level and an erratic rainfall pattern, water is becoming scarce resource at national level. Hence the conservation and management of water is essential for the sustenance of agriculture as well as population on the earth. Out of the various techniques to arrest the ground water withdrawal, using tensiometer in paddy is very useful. The results of demonstrations conducted at farmer’s fields in Amritsar show that there is no significant change in yield of paddy when irrigated using tensiometer. But there was saving of 23.3 per cent water in demonstrations using tensiometer as against farmer’s practice in Amritsar. Similarly irrigation to paddy fields at least two days after infiltration of pounded water is an important improved practice. The regulation of Punjab government regarding transplanting of paddy after June 10 is an important step for saving irrigation water. Laser leveling of fields saves irrigation water and is also popular with farmers.

*Guru Arjan Dev Institute of Development Studies*



***Resources for Sustainable Production of Vegetable Crops***” explained the effects of under watering and over watering on crop production. The paper highlighted the following issues:

1. Proper scheduling of irrigation has to be followed for the crop
2. The critical stages of the crop to be kept in mind, while planning irrigation scheduling
3. Suitable irrigation method has to be adopted for efficient use of water
4. Mulching & Micro irrigation system is to be adopted to improve the WUE

Prof. Amerjeet Singh Sethi of Guru Nanak Dev University in his paper on ***“Gravity Flow Irrigation System (Kuhls) in Palampur Region of Himachal Pradesh”*** highlighted the importance of *kuhls* in irrigation system of Hills region of Himachal Pradesh covering its potential, management system and its current state of affairs. He expressed his concern on dilapidated status of *kuhls* in the state which are the important source of irrigation in state. This situation has arisen as people participation has reduced due to increased non-farm sector activity in the area. He suggested that there is dire need to revamp *kuhls* systems by active people’s participation and government intervention.

A paper on ***“Soil and Crop Management Strategies to Sustain Crop Productivity under Water Deficit Conditions in Punjab”*** was presented by Dr. Meharban Singh jointly with Prof V K Arora of Department of Soil Science, Punjab Agricultural University, Ludhiana. This paper highlighted the increased use of water in Agriculture sector, particularly the ground water resources, and need for the efficient water management in the Agriculture. Efforts should be made to popularize the crop diversification, use of water saving devices, proper irrigation scheduling, etc. for the better management of water resources. The state of Punjab is a part of Indus Basin, which is separated from Ganga basin by the flood plains of Ghaggar river. Punjab is situated in the North-west of India Punjab, the very name of the state, has emanated from ***“Punj*** (five) and ***Aab*** (waters) i.e. the land of five rivers. Groundwater utilization in the state got impetus in late 1960’s with advent of high yielding varieties of rice and wheat. Punjab has witnessed a phenomenal increase in agricultural production during this period, due to large scale adoption of rice-wheat cropping coupled with assured irrigation facilities and high fertilizer use. Moreover, the intensive irrigation that is contributing to land degradation and emerging water quality issues are now threatening the very benefits that irrigation has delivered to the farmers.



Depleting water resources due to over-exploitation of groundwater in Punjab threatens the maintenance of agricultural productivity. It calls for devising and applying management interventions so as to sustain and enhance crop yields per unit of water input or consumed. Groundwater use can be reduced by manipulating evapo-transpiration (ET) and percolation components of field water balance. Reduction in groundwater use with different management practices results in water savings. This paper gives an estimate of the present state of water deficit in Punjab and an overview of soil and crop management strategies/interventions to reduce groundwater use while maintaining / improving crop productivity for major crops.

***“Role of Irrigation In Agricultural Production In India”*** by Dr. Sudhanshu Joshi from Doon University, Dehradun jointly with Ms Puneet Kaur from SSSS College of Commerce, Amritsar reveals that food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life and it requires enough food production (agricultural production), sufficient income to purchase food and access to unobstructed clean drinking water as well. Agricultural production vital for food security, provides means of subsistence to sixty percent of population in India. The paper emphasizes the need for irrigation in agriculture, this paper an attempt has been made to examine the role of irrigation in agricultural production (positive impact) and also to analyze the negative impact of irrigation.

The paper on ***“Shift in Cropping Pattern Vis-A-Vis Stress on Water Resources in Punjab”*** was presented by Dr. Arjinder Kaur jointly with Dr Parminder Kaur from Department of Economics and Sociology, Punjab Agricultural University, Ludhiana. Paper highlighted that it is the need of the hour to make serious efforts on efficient water management in Agriculture as 85 per cent of available water resources are being used in Agriculture. When talked about the shift in cropping pattern, they alarmed that the paddy area in Punjab has increased over the years which is the reason for over exploitation of ground water and insisted that there is a need for shift in cropping pattern. Off late, ground water usage has become more in agriculture and other sectors, which is evident from the increase in number of tube wells from 1.92 lakhs in 60's to 12.76 in Punjab. This situation is alarming and to be looked into by the policy makers. She said that Investment in deepening of wells and purchase of pumps are also increased in line with increase in tube wells.

Fisheries is an important economic activity in developing countries like India. The paper



***“Institutional Approach to Improve Status of Inland Fishery in Rainfed Agriculture Area: A Case Analysis of Fishing Cooperatives in Madhya Pradesh”*** by Neel Kanth Mishra from Inland Fisheries Node- Revitalizing Rainfed Agriculture (RRA) Network Lucknow reveals that Indian fishery sector has observed a sharp growth in terms of production, productivity and support for employment of millions of people from fishing communities. The contribution of the fisheries sector to the GDP of the country has also been increasing. India is now the third largest producer of fish and the second largest producer of fresh water fish in the world and that fishery sector contributes significantly to the national economy. India is known for its inland fishery resources and once with rich indigenous fishery resources with great biodiversity. The poor inland fishers and rural community depended for their livelihood and food security on these indigenous species. India has vast inland fishery resources in the form of rivers and canals reservoirs, tanks and ponds, floodplain. It states that the capture fisheries in the rivers, lakes, channels, flood plain water bodies, tanks and ponds, were always the source of rural livelihood and food security base. This paper is divided into three sections; the first section captures community level technological intervention in Tikamgarh district of Madhya Pradesh that has been adopted by more than 100 fishery cooperatives, the second section of this paper attempt at identifying issue and challenges in rainfed area and the third section presents recommendations to extend technological and policy intervention in order to increase the growth rate. Thus, this paper attempt to promote the concept of extension of locally suitable techniques through Peer learning at the community level based on understanding of the current policy and practice in fishery sector. There is a significant and emergent local market for fish in India; inland fishery holds noteworthy prospective and production base like fishing nursery in small sized water bodies and in seasonal ponds; can realistically be promoted as means of livelihood for poor people. The paper concludes with four key lessons from community based intervention in Tikamgarh that fishery department and technical institutes might consider to improve status of inland fishery sector in rainfed agriculture zone, more specifically these are; Social inclusion, extension of locale specific fishery techniques, Policy framework and support to develop value chain. The paper suggests that the policy paradigm needs to be seen differently from “production” to “value chain” perspective that will address issue of all the engaged stakeholders in production process. Simultaneously, it is quite important for policy makers to engage with primary stakeholders so that pragmatic environment can be created as better support system to producer groups.



Water resources are crucial to the conduct of farming and dairying activities including bovine rearing. Water is a crucial constraint besides feed, fodder, labour and credit constraints. One can think of a water (environmentally available or man created ones wells or bunds and tanks) which acts as a prerequisite for these composite but complementary activities.

**Morning Session of third day** was chaired by Er. R.K. Khanna former Chief Engineer (Environment Management) of Central Water Commission, Government of India, New Delhi and afternoon session was chaired by Dr A K Gahlot, Vice Chancellor, Rajasthan University of Veterinary & Animal Sciences, Bikaner and Rapporteur for both the session was Shri Sanjay Kumar Soni Manager, Uttar Pradesh Regional office of NABARD at Lucknow. The session was opened by Dr. Manmohan Singh Gill, Trustee of the society. He welcomed the distinguished guest Dr. Jagir Singh Samra, Chief Executive Officer National Rainfed Area Authority of India and Dr. A.K. Gahlot, Vice Chancellor of Rajasthan University of Veterinary and Animal Sciences, Bikaner and focused on contribution made by these dignitaries in the development of water resources. All the papers presented were very informative and emphasized on the impact of climate changes in the water resource sector and on the need for efficient irrigation water management.

The presentation was made by Dr. Rajni of Directorate of Extension Services, Punjab Agricultural University, Ludhiana on ***“Climate Change and Its effects on Agriculture”*** jointly



with Dr Meharban Singh was adjudged as the Best Presentation. In her presentation she emphasized that Green House gases are responsible for Global warming which in turn is leading to increase in temperature and CO<sub>2</sub> contents in atmosphere and erratic rainfall pattern. These climatic changes are affecting the crop productivity and lead to shortening of Rabi season with increased incidence of pest



and diseases. It was studied that the positive effect of increase in CO<sub>2</sub> level is being overshadowed by the negative impact of increased temperature on productivity. It was suggested that impact of climate change can be mitigated by Adopting new breed of short duration and temperature resistant crops; Resource Conservation Technology like Rain water Harvesting, Zero Tillage etc, Direct seeding; Crop diversification and avoiding mono cropping of Rice in water scarce regions and Green Manuring.

The paper ***‘Impact of Climate Change on Snow Melt Runoff: A Case Study from Lang tang Basin, Nepal’*** by Sh Bhattarai, B.C from Central Department of Environmental Science, Kathmandu, Nepal and Sh. Regmi. D from Society of Ecological Restoration Scout Building Lainchaur Kathmandu, Nepal presents observations and model-based studies suggesting that the substantial hydrological changes in mountain watersheds where hydrology is dominated by cryospheric processes. The response of cryospheric processes to a warming climate in mountainous areas can be analyzed by examining the responses in the seasonal and annual hydrologic regimes of rivers where snow and ice contribute significantly to the runoff. This study which aims to access the impact of potential warming on river discharge utilizes a snowmelt runoff model in the Lang tang River Basin in Nepalese Himalaya. For this purpose data were derived from remotely sensed snow cover from Moderate Resolution Imaging Spectroradiometer (MODIS). The paper states that although snowmelt hydrology has been examined at a large watershed scale in the Hindu Kush-Himalaya region, changes in hydrologic processes with climate change need to be examined and compared across finer basin scales for assessing water availability and vulnerability. The paper uses three climate change scenarios in order to drive the model in order to understand the impact of changing conditions. The results show the significant impact of increasing temperature on snowmelt runoff and importance of improved monitoring and modeling to better understand the impact of climate change on hydrology. The outputs of this study are guidance for water resources managers to make and implement appropriate strategy for water resources management and hydropower development. It is also useful tool for adoptive planning i.e. more and efficient use of winter flow and mitigative and preventive measure for high flow periods. However the results presented here are not the predictions, but rather the model simulations on the snowmelt.

The paper, ***“Global Climate Change and Its impact on Indian Water Resources: Challenges and Strategies”*** by Dr Swami Prakash Srivastava from Department of Economics, Faculty of



Social Sciences, Dayalbagh Educational Institute, Dayalbagh, Agra says that water is essential for sustaining all forms of life , food production , economic development , and for general well being. It is impossible to substitute for most of its uses, difficult to de-pollute, expensive to transport, and it is truly a unique gift to mankind from nature. Water is also one of the most manageable of the natural resources as it is capable of diversion, transport, storage , and recycling. All these properties impart to water its great utility for human beings. The surface water and ground water resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities, etc. India is endowed with a rich and vast diversity of natural resources, water being one of them. Its development and management plays a vital role in agriculture production. To meet the gap between supply and demand, water conservation, water efficiency, rainwater capture, water recycling and drip irrigation would have to be embraced at national, provincial and local levels. The paper is divided into sixteen sections including the introductory section. These include - Review of literature; Demand and Availability of water in India; Impact of Climate Change on Water Resources of India; Factors responsible for Climate Change; Impact of Climate Change on water and Coastal Sectors; Impact of Climate Change on Food Security; Crisis of Dirty and Dying Rivers; Water conservation in India; Water Security vs, National Security; National Water Mission; Water Supply and Sanitation in India; Demand Driven Approaches in Rural Water Supply; External Co-operation in Water Supply and Management; Impact of China's Dam on water resources of other countries; and lastly the conclusion , suggestions and recommendations. The author fears that our planet will encounter in the next few decades severe shortages of water if we are not careful in conserving and preserving the precious and increasingly scarce water resources of our country. The Indian government has undertaken significant steps to try and mitigate these problems by outlining new regulations and developing 'green' business codes. Renewable energy and energy efficient incentives are being actively promoted. Adaptation strategies, which aim to make agriculture more resilient to the impact of climate change, have also been proposed. But, despite these measures and public acknowledgement that climate change is a real and pressing problem for India.

Dr. Archana Sinha from Rural Development Research Department of Indian Social Institute, New Delhi in her paper entitled ***“Climate Crisis, Water Security and Those Most Affected”*** reveals that climate change and its impacts are affecting people, individuals and communities all



over the world. Geographic location with high population density and deeply embedded poverty renders South Asia as the most vulnerable region to the impacts of climate change. It highlights that climate change is already taking place and has deeply affected the economic growth and development of South Asian region. The impacts of higher temperatures, more variable precipitation, more extreme weather events, and a rise in sea level are being felt and will continue to intensify. Increased risk of floods and droughts is expected to have a severe impact on economies which rely mainly on agriculture, natural resources, forestry and fisheries sectors. The impacts of current climate change, however, are and will continue to fall disproportionately on those with the least capacity to deal with the consequences. People have been responding to the consequences of climate change based on the local and traditional knowledge. But the people who are hit the hardest are not adequately involved in policy discussions about mitigation and adaptation. Lack of recognition and integration of people's knowledge is already leading to strategies that are not benefiting who need them most. Incorporating this knowledge is essential for achieving sustainable development. Her paper highlights the fact that there is a need to focus on the local communities, their needs and priorities, to look into various factors affecting climate change - the impacts and the challenges, with a focus on disaster preparedness and agriculture. Dr. Sinha's paper also highlights the importance to emphasize the need for integrating people's participation and practices in developing adaptation strategies. The purpose of this paper is to understand and discuss climate change impacts from a grassroots perspective and to explore how local people's participation in decision making and their involvement in policy formulation could be assured.

Water security is critical for the survival of communities and nations. It represents a major challenge, especially in parts of the world facing increasing water scarcity, such as arid and semi-arid regions or densely populated areas. Water security also directly affects food security, as most of the world's water is used in agriculture for food production. The water/food/energy security nexus was recently identified as one of three important risk clusters that may threaten economic growth and political and social stability in the future. The paper, "***Water Security and Climate Change: Challenges and Strategies***" by Dr. Jignesh M Kauangal from Shree Narayana College of Commerce, Ahmedabad, and Dr. Harigopal Agrawal Sheth from C L Commerce College, Ahmedabad, Gujarat states that achieving basic water security, both harnessing the productive potential of water and limiting its destructive impact, has always been a societal



priority. To capture this duality, water security is defined here as the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies. It says that water management should aim at the sustainable use of renewable water resources and the planned depletion of nonrenewable water resources within well-defined timeframes. Where possible, this should be supplemented by the use of unconventional water sources such as treated wastewater and desalination. The climatic changes taking place in recent years also proves a threat towards water security hence it is very much important to save water from further polluting and improvise up the use of new and cheap technology which in turn would help save the mother nature. This paper discusses about the climate changes and the technology in regards to India, the policy changes and projections of future changes.

The paper, ***“Strategies to Engage Community Participation for Water Security and Climate Change, especially in Developing Nations”*** by Aditya Vidyasagar Executive Director, Academy of Competence Exploration and Chief Executive Facilitator, Vidyasagar Associates Lucknow says that the theme “Water Security and Climate Change: Challenges and Strategies”, is much needed. International effort and is becoming an increasingly alarming need of the hour. In the wake of water scarcity with a rapidly depleting per capita availability of water, the issue of water conservation, protection, maintenance and the management of the whole process is a matter of global concern. It assumes greater significance in India and especially for the State of Uttar Pradesh, which has the responsibility of over 200 million of its populace. Furthermore, in this context the single solution lies in an apt management of ground water with sound strategies and practical approaches derived by prioritizing a community-driven agenda. The paper highlights the need to work on the remedial action among the communities to practice what they are concerned of and that is managing the ground water resource. It would call for a quick list of tasks and before that an understanding about the GWM (Ground Water Management). Besides this basic understanding, the scientific R&Ds would continue helping us from time-to-time to learn about the implications of the hydro-geological dynamics vis-à-vis our day-to-day behaviour with the ground water. Thus, expectation through this paper is that the learned participants come forward with an action-oriented agenda to serve the objectivity of the purpose of this workshop and the submissions made here are included in the proposed Resolution, which would emerge from this Seminar to culminate the effort fruitfully.



Prof. A.K. Gahlot, Vice Chancellor, Rajasthan University of Veterinary & Animal Sciences,



Bikaner deliberated in his paper on ***“Effects of Climate Change on Animal Husbandry in Rajasthan-Some Challenges”***. He highlighted some of the efforts of Rajasthan government like banning Shallow Tube in dark areas, promoting Rainwater harvesting and making rooftop water harvesting mandatory in all government offices in the state. He opined that there is need to develop breed of animals like camel etc which are resilient to climate change. He added that in case of live stock, the change in human life style has also affected the live stock population. He cited the case of reducing population of camels which was useful transportation

animal due to preference for better transportation vehicles like bolero etc.

Presentation was made by Dr. V.K. Bhatt and Dr A K Tiwari from Central Soil and Water Conservation Research & training Institute, Research Centre, Chandigarh on ***“Present Water Scenario and Future Strategies in North West Region of India With Reference to Climate Change”***. He emphasized that ground water exploitation in the states like Punjab and Haryana is to be controlled with efficient water management systems. He also pointed out certain future strategies for ground water resources management which *inter alia* includes: Watershed management and water harvesting; Delay in paddy planting; Increase in water use efficiency; Recycling of used water and Desalination of water. With the present stage of over-exploitation of ground as well as surface water survival of life would become difficult in future. All the water sources should be used economically and judiciously so that no water is wasted.

There are different ways in which wastewater is used for irrigation. Impure waste water used for irrigation will have health impact according to the ways it is used. Irrigation with wastewater will have both beneficial and harmful effects to the extent it contains substantial amounts of beneficial nutrients and toxic heavy metals. Reliability and nutrition richness are considered as two important attributes of wastewater being beneficial for agriculture. It is believed that nutrients present in wastewater result in higher crop yields and thereby considerably reduce the need to apply chemical fertilizers.



With an extremely uneven natural distribution of water resources in space and time, intensive human activities and rapid population growth, there is currently significant freshwater deficit facing several countries around the world. Global projections show that in the coming decade most of the world population will face severe water crises in terms of both availability and supply. This will be a factor depressing the living standards of population and retarding the economic and social developments in most developing countries of the global village. The humankind is witnessing the growing serious concerns with respect to water security in the coming millennium. Globally, we are faced with three major problems associated with the water security namely: Salinity, Drought and Water Quality. The paper, ***“Managing Water Security: The Role of Science and Technology”*** by Dr Gursharan Singh Kainth of the host institute( Guru Arjan Dev Institute of Development Studies, Amritsar) says that water is a fundamental human need and key to socio-economic development and quality of life. As the pressures of population and economic activities converge on water requirement, the water sector will increasingly face the challenge of bridging the demand-supply gap. It is widely accepted that water will become a prime constraint in several parts of the world in the coming century in relation to both food and health security. Continuing imbalance between carbon emission and absorption is likely to lead to adverse changes in temperature, precipitation and sea level rise in many countries. Water is becoming scarcer, and more difficult to access. Less water is available for maintaining ecosystems. And conflicts over shared water resources are growing. The paper highlights that there is an urgent need to ensure that potential crisis is confronted on all fronts - from research to policy to action. Recent advances in science and technology can play in mitigating the adverse impact of drought and salinity on crop yields. In addition, the role of bioremediation and other waste water bio-treatment technologies in water purification and recycling can be considered.

Water is a basic input for human life. Managing water supplies on the other hand is becoming increasingly complex due to increased length of water stress periods, drought, decreasing water quality, escalating cost of augmentation and transportation of fresh water resources etc.

Dr. Kuldeep Singh jointly with Dr Meharban Singh from Department of Soil Science, Punjab Agricultural University, Ludhiana presented a case study on ***“Pollution of Surface Irrigation Water- Budha Nalaaha, Ludhiana”***. He pointed out that once a major tributary to Sutlej River has been converted in to ***sewer nalaaha*** due to high pollution from paper industry waste, urban sewage disposal, Fly ash, solid waste etc. The pollution level is such that even after 1-2 km of



confluence in Sutlej River the Budha nalaaha water is distinct as black water stream. The high pollution level has led to toxicity in the water with increased Nickel and chromium contents. Even hand pumps in the vicinity of 200 meter on both sides of Budha Nalaaha have become non potable. He suggested that there is need to have 4-5 sewage treatment plants to rejuvenate the water in the Buddha nalaaha. However, extra safeguards are required for treatment of bacterial (contents like E. collie etc.) pollution.

Pollution of surface waters due to industrial growth and municipal wastes is a serious concern for agriculture and human health. Safe disposal of contaminated waters and/or treatment of polluted waters before using it for agriculture or civic utilities are most desired to protect the valuable soil resources from being polluted and mitigate the effects of water scarcity. Promoting the use of non-conventional water sources as waste waters can be valuable way to cope with water scarcity in irrigated agriculture. Soils are rather considered as ultimate and most logical sink for waste waters, since the pace of urbanization and industrialization is leading to production of quantities of these waters those are beyond the capacity of natural systems to assimilate. Industrial and agricultural activities in developing countries have led to considerable increase in soil and groundwater contamination during the past decade. This is due to production of large quantity of industrial effluents containing toxic elements. Use of sewage waters mixed with the untreated industrial effluents, for irrigation to agricultural soils is common practice with the farmers, as it provides essential nutrients and organic matter to the soil. However, contamination of soils and the plants grown on these soils, with heavy metals is a serious problem which has a bearing on the quality of the produce grown on these soils. It can be presumed that crops grown in these polluted soils accumulate heavy metals to such an extent that it causes health hazards to human beings and animals. Health hazards from contamination of pathogens, domestic pesticides and medical waste further multiply the complexity of their use. In Punjab, many workers observed that waste waters of many towns of Punjab contained large amounts of toxic elements. The long term use of such waters for irrigation will cause contamination of agricultural land with heavy metals. Treated sewage water of sewage treatment plants have been found suitable for irrigation, in general. So, this needs close attention and there is urgent need to determine the heavy metal content of these waste waters and treat those contaminants accordingly.

Dr. D.S. Bhupal from Agro-Economic Research Centre, University of Delhi, Delhi in his paper “*Wastewater Utilization: Economic Potential and Challenges*” reveals that the increasing rate



of urbanization leading to wasteful use and pollution of water resources is leaving no other alternative except that we have to learn not wasting any amount thereof and make economical use rather recycle and reuse it. Everywhere, from international level to street/ *mohalla* level water resources are being fought over for drinking requirements, irrigation and industrial needs. Ground water table in many parts of the country is rapidly depleting to dark levels. To meet the nutrition needs of the largely vegetarian society like India judicious use and reuse of the available resources, water specifically to grow fruits and vegetables has to be planned. The vegetables prone to moisture, temperature, packaging and transportation are mostly grown in fringe areas of the cities and irrigated with wastewater which in many cases contain harmful pollutants like toxic material, heavy metals, pathogens, dangerous chemicals etc. to cause serious health problems. It will be prudent therefore to either release it in a reusable form or clean properly before reuse. The irrigation with urban wastewater if treated for impurities can be economically beneficial to grow horticultural crops, enrich land use and cropping pattern. It will also be helpful in providing gainful employment and generating extra income, particularly for women in poor households. In this paper an attempt has been made to find out changes in land use and cropping patterns, employment and income of the stakeholders due to reuse of urban waste water in growing of horticultural crops.

Rainwater quality always exceeds the surface water and comparable to ground water because of it does not come in contact with soil and rocks where it can dissolve salts and mineral which is harmful for potable and non-portable uses, and is valued for its purity and softness. Demand on water resources has been increasing day by day due to the population growth and expansion in urbanization, industrialization and irrigated agricultural. Adopting the concept of sustainability and conservation of water resources can help to cope with the global water shortage. Rainwater harvesting system is one of the concepts that can be implemented to meet the water shortage problem. The paper ***“Water Crisis and Rain Water Harvesting”*** by Mrs. Kirandeep Kaur Hundal and Dr B.S. Hundal says that water is a prime natural resource, a basic human need and a precious national asset. Seventy-one percent of the earth’s surface is covered with water but water for human consumption that is fresh water is available in limited quantity and is of poor quality. Of all the resources on earth only one percent is available as fresh water, ninety-seven per cent is salt water in oceans and two percent is frozen as glaciers. Over the years rising populations, industrialization and extensive agriculture have pushed up the demand for water.



During water recycle fresh water is renewable only by rainfall and can be stored as underground water. Efforts have been made to collect water by building dams, reservoirs and digging wells. Some countries have also tried to recycle and desalinate water. The need of the hour is to preserve water, a priceless resource by suitable means such as Rain Water Harvesting to recharge the ground water levels. Rain Water Harvesting is collecting and storing of water through scientific techniques from areas where rain falls. Its purpose is to store rainwater for ready use in containers above or below ground and to recharge the ground water. Water can be harvested from rooftops, paved and unpaved areas, water bodies and storm water drains. Various components of rain water harvesting system are catchments, coarse mesh, gutters, conduits, first-flushing, and storage and recharge structures. Rain Water Harvesting involves two techniques – Traditional technique which involves storage of surface rain water by using underground tanks, ponds, check dams and weirs, for future use and other is based on a new concept involving use of pit recharge, trenches, dug wells, hand pumps, recharge wells, recharge shafts and spreading technique. This paper suggests that rainwater harvesting is an ideal solution to water problem in areas having inadequate water resources. It mitigates effects of drought, reduces runoff and flooding of roads and improves quality of water which is also highly beneficial for agriculture.

It is a very general practice in all spheres of our life that we spend only as much as we have or can afford to spend. So is the case with ground water. Any remedial action towards establishing such a connect with ground water would depend upon our understanding about the status of ground water in the area we live-in or rather use the ground water from. So, it is the basic knowledge base for all the communication functionaries to acquire.

The paper ***“Innovation in Stormwater Management in India: The Way Forward”*** by Abhishek Pande from Orange School of Business, Nagpur, Maharashtra deals with rapid urban expansion, increased traffic, ageing infrastructure, greater climatic variability, and the need for enhanced sustainability of urban water resources that pose significant challenges to conventional stormwater management. Innovative approaches are needed in order to mitigate the risk of flooding, pollution and aquatic ecosystem degradation, and enhance beneficial uses of urban waters. No single innovative measure is adequate under all circumstances, a multibarrier approach is deemed to be most effective. Examples of innovations at the property level include harvesting roof runoff and reusing water, managing rainwater by infiltration in swales and into soils in bioretention areas, minimizing impervious surfaces, and using pervious pavement. This



paper focuses on innovative approaches that range from rainwater retention, reuse and infiltration at the property level, to detention and infiltration of runoff at the neighbourhood scale. All such efforts should take into account the linkages to the urban watershed by managing large riparian buffer zones, refraining from channelization of streams and rivers, and designating areas in floodplains for temporary storage of storm water during storm events. Roof-water harvesting, minimization of impervious surface areas, diversion of runoff into detention and wetland systems, use of pervious pavements, and directing road and parking lot runoff into filter systems are all approaches that are well documented in different parts of the country. The recommended approach in this paper emphasizes the use of a wide range of combinations of innovative measures, rather than focusing on single innovations, in order to hedge against uncertainties and to integrate individual efforts between the site, neighbourhood and watershed levels.

Women have been treated as Goddesses in our scriptures and religion : Laxmi- the Goddess of wealth, *Saraswati* – the Goddess of Knowledge and *Kali* - the Goddess who destroys all evil and evil doers. Water has also been worshipped as God – *Varun* or *Jal Devta*. Woman is the mother of all mankind, while water is treated as the harbinger of prosperity. Also, there has been an intricate relationship between women and water: one, a living being and other, a life giver. The paper entitled “***Women in Water Sector- Need for a Revolution***” by Er. R.K. Khanna Former Chief Engineer, Central Water Commission, New Delhi says that woman, the carrier and giver of life to the human species and water, the essential ingredient and symbol of life, are two universals, without which life cannot exist. Both need to be healthy for mankind and the planet in general, to prosper and survive. No wonder, *Vedic* hymns have praised most of the rivers as goddesses. The names of Ganga, Yamuna and *Sarvaswati* have become living emotions in our lives, symbolizing the oneness of ‘Woman and Water’. Woman plays a very significant role in water sector. However, there is a need to make their role more effective. His paper touches upon the role of women at global level while describing it in detail at the national level. It presents the need for reforms in this regard and the steps needed to be taken there for.

***In his Valedictory address***, Dr. Jagir Singh Samra Chief Executive Officer, National Rainfed Area Authority, Planning Commission, Government of India, New Delhi said that the topic of this seminar is highly debated in the world. The intensity and frequency of occurrences of extreme weather events has increased during past 15-20 years. While presenting the facts and



figures, Dr. Samra told that Himalayan glacier constitute largest part of fresh water. During



2004-2007, 32,392 glaciers having 71,182 sq. km area of Indus, Ganga and Brahmaputra basin drain into India. 19 per cent deglaciations during 1962-2001 in Baspa basin. Glaciers of Indus basin are relatively stable as compared to Ganga and Brahmaputra. He stated that rainfall redistribution is being triggered by climatic changes. At the same time water is a great adaptor or mitigator of the climatic changes.

India is sharing its water resources with China, Pakistan and Bangladesh. Dispute settlements with China and Bangladesh are non-existent. Examples of Mekong, Nile and other basins may be pursued. There are interstate disputes within India and their settlement is being incentivized in giving 90 per cent central grant in such cases as compared to 25 per cent otherwise.

He informed to the house that “National action plan on Climate change” for 12<sup>th</sup> Five year Plan 2012-16 has been drafted and comprises of eight mission of which National water mission and Nation mission for sustainable Agriculture relates to the theme of the seminar. The issue of climate change has been very much focused in policies and investment portfolio. He explained the climate changes by understanding its vulnerability, possible adaptation mechanism and possible mitigation strategies. He focused on ground water exploitation in Punjab and informed about the “Ghaggar National Recharging project” with estimated project cost of Rs. 1150 crore involving Punjab Haryana and Himachal Pradesh. He expressed his concern as Punjab was not agreeing despite of being one of the major beneficiaries of the project. Under the project about 10 to 15 thousand recharge shaft costing Rs. 1 lakh approximately are to be constructed with twin purpose of recharging during monsoons and draft during summer seasons. Further, he emphasized on need of recycling of waste water, efficient water utilization and precision farming. He also propagated the idea of re- diversification of crops i.e. changing existing wheat rice system which is responsible for water scarcity in the region and equitable use of water in head and tail region of canal command area. The suggested safety net to combat water security



included government intervention by way of calamity relief funds, Food security bill, PDS, MNREGA, Minimum support price, Payments and Procurement and Storage facility.

He further shared that an innovative approach paper to the 12<sup>th</sup> Five year Plan (2012-2016) of India has been approved by National Development Council of India. The issue of climate change has been very much focused in policies and investment portfolio. While deliberating on the challenges and strategies, he stated that irrigation is an important prescription to cold, heat and other injuries of extreme weather events.

- Demographic growth, urbanization and industrialization are increasing demand of fixed water supplies.
- There are inter-state disputes within India and their settlement is being incentivized in giving 90 per cent central grant in such cases as compared to 25per cent otherwise.
- About 83 per cent of water is allocated to agriculture and is major concern of its security. About 60 per cent of India's irrigation is ground water based. It is as high as 75 per cent in Punjab. Overall western India has over exploited its ground water resources whereas in Eastern India they are under-utilized. Roof water harvesting is a small option of limited scope
- There is hardly any surplus water in Beas River. Satluj river water is polluted and unfit for recharging Groundwater. Drainage system of Punjab is being gauged and enough flow is not available. Leveled and banded rice fields contain most of the rainfall and puddling reduces recharging. Ghaggar flood water is of good quality and available for recharging.

Dr Samra recommended various Safety nets against water insecurity and climate change. These recommendations include Traditional methods of resilience like mixed cropping, mixed farming, agro-forestry, livestock etc. Calamity relief funds, Mahatma Gandhi National Rural Employment Guarantee Act, MSP, procurements, payments, safe scientific storage etc; Public distribution system; Food Security Bill; Restructuring of loan payments, loan wavers; Insurance and its many derivatives; Economic losses due to depletion of groundwater, bio-diversity, livestock fertility, injury to perennials/orchards during extreme weather events are difficult to quantify for compensation. Dr. Samra also deliberated on the implications of declined ground water table; treatment of domestic, industrial effluents and poor quality water; re-diversification; safety nets against water insecurity and climate change; and efficient water utilization.



To encourage young researchers for contribution and presentation, two consolation prizes were awarded to Mr Bhogtoram Marwoh from Shillong and Anthony Imoudu Oyeogbe from Niger. At the end the vote of thanks was proposed by Dr. Manmohan Singh Gill, Trustee, Guru Arjan Dev Institute of Development Studies Society.

Seminar signals that managing water scarcity is a real challenge and the need for a radically new approach. If things are left to business as usual, the situation will worsen steadily. Since water is largely state subject, success largely depends critically on state governments. They need to act on both the supply and the demand side. The first step in evolving a rational water policy is to make a scientific assessment of the available water resources in each basin in the country and then define basin specific strategies for water management. Based on the aquifer mapping exercise, we need to develop sustainable groundwater management plans for each aquifer. This requires action on the ground involving partnerships of stakeholders at the village level with hydro geologist and social mobilizers who would guide collective sharing and sequential use of groundwater based on a careful understanding of the storage and transmission characteristics of different aquifers.

Water Management is critical for agriculture. Steps to greatly improve governance in water management through water User Associations such as *Pani Panchayats* and similar *PRI* based institutions; focus on *Command Area Development* and the rehabilitation and physical modernization of existing major irrigation systems; Extensive rainwater harvesting assisted by space based maps with active ground truthing and convergence with other development schemes; Comprehensive aquifer mapping and extensive groundwater recharge; Move towards sprinkler and drip irrigation and away from flood irrigation; Enable assured irrigation to much more land far beyond the present 42 per cent of arable land. Strengthen drinking water resource, and integrate these activities with existing surface reservoir based canal irrigation. Rational water pricing is important and must be pursued but pricing itself may not solve the problem since prices would have to set at unacceptability high level close to optimal water use. Besides, the real issues are policy rules for fast replicability of existing knowledge and success stories. Community institutions have to be at the heart of this process.