

47

STANDING COMMITTEE ON AGRICULTURE  
(2008-09)

FOURTEENTH LOK SABHA

MINISTRY OF AGRICULTURE  
(DEPARTMENT OF AGRICULTURAL RESEARCH AND  
EDUCATION)

IMPACT OF GLOBAL CLIMATE CHANGE ON  
AGRICULTURE AND ALLIED SECTORS IN INDIA

FORTY-SEVENTH REPORT



LOK SABHA SECRETARIAT  
NEW DELHI

FEBRUARY, 2009/PHALGUNA, 1930 (Saka)

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AGRICULTURE AND ALLIED SECTORS IN INDIA

Presented to Lok Sabha on 25.02.2009.

Laid in Rajya Sabha on 25.02.2009.



LOK SABHA SECRETARIAT  
NEW DELHI

FEBRUARY, 2009/PHALGUNA, 1930 (Saka)

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COMPOSITION OF THE STANDING COMMITTEE ON AGRICULTURE (2008-2009)

@ Shri Mohan Singh – Chairman

MEMBERS  
LOK SABHA

2. Shri Ranen Barman
3. Shri Anil Basu
4. Shri Manoranjan Bhakta
5. Shri Girdhari Lal Bhargava
6. Shri Khagen Das
7. Shri Dharmendra
8. Shri Gadakh Tukaram Gangadhar
9. Shri Deepender Singh Hooda
10. Smt. Kalpana Ramesh Narhire
11. Shri Mahendra Prasad Nishad
12. Shri Prabodh Panda
13. Shri Raosaheb Danve Patil
14. Smt. Rupatai Diliprao Nilangekar Patil
15. Shri K.J.S.P.Reddy
16. Shri Y.S.Vivekananda Reddy
17. Shri Chandra Bhushan Singh
18. Shri M.P.Veerendra kumar
19. Shri Baleshwar Yadav
- \*20. Vacant
- #21. Vacant

RAJYA SABHA

22. Shri Ishwar Singh
23. Smt. Mohsina Kidwai
24. Shri Vikram Verma
25. Shri Vinay Katiyar
26. Dr. Janardhan Waghmare
27. Shri Sharad Anantrao Joshi
28. Prof. M.S.Swaminathan
29. Shri M.Rajasekara Murthy
- \$30. Shri Kore Prabhakara
- %31. Vacant

---

@ Shri Mohan Singh has been appointed Chairman of the Committee by Hon'ble Speaker, w.e.f. 5 December, 2008 vice Prof.

Ram Gopal Yadav elected to the Rajya Sabha, w.e.f. 14.11.2008.

\* Sh. Kuldeep Bishnoi ceased to be the Member of this Committee owing to disqualification under 10<sup>th</sup> Schedule by Hon'ble

Speaker w.e.f. 10<sup>th</sup> September, 2008.

# Sh. Hari Rama Jogaiah ceased to be the Member of the Committee owing to his Resignation from Lok Sabha w.e.f. 6 November, 2008.

\$ Sh. Kore Prabhakara was nominated by the Chairman, Rajya Sabha, to be the Member of the Committee w.e.f. 1<sup>st</sup> September, 2008.

% Shri Harish Rawat ceased to be the Member of the Committee due to retirement from Rajya Sabha w.e.f. 25.11.2008.

## SECRETARIAT

- |    |                   |   |                            |
|----|-------------------|---|----------------------------|
| 1. | Shri A.K. Singh   | - | Joint Secretary            |
| 2. | Smt. Veena Sharma | - | Director                   |
| 3. | Shri N.S. Hooda   | - | Deputy Secretary           |
| 4. | Shri Anil Kumar   | - | Senior Executive Assistant |

## PREFACE

I, the Chairman, Standing Committee on Agriculture, having been authorized by the Committee to submit the Report on their behalf, present this Forty-Seventh Report on 'Impact of Global Climate Change on Agriculture and Allied Sectors in India' of the Ministry of Agriculture (Department of Agricultural Research and Education).

2.The Committee took a briefing on the subject from the representatives of the Ministry of Agriculture (Department of Agricultural Research and Education) on 6<sup>th</sup> February, 2008 and their oral evidence was taken separately on 8<sup>th</sup> September, 2008 and jointly with Ministries of Environment & Forests, Earth Sciences, Water Resources, Department of Agriculture and Cooperation, Department of Animal Husbandry, Dairying & Fisheries and Planning Commission on 30<sup>th</sup> September, 2008 in order to know about their collective efforts put in to tackle the impacts of global climate change on Indian agriculture and allied sectors.

3.The Committee also heard the views of the following experts/scientists and discussed with them on various aspects of the Subject on 27<sup>th</sup> August, 2008:

- |       |                        |  |
|-------|------------------------|--|
| (i)   | Prof. Sulochana Gadgil | Honorary Professor & Former Chairman<br>Centre for Atmospheric and Oceanic Sciences<br>Indian Institute of Science, Bangalore;                   |
| (ii)  | Dr. Suhas Wani         | Principal Scientist & Regional Coordinator for<br>Asia International Crops Research Institute for<br>the Semi-Arid -Tropics, Andhra Pradesh; and |
| (iii) | Dr. A.A.Nambi          | Project Director (Climate Change)<br>M.S. Swaminathan Research Foundation,<br>Chennai.   |

4.The Committee considered and adopted the Report at their sitting held on 25<sup>th</sup> February, 2009.

5.The Committee wish to express their thanks to the officials of the Ministries of Agriculture (Department of Agriculture and Cooperation, Department of Agricultural Research and Education & Department of Animal Husbandry, Dairying and Fisheries),

Environment & Forests, Earth Sciences, Water Resources and Planning Commission for tendering evidence and also for placing before the Committee the study material and information desired in connection with the examination of the Subject.

6. The Committee express their thanks to the experts/associations who gave their valuable suggestions/views to enable the Committee to understand the various dimensions of the Subject.

7. The Committee would also like to place on record their appreciation for the invaluable assistance rendered to them by the officials of the Lok Sabha Secretariat attached to the Committee.

8. For facility of reference, the observations/recommendations of the Committee have been printed in bold letters and placed at Part II of the Report.

**NEW DELHI;**  
**25 February, 2009**  
**6 Phalgun, 1930 (Saka)**

**MOHAN SINGH**  
**Chairman,**  
**Standing Committee on Agriculture.**

# REPORT

## PART I

### INTRODUCTION

1. Global warming is progressive gradual rise of the earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns. Global warming has occurred in the distant past as a result of natural influences, but the term is most used to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases.

2. The Earth's atmosphere is composed of Nitrogen 78%, Oxygen 21%, trace gases 1% (argon 0.9%, 0.1% includes neon, krypton, xenon, hydrogen, water vapour and Greenhouse Gases (GHGs) (approx 0.04%). Trace Gases are called so because they are present in very small quantities. Among GHGs, nitrous oxide 6%, methane 13%, fluorocarbons 5%, and carbon dioxide 76%. These gases are also called greenhouse gases because they act as a blanket and trap heat radiating from the earth and make the atmosphere warm. The atmospheric composition remains same across the globe.

3. Increase in atmospheric temperature affects the various aspects of global hydrological cycle. As a result, we can expect changes in rainfall, evaporation, and runoff. These changes in temperature and hydrology have considerable impact on different aspects of life including crops, livestock, fisheries, insects, microbes, etc.

### THE ROLE OF OZONE LAYER IN EARTH'S ATMOSPHERE

4. Ozone layer in earth's atmosphere (stratosphere) absorbs the harmful UV-B radiation from sun and acts as protective shield for earth. A variety of biological consequences such as increase in skin cancer, damage to plants, and reduction of plankton populations in the oceans may result from the increased UV exposure due to ozone depletion.

Ozone layer at the top of atmosphere is depleted by an increase in concentration of GHGs, especially, nitrous oxide.

## **HOW AND WHY THE CLIMATE IS CHANGING**

5. Climate Change is any long-term significant change in the “average weather” that a given region experiences. Average weather may include average temperature, precipitation and wind patterns. Climate Change may be due to natural internal processes or human actions.

6. In recent usage, Climate Change is often linked to changes in modern Climate of which one of the major causes is human activities. Though human beings have always influenced their environment, it is only since the beginning of the Industrial Revolution mid 18<sup>th</sup> century that the impact of human activities has begun to extend globally. As per Intergovernmental Panel on Climate Change (IPCC), anthropogenic activities, such as those involving combustion of fossil fuels leading to increase in greenhouse gases (GHGs), are considered to be the prime anthropogenic cause leading to Climate Change. The increase concentration of GHGs in the atmosphere results in enhanced greenhouse effect. Some of the key GHGs contributing to Climate Change include: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) nitrous oxide (N<sub>2</sub>O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>). IPCC Fourth Assessment Report states that it is “very likely” that emissions of heat-trapping gases from human activities have caused most of the observed increase in globally averaged temperatures since the mid 20<sup>th</sup> century.

7. There is now a consensus that the Climate is changing due to increased emissions of greenhouse gases. Increased human activities in the last century, especially increased fossil fuel usage, industrialization, and land use changes, have caused the buildup of carbon dioxide and other greenhouse gases in atmosphere. These gases in turn, are causing changes in the Climate of the earth. The global mean annual temperature at the end of the 20<sup>th</sup> century was 0.70°C above those recorded at the end of the 19<sup>th</sup> century. The 12 warmest years over globally in the instrumental record have occurred after 1990. Climate extremes such as droughts, floods, rainfall distribution and snowmelt have increased at several places. There are reports that Himalayan glaciers are receding, and pace of this is increasing with time. The rate of change in climatic parameters is projected to be faster in the coming decades. The globally averaged temperature of the air above the earth's surface is

expected to rise by 1.4 - 5.8°C over the next 100 years. CO<sub>2</sub> is rising currently at the rated 1.8 ppm.

### **GLOBAL CLIMATE CHANGE CURRENT SCENARIO**

8 (i) Global average sea level rose at an average rate of 1.8 mm per year over 1961 to 2003. This rate was faster over 1993 to 2003, about 3.1 mm per year.

(ii) Analyses done by the Indian Meteorology Department and the Indian Institute of Tropical Meteorology generally show the same trends for temperature, heat waves, glaciers, droughts and floods, and sea level rise as by the Inter-Governmental Panel on Climate Change (IPCC) of United Nations. Magnitude of the change varies in some cases.

(iii) There are evidences that glaciers in Himalayas are receding.

(iv) The rainfall is also likely to become more uncertain.

(v) The projected global, mean annual temperature increase by the end of this century is likely to be in the range 2 to 4.5°C. Values substantially higher than 4.5°C cannot be excluded. For south Asia (Indian region), the IPCC has projected 0.5 to 1.2°C rise in temperature by 2020, 0.88 to 3.16°C by 2050 and 1.56 to 5.44°C by 2080, depending on the scenario of future development (Table 1; IPCC 2007b). Overall, the temperature increases are likely to be much higher in winter (rabi) season than in rainy season (kharif). Precipitation is likely to increase in all time slices in all months, except during December-February when it is likely to decrease.

(vi) It is likely that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation. Himalayan glaciers and snow cover are projected to contract. It is very likely that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent. For the next two decades, a warming of about 0.2°C per decade is projected. Even if all future emissions were stopped now, a further warming of about 0.1°C per decade would be expected. The projected sea level rise by the end of this century is likely to be 0.18 to 0.59 meters.

(vii) **Table 1.** Projected changes in surface air temperature and precipitation for South Asia under SRES A1FI (highest future emission trajectory) and B1 (lowest future emission trajectory) pathways for three time slices, viz. 2020s, 2050s and 2080s. Source: IPCC (2007).

Season	2020				2050				2080			
	Temperature		Precipitation		Temperature		Precipitation		Temperature		Precipitation	
	°C		%		°C		%		°C		%	
	A1F1	B1	A1F1	B1	A1F1	B1	A1F1	B1	A1F1	B1	A1F1	B1
<b>Dec-Feb</b>	1.17	1.11	-3	4	3.16	1.97	0	0	5.44	2.93	-16	-6
<b>Mar-May</b>	1.18	1.07	7	8	2.97	1.81	26	24	5.22	2.71	31	20
<b>Jun-Aug</b>	0.54	0.55	5	7	1.71	0.88	13	11	3.14	1.56	26	15
<b>Sept-Nov</b>	0.78	0.83	1	3	2.41	1.49	8	6	4.19	2.17	26	10

### **INTER-GOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)**

9. Climate Change is a very complex issue: policymakers need an objective source of information about the causes of Climate Change, its potential environmental and socio-economic consequences and the adaptation and mitigation options to respond to it. This is why WMO and UNEP established the Intergovernmental Panel on Climate Change (IPCC) in 1988. Ministry of Environment and Forests is the nodal agency from India for the IPCC. Membership of IPCC is open to all member countries of WMO & UNEP. The IPCC does not conduct any research nor does it monitor climate related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced Climate Change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors.

They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage.

### **Inter-Governmental Panel on Climate Change (IPCC) Reports**

10. In accordance with its mandate and as reaffirmed in various decisions by the Panel, the IPCC prepares at regular intervals comprehensive Assessment Reports of scientific, technical and socio-economic information relevant for the understanding of human induced Climate Change, potential impacts of Climate Change and options for mitigation and adaptation. Four Assessment Reports have been completed in 1990, 1995, 2001 and 2007.

11. The findings of the first IPCC Assessment Report of 1990 played a decisive role in leading to the United Nations Framework Convention on Climate Change (UNFCCC), which was opened for signature in the Rio de Janeiro Summit in 1992 and entered into force in 1994. It provides the overall policy framework for addressing the Climate Change issue. The IPCC Second Assessment Report of 1995 provided key input for the negotiations of the Kyoto Protocol in 1997 and the Third Assessment Report of 2001 as well as Special and Methodology Reports provided further information relevant for the development of the UNFCCC and the Kyoto Protocol. The IPCC continues to be a major source of information for the negotiations under the UNFCCC. IPCC in its latest Fourth Assessment Report (“Climate Change 2007”) has mentioned about ‘Agriculture’ in Chapter 8.

### **FUTURE GLOBAL TRENDS**

12. Agricultural Nitrous Oxide (N<sub>2</sub>O) green house gas emissions are projected to increase by 35-60% up to 2030 due to increased nitrogen fertilizer use and increased animal manure production (FAO, 2003).

13. If CH<sub>4</sub> emissions grow in direct proportion to increases in livestock numbers, then global livestock-related methane production is expected to increase by 60% up to 2030 (FAO, 2003).

14. The area of rice grown globally is forecast to increase by 4.5% to 2030 (FAO, 2003), so methane emissions from rice production would not be expected to increase substantially. There may even be reductions if less rice is grown under continuous

flooding (causing anaerobic soil conditions) as a result of scarcity of water, or if new rice cultivars that emit less methane are developed and adopted. The future evolution of CO<sub>2</sub> emissions from agriculture is uncertain. Due to stable or declining deforestation rates (FAO, 2003), and increased adoption of conservation tillage practices (FAO, 2001), these emissions are likely to decrease or remain at low levels.

15. The Committee desired to know about the major findings and recommendations with reference to Indian sub-continent's agricultural and allied sectors (present & future scenario). To this point, the DARE/ICAR replied as under:

“The major findings and recommendations of IPCC are as follows:

- In mid- to high-latitude regions, moderate to medium local increases in temperature (1-3°C), along with associated carbon dioxide (CO<sub>2</sub>) increase and rainfall changes can have small beneficial impacts on crop yields. In low-latitude regions, even moderate temperature increases (1-2°C) are likely to have negative yield impacts for major cereals. Further warming has increasingly negative impacts in all regions (medium to low confidence).
- About 2.5 to 10% decrease in crop yield is projected for parts of Asia in 2020s and 5 to 30% decrease in 2050s compared with 1990 levels without CO<sub>2</sub> effects (medium confidence).
- Projected changes in the frequency and severity of extreme Climate events have significant consequences for food production, and food insecurity, in addition to impacts of projected mean Climate (high confidence).
- Smallholder and subsistence farmers, pastoralists and artisanal fisherfolk will suffer complex, localised impacts of Climate Change (high confidence).
- Food trade is projected to increase in response to Climate Change, with increased dependence on food imports for most developing countries (medium to low confidence).
- The marginal increase in the number of people at risk of hunger due to Climate Change must be viewed within the overall large reductions due to socio-economic development (medium confidence).
- Simulations suggest rising relative benefits of adaptation with low to moderate warming (medium confidence), although adaptation stresses water and environmental resources as warming increases (low confidence). On

average, in cereal cropping systems worldwide, adaptations such as changing varieties and planting times enable avoidance of a 10-15% reduction in yield corresponding to 1-2°C local temperature increase. Adaptive capacity in low latitudes is exceeded at 3°C local temperature increase.”

16. The Committee were informed by the Secretary, DARE that “in 1997 Government of India signed the Kyoto Protocol where all the nations have agreed that by 2008-2012 at least 5 per cent minimum cut should be there in the emission level as it was in 1990 and specific targets were given; for USA-7 per cent, Japan-6 per cent and European Union-8 per cent. I would like to bring to your kind attention that Kyoto Protocol as on date has not been ratified by the USA and in the same vein I would like to bring to your kind attention that on this issue Australia was also part and parcel along with the USA...” we need to press hard so that the Kyoto Protocol is religiously followed and monitored.

### **INDIAN SCENARIO OF CLIMATE CHANGE**

17. (i) At all India level, there is no trend in monsoon rainfall during last 100 years, but there are some regional patterns. Areas of increasing trend in monsoon rainfall are found along the west coast, north Andhra Pradesh and north-west India, and those of decreasing trend over east Madhya Pradesh and adjoining areas, north-east India and parts of Gujarat and Kerala (-6 to -8% of normal over 100 years).

(ii) Rainfall analysis of data of 1140 stations in the country indicated that greater than 70 per cent of the stations showed a short term fluctuations in annual rainfall for less than 10 years period.

(iii) Surface air temperature for the period 1901-2000 indicates a significant warming of 0.4°C for 100 years. The spatial distribution of temperature changes indicated a significant warming trend has been observed along the west coast, central India, and interior Peninsula and over northeast India. However, cooling trend has been observed in northwest and some parts in southern India.

(iv) Season wise temperature trends indicated that maximum increase in temperature was observed in post monsoon (0.7°C) followed by winter (0.67°C) and

premonsoon (0.5°C) and monsoon (0.3°C)

(v) Instrumental records over the past 130 years do not show any significant long-term trend in the frequencies of large-scale droughts or floods in the summer monsoon season.

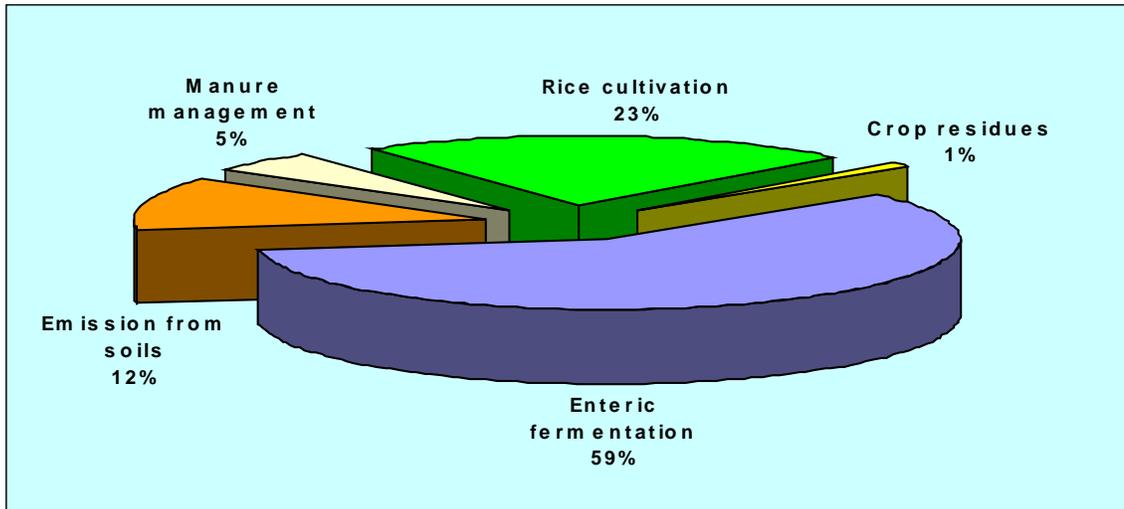
(vi) The total frequency of cyclonic storms that form over Bay of Bengal has remained almost constant over the period 1887-1997.

(vii) There are evidences that glaciers in Himalayas are receding at a rapid pace.

18. There is considerable uncertainty in rainfall projections for future. It is projected that by the end of the 21st century rainfall will increase by 15-31%, and the mean annual temperature will increase by 3°C to 6°C. All regions will not be similarly affected. The warming will be more pronounced over land areas, with the maximum increase over northern India. The warming is also projected to be relatively greater in winter and post-monsoon seasons.

### **CONTRIBUTION OF INDIAN AGRICULTURE TO CLIMATE CHANGE**

19. The Committee have been informed that agriculture sector contributes 28% of the total GHG emissions from India (as per the data of 1994; Ministry of Environment and Forest, this estimate does not include emissions from fossil fuels used in running agricultural machines). The emissions are primarily due to methane emission from rice paddies, enteric fermentation in ruminant animals, and nitrous oxides from application of manures and fertilizers to agricultural soils.



20. The emissions from Indian agriculture are likely to increase significantly in future due to our need to increase food production. The latter would require greater emphasis on fertilizer application of fertilizers and other inputs. This, in a globally warm environment, leads to increased emissions of nitrous oxides and other GHGs. Increased temperatures would lead to higher emissions even at the current level of fertilizer consumption.

### **AGRO-CLIMATIC ZONES IN INDIA**

21. There are 15 agro-climatic zones in India as delineated by Planning Commission which are as follows:

1. Western Himalayan Region: J&K, HP, UP, Uttarakhand
2. Eastern Himalayan Region: Assam Sikkim, W. Bengal & all North-Eastern States
3. Lower Gangetic Plains Region: W. Bengal
4. Middle Gangetic Plains Region: UP, Bihar
5. Upper Gangetic Plains Region: UP
6. Trans-Gangetic Plains Region: Punjab, Haryana, Delhi & Rajasthan
7. Eastern Plateau and Hills Region: Maharashtra, UP, Orissa & W. Bengal
8. Central Plateau and Hills Region: MP, Rajasthan, UP
9. Western Plateau and Hills Region: Maharashtra, MP & Rajasthan
10. Southern Plateau and Hills Region: AP, Karnataka, Tamil Nadu
11. East Coast Plains and Hills Region: Orissa, AP, TN, & Puducherry
12. West Coast Plains and Ghat Region : TN, Kerala, Goa, Karnataka, Maharashtra
13. Gujarat Plains and Hills Region: Gujarat
14. Western Dry Region: Rajasthan
15. The Islands Region: Andaman & Nicobar, Lakshadweep

22. Although detailed zone wise analysis has not been done, broadly, the wheat production in the Indo-Gangetic plain zones is likely to be affected negatively while the crops in coastal and Island zones are likely to suffer from sea water inundation. Productivity of fruit crops will be affected in the hill zones due to rise in temperature and precipitation.”

### **CLIMATE CHANGE RESEARCHES, SOME PROJECTED IMPACTS OF CLIMATE CHANGE ON CROPS/HORTICULTURAL CROPS SECTOR.**

23. The Committee have been informed that Department of Agricultural Research & Education (DARE) and Department of Agriculture & Cooperation (DAC) are jointly preparing the Mission Document on the National Mission on Sustainable Agriculture. There were four issues of dryland agriculture, risk management, access to information, and use of bio-technology. In addition to that, ICAR has initiated a Project

on Climate Change since 2004. In the current plan, ICAR have initiated projects which deal with the methane production and mitigation strategies in livestock, shelter management, food and fodder quality issues. Then, they are also looking at how to convert  $C_3$  plants to  $C_4$  plants, and coastal area management. They have also initiated a project which deals with eline mining. They are looking at drought submergence salinity and terminal heat tolerance. They are planning to set up three institutes which will be focusing on these very aspects on A-biotic, biotic and bio-terminals.

24. The Committee were informed about the factors to maintain the temperature at lower level, as under:

“One is carbon sequestration by residue management, restoration of rigged soils, and conservation of agriculture; agro forestry, focussing on the modification of feeding strategy, scientific water and nutrition management with a special focus on rice paddies and then specific nutrition management strategies. So, these are some of the measures. If we take these measures, we can probably keep this scenario at the lower level.”

25. On the water quality aspects, the ICAR has an All India coordinated project which looks at the use of poor quality water, saline water for crop production. Then, they also have aquaculture as a technique for trying to use these waste waters or poor quality waters. They are also looking at bio-remediation aspects as to how they can make these waters fit for irrigation. However, ICAR is basically looking at irrigation water, and do not look at potable water.

26. As far as resource conservation technologies are concerned, ICAR has been addressing this problem for a very long time. A zero tillage technology, laser levelling, which has really spread in the north part of the country, has really contributed in this resource conservation, increasing the efficiency and also saving the cost of inputs to the farmer.

27. During evidence Prof. Sulochna Gadgil, an expert in meteorological and agriculture sectors explained about monsoon behaviours in India that:

“If you look at rainfall over our region from June to September, about slightly more than half the IPCC assessment models say that the rainfall will increase and

slightly less than half of the models say that the rainfall will decrease. So, in some sense, what is going to happen to the total rainfall is as yet in the area of uncertainty. We cannot rely on the estimates on what is going to happen to the rainfall over our region. But I should also mention that one robust feature about rainfall that is coming out is that the extreme events frequency is going to change. Perhaps, frequency of droughts will change; perhaps, frequency of very heavy rainfall will change and so on. This is a robust result that has come.

My suggestion is that we have to mitigate against or adapt our strategies for the variability of the Climate between droughts and very good monsoon years and so on.”

28. She further explained that ‘I have worked with a set of farmers, as you know, in the semi-arid region and also tried to read up on what is done. I am not happy with what we have done to adapt to Climate variability so far in agriculture. I think in comparison with irrigated regions, for example, our rain-fed regions have not prospered at all. I think we have not taken Climate variability into account sufficiently to adapt properly to take care of the strategies. One result of this we found in a very recent study in which we tried to see what is the component of change in the food grain production during excess monsoon years *versus* deficit monsoon years, and we found to our surprise that in deficit monsoon years, of course, the production goes down very much, whether you are in 2002 or 1965 and so on. It is not made up in excess monsoon years. Normally, you have excess and deficit in cycles and if the production is not sufficiently higher in excess monsoon years, then you do not make up the production and this is a very serious thing. This kind of asymmetry is even more in the present era after 1980. I think there is a lot more work to be done to adapt to Climate variability. Part of the problem has been that not enough attention has been paid to the economics, cost benefit ratios that the farmers actually have to operate under in deriving the strategies.’

29. To a specific question whether she was satisfied with the present relationship between agro-meteorologists, agronomists and production experts because you are a very eminent agro-meteorologist, the witness replied as under:

“I think a lot more needs to be done and in particular there are new areas in which we need the genuinely inter-disciplinary effort. Development of good crop models are needed because only with crop models we can assess the impact of

different strategies for various rainfall regions. That kind of a thing has to be given emphasis. I think certainly more work is required in promoting inter-disciplinary research. Indian Meteorological Department is very, very rich in data, but meteorologists traditionally always have this attitude that they will analyze what they want and you take it or leave it. I am not blaming particularly IMD or anybody else. This is all over the world. So, we scientists have also not delivered the way we should have because we did not have an end-to-end approach. We said, 'Okay, this is the information and prediction on rainfall and you do what you can'. So, I think all of us, scientists, have to go to the farmers and the agricultural experts and say what sort of information on variability is critical and wanted and accordingly generate that and generate the predictions."

### **LIKELY IMPACT OF GLOBAL CLIMATE CHANGE ON INDIAN AGRICULTURE SECTOR**

30. Climate Change is likely to impact negatively many aspects of agriculture including irrigation availability, soil health, pests, and crop and livestock production. Preliminary calculations to quantify the decrease in production of wheat suggest a likely decrease of 4 to 5 million tonnes with an increase of 1° C increase in temperature throughout the growing season. Work on other crops is being done. At present, comprehensive estimates of costs of abating them are lacking.

31. When asked about the sectors of agriculture in India contributing to Climate Change and to what extent when compared to other sectors, the Department replied as under:

"Agriculture sector contributes 28% of the total GHG emissions from India (as per the data of 1994; Ministry of Environment and Forests). The emissions are primarily due to methane emission from rice paddies, enteric fermentation in ruminant animals, and nitrous oxides from application of manures and fertilizers to agricultural soils."

### **IMPACT ON CROP SCIENCE SECTOR**

32. (i) Changes in Climate are expected to create both positive as well as negative impacts on rice yield of Tamil Nadu. Impact is more during Kharif season (Southwest monsoon) than in Rabi (Northeast monsoon) season.

During Kharif season in 2020, 10 to 15 per cent reduction in rice yield is expected due to increase in temperature and change in rainfall. In 2050, 30 to 35 per cent yield reduction and in 2080, up to 80 per cent yield reduction is expected in Tamil Nadu.

- (ii) High temperature around flowering, increased pollen sterility in rice and reduced pollen germination on stigma. Aromatic rice was more sensitive than non-aromatic rice. High temperature also reduced test weight, grain elongation and aroma in basmati rice.
- (iii) Yields of onion & tomato have shown response to elevated concentration of CO<sub>2</sub> (550 ppm). GIS studies on prediction of suitability of growing ginger in Orissa and West Bengal now a highly suitable region have shown that these areas would be less suitable with rising in temperature by about 1.5 to 2°C. Research has shown that Grape cv. Cabernet Sauvignon differs in maturity in different growing conditions, which can be used to increase our adaptive capacity to Climate Change. Studies are also being done to characterize environmental response of other crops as well. Low temperature (4.0-11.5°C), high humidity (more than 80%) and cloudy weather delayed panicle emergence in mango. Coconut productivity increased fast during the last 50 years in Ratnagiri district of Maharashtra, Maidan Karnataka and Coimbatore of Tamil Nadu, except recent declining trends due to consecutive droughts.
- (iv) Analysis of recent weather data in Himachal Pradesh indicated that the maximum temperature is showing an increasing trend during November to April. This has resulted in a possible shift of apple belt upwards (and thus limited fulfilment of chilling hour's requirements of the crop) and increasing area of apple in higher elevations. The new areas of apple cultivation have appeared in Lahaul and Spiti and upper reaches of Kinnaur district of Himachal Pradesh. Trend predicted apple productivity in Kullu, Shimla as well as overall average productivity of the State has shown declining trend. Average State productivity in 1980-81 was 7.06 tons ha that decreased to 4.65 tons ha in 2004-05.

- (v) Coconut yields are likely to be affected by Global Climate Change. Plains of Karnataka, Eastern TN, coastal AP, Pondicherry, WB and Assam were found to be hotspots as per HadCM3 model scenarios of climate change; No change in productivity was projected due to Climate Change in coastal Karnataka and Kerala.
- (vi) Two generations of castor crop showed significant response under elevated CO<sub>2</sub> levels (700 & 550 ppm) in terms of growth, biomass and yield. The growth characters viz., root and shoot lengths, root shoot ratios, leaf area, root, stem, and leaf dry weights and specific leaf area were found to be significant at higher at 550 and 700ppm CO<sub>2</sub> in both the generations.
- (vii) Inventory of greenhouse gases emissions from rice and wheat production systems was developed for all India based on InfoCrop model. It indicated higher emissions in intensely cultivated regions of Indo-Gangetic plains, Coastal Andhra Pradesh & Orissa. No tillage mitigated emissions to a limited extent in upland cropping.
- (viii) Annual C sequestration in coconut above ground biomass varies from 15 CERs to 35 CERs depending on cultivar, agro-climatic zone, soil type and management; Annually sequestered carbon stocked into stem in the range of 0.3 to 2.3 CERs; Standing C stocks in 16 year old coconut cultivars in different agro-climatic zones varied from 15 CERs to 60 CERs; Annual C sequestration by coconut plantation is higher in red sandy loam soils and lowest in littoral sandy soils.
- (ix) Regional climatic zone-wise carbon inventory of agroforestry systems of Himachal Pradesh based on revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory has been prepared. The agroforestry systems inventories were agri-silviculture, agri-horti-silviculture, agri-horticulture and silvi-pasture systems under the business as usual scenario i.e. current management scenario agri-silviculture and silvi-pasture systems were evaluated to contribute positively towards carbon sequestration whereas agri-horticulture and agri-horti-silviculture systems were found to release more carbon to the atmosphere.

33. The Committee pointed out that as per projected impacts of Climate Change on Indian agriculture, productivity of cereals would decrease due to increase in temperature and decrease in water availability, especially, in Indo-Gangetic plains and asked ICAR's projections about decrease in production of foodgrains/cereals and the remedial measures they would suggest to increase the production and productivity of foodgrains/cereals in spite of Global Climate Change. To this point, the Department in their written reply stated as under:

“Remedial measures include development of heat tolerant varieties. In addition, there are several other options:

- Augment production
- Improve land-use management
- Improve land-use and natural resource management policies
- Improve risk management through early warning system and crop insurance
- Establish regional food security programmes
- Raise capacity in Global Climate Change assessments
- Recycle waste water and solid wastes in agriculture

In the specific case of wheat, simple adaptations such as change in planting dates and crop varieties could help in reducing impacts of Climate Change to some extent. For example, the losses in wheat production can be reduced from 4-5 million tons to 1-2 million tons if a large percentage of farmers could change to timely planting. This may, however, not be easy to implement due to constraints associated with wheat planting time in rice-based cropping systems.”

34. ICAR considers that the changes which are taking place, probably transgenic technology is likely to pay much needed dividends be it drought or be it salinity or be it varying biotic and abiotic stresses. So, they believe this is probably the area which would be receiving pinpointed attention and therefore for insulating crops to weather vagaries including that in agriculture, horticulture, livestock and fishery.

35. When enquired about which food crops would be benefited by increased CO<sub>2</sub> presence in the atmosphere and which other crops would face loss in their production

and whether any study has been made in this regard and the progress made to mitigate the loss of food crops production, the representative of DARE/ICAR replied as under:

“With increase in CO<sub>2</sub> concentration, all the food crops will be benefited with higher biomass. No reduction in the crop growth is reported so far in the literature. The benefits are more prominent with C<sub>3</sub> photosynthetic pathway crops compared with C<sub>4</sub> pathway crops. The major food crops like rice, wheat, all the pulse and oilseed crops fall under C<sub>3</sub> category, whereas maize, sorghum, pearl millet and sugarcane are C<sub>4</sub> crops. However, under moisture stress condition increased CO<sub>2</sub> was found to be more beneficial even to C<sub>4</sub> crops.

The impact of increased CO<sub>2</sub> on the growth and yield of different food crops is in progress under Network Project on Climate Change (NPCC) at different ICAR Institutes. The major options like scientific water and nutrient management, site specific nutrient management, residue management, restoration of degraded soils, conservation agriculture, and agroforestry can help in reducing the impact of Climate Change.”

36. On a point, as to why there is so much variation and the reasons for this and to what extent this variation will change the crop pattern and their production across the country, the DARE/ICAR replied as under:

“The variation in response of different food crops to increase CO<sub>2</sub> is basically due to the difference in photosynthetic pathways (C<sub>3</sub> and C<sub>4</sub>). The response is also depends upon the fertilizer, irrigation and temperature. The temperature rise in wheat belt in the central India resulted in the shift of wheat growing area towards north. The similar trend was found with shift in apple cultivation towards higher altitudes in Himachal Pradesh.”

37. The Committee further enquired about the factors which can keep the rise in temperature at lower level of 1.5°C instead higher level of 4.5°C. To this point, the representative of DARE/ICAR responded as under:

“The increased level of Green House Gas (GHG) emissions, deforestation and changing land use patterns are the major factors for rise in temperature. The energy sector is the major contributor of GHGs and agriculture sector comes next.

By reducing the GHG emissions from all the sectors, viz., energy, transport, industries and agriculture globally it is possible to keep the rise in temperature at lower levels of 1.5°C. However, this requires designing energy efficient systems and following the International guidelines in reducing GHG emissions.”

### **METHANE EMISSION FROM RICE**

38. The Committee also asked the Department to confirm that the rice cultivation in India alone contributes about 23% of total agricultural sector contribution to Climate Change and their opinion, as to what can be done to reduce or minimize this 23% contribution of emissions from rice cultivation. To this point, the Department in a written reply stated as under:

“As per the recent inventory made by the Ministry of Environment and Forests, rice contributes almost 23% of the total emissions from agriculture. Recent research, using better characterization of agro-ecosystem properties, indicates that this fraction could be even lower.

Minimizing the emissions from rice paddies: A significant proportion of emission is inevitable from rice fields, which remain flooded. There is a limited scope of reducing emissions from irrigated rice fields by midseason drainage or alternate drying instead of continuous flooding, use of nitrification inhibitors, such as neem-coated urea, and fertilizer placement practices.”

39. The Committee wanted to know about reasons for the claims made by ICAR-IARI that Methane emissions from rice is much smaller than estimated by Western agencies, the Department in their written reply stated as under:

“Yes, Methane emissions from rice fields in India are much smaller than estimated by western agencies. This was due to the fact that estimates given by western agencies were based on a very limited study conducted in Europe and USA, and extrapolated to India and other tropical regions. Emission factors in these studies were high due to higher soil organic carbon content of their soils, large use of organic manure and continuous flooded conditions.

There are several studies done in India, which have indicated low emission factors from Indian paddies due to our low soil organic matter content, limited addition of organic materials, and intermittent flooding conditions of large areas of rice fields.

To produce, one kilogram of rice today about 3000 litres of water is required. This is the average at the global level with a range of 2200 to 5200 litres of water to produce one kilogram of rice. India is only having 4.2 per cent water of the whole world and 17 per cent of the population of the world. That is the reason, Sir, if we go for intermittent drying and wetting same amount of yield can be had rather than with impounding of water and the greenhouse gas emission would also be reduced. So, we are very clear what is precisely required to be done.

Based on research, Dr. N.K. Singh team from IARI have clearly demonstrated that in 12 chromosome of rice as well as A, B and D genome of wheat there is synteny. This very clearly indicates that the characteristic of rice could be transferred to wheat.”

#### **SOME PROJECTED IMPACTS OF CLIMATE CHANGE ON SOIL, STREAM FLOWS AND PEST**

40. (i) In future, soil conservation efforts would need greater focus in Peninsular and central India because of their projected high runoff and soil losses associated with global climate change. A decreasing trend of runoff and soil loss is observed when we move from tropics to temperate region.
- (ii) Simulation results indicated an increase in mean annual streamflow at several places in 2020 and 2050 under PRECIS RCM scenarios. Though there is increase in annual streamflow, a decrease in monthly streamflow, particularly during summer months (February – June) was projected.
- (iii) Pest prediction equations in relation to temperature were developed for thrips population in horticultural crops. It was observed that thrips on rose required 265 and aphids 119 thermal day degrees (TDD) for development under field conditions.

## SOME PROJECTED IMPACTS OF CLIMATE CHANGE ON ANIMALS HUSBANDRY SECTOR

41. (i) A rise of 2-6°C due to global warming (time slices 2040-2069 and 2070-2099) will negatively impact growth, puberty and maturity of crossbreds and buffaloes and time to attain puberty of crossbreds and buffaloes will increase by one to two weeks due to their higher sensitivity to temperature than indigenous cattle.

(ii) Global warming is likely to lead to a loss of 1.8 million tonnes in milk production by 2020 and 15 million tonnes by 2050. High producing crossbred cows and buffaloes will be affected more by Climate Change. Based on temperature-humidity index (THI), the estimated annual loss in milk production at the all-India level is 1.8 million tonnes by 2020 (valued at Rs. 2661.62 crores at current prices). The economic losses were highest in UP followed by Tamil Nadu, Rajasthan and W. Bengal.

(iii) An inventory of enteric methane emission for 2006 was prepared following IPCC guidelines on good practice guidance and uncertainty reduction and using Tier 2 methodology of IPCC. Tier 1 methodology and default factors of IPCC have been used for estimating enteric methane emissions for Sheep, Goats, Equines, Pigs and other animals. The emissions for the year 2006 were estimated at 9.39 Tg/annum from both enteric emissions and manure management. The contribution of indigenous cattle to enteric emission was 38% and that of buffaloes 43%.

42. The Department was asked whether they have started any research on the likely impact of Global Climate Change on imported as well as pure Indian breeds of various livestock and their products in all the agro-climatic zones of India and the details of the research conducted so far, future plans and cost of R&D involved in this regard. To these points, they replied as under:

“The ICAR has proposed research programmes in the XI plan through network mode involving SAUs, NGOs, State Departments in different agro-eco regions for both adaptation and mitigation strategies in livestock. Some of the programmes focus on:

§ Shelter management.

- § Biotechnological approaches on rumen manipulation.
- § Allele mining for better adaptive traits.
- § Reducing methane due to enteric fermentation through feeding strategies.
- § Surveillance and monitoring of livestock and poultry diseases in different agro-climatic zones of the country.

A modest funding of about Rs. 30.00 crore is proposed during the XI Plan for the various R&D activities concerning Climate Change and livestock.

The assessment of qualitative and quantitative changes in livestock production is difficult to project due to variable factors associated. However, few studies on impact of heat stress on dairy cattle in terms of temperature humidity index (THI) have shown that a THI less than 72 has no stress effect; at THI between 72 to 79; there is slight effect on milk production; at THI between 80 to 89, there is 7-8 per cent decrease in milk production. The annual loss is projected to be 1832 million litres as per the study conducted by NDRI, Karnal.

ICAR has taken up studies to know the affect of temperature humidity index on physiological parameters and on production in collaboration with Department of Animal Husbandry Dairying & Fisheries for developing a database on this aspect.

ICAR has also proposed several programmes in a network mode for adaptation and mitigation strategies that include:

- Assessment of methane production under different production systems.
- Methane mitigation strategies through nutritional and biotechnological approaches.
- Shelter management studies for different species of livestock.
- Allele mining for biotic stress and development of biochemical markers like HSP.
- Development of data base on animal response to different THI.”

43. The Department was further asked to determine the optimal size of livestock population for the present and future times, considering milk requirement, diet, greenhouse gas emissions, and social issues and also to suggest to integrate livestock rearing with fodder and crop farming. To these points, the Department in a reply stated as under:

“The optimal size of livestock population of the country is to be determined based on the projected requirement of livestock products, availability of feed and fodder resources, land resource availability and environmental sustainability. The estimated requirement of milk, meat and egg by 2020 would be about 160.0 million tonnes, 10.58 million tonnes and 90 billion, respectively. The strategies for regulating the cattle population without affecting the overall production target are (a) selecting high producing animals using marker assisted selection for developing elite herds (b) improving the production potential of animal genetic resources (c) increasing per animal productivity through improved breeding, feeding and health care, (d) enhancing the supply of quality fodder seeds, (e) integrating and strengthening the linkages between the Departments of Agriculture, Animal Husbandry and Environment & Forest.”

44. The Committee enquired about the enteric fermentation and emissions from soils respectively, out of the total contribution of agricultural sector to Climate Change in India, and their proposal to minimize these emissions, the Department replied as under:

“As per the recent inventory made by the Ministry of Environment and Forests, enteric fermentation and emissions from soils contribute about 59% and 12% respectively of the total agricultural sector’s contributions to Climate Change. A large fraction of these emissions are inevitable due to the importance of livestock for our food and livelihood security, and need to fertilize soils to raise production.

There are several options to reduce emissions but these need greater research for estimating their practical effectiveness, and associated costs: benefits. Enteric fermentation of methane emission can be reduced by feeding strategies (balancing of nutrients through complete feed blocks, total mixed rations, use of feed additives, use of plants secondary metabolites and manipulation of rumen microbes through biotechnological approaches).

Soil carbon sequestration is considered the main mechanism responsible for mitigation potential from soils. There are several approaches to increase carbon sequestration in soils of South Asia. These include scientific water and nutrient management, minimal tillage, and agroforestry.”

## **DEPARTMENT OF ANIMAL HUSBANDRY, DAIRYING & FISHERIES**

45. The Secretary, DAHDF, during evidence explained the effects of Climate Change as under:

“...Like other sectors, the Global Climate Change will have some impacts on the livestock sector and also on the fisheries sector. Basically, what we anticipate is that the heat stress and increase in temperature may have adverse impact on the productivity of the animals, which will lead to an adverse influence on total milk production.

The second likely impact may be on the availability of fodder. There is already severe deficit of green fodder and feed for the animals which is having an adverse impact on the productivity of the animals. It is because of the more incidences of floods or droughts or weather pattern, the area under fodder is already coming down and it will have an adverse impact on the total area under fodder. Second will be the impact in terms of availability of feed and fodder.

The third impact is that there may be increase in the vector-borne diseases. Animal disease is a serious problem already. We anticipate that this Climate Change will have an adverse impact on animal disease and animal health.

Then, another likely impact is that with the increase in the sea level, the coastal areas will get inundated and there may be adverse impact on the mangroves and also bleaching of coral reefs. These are very important breeding grounds for many important breeds of fishes. This will also have an adverse impact on the biodiversity as far as fishery resources are concerned.”

46. To offset these above impacts of global warming, the Department of AHD&F is doing the following:

“Firstly, the R&D is going to play a very important role in various areas whether it is improvement of productivity or tackling the problem of disease or raising the productivity of fishery resources etc. We have identified certain priority areas where we want to collaborate with the ICAR and undertake research in those areas.

We have a major programme which is called the National Project for Cattle and Buffalo Breeding. The basic idea is how we increase the productivity of the animal. We have a very large animal population whether it is cattle, buffaloes, goats or sheep.

But the productivity is very low. Our productivity is less than half of the world average and almost about 10 per cent of what we achieve in a country like Israel. So, a major focus is that we want to stabilise the population of animals to be in line with the carrying capacity of the land. Our focus is on artificial insemination especially of the non-descript cattle where if we can improve the productivity, the milk productivity will certainly rise. Our indigenous breeds in cattle especially have the capacity to bear stress whether it is heat stress or humidity stress or fighting the diseases.

Another focus area for the Department is that we want to improve the infrastructure and the condition of veterinary services which really are in a very bad shape in various States. We are trying to improve the condition of infrastructure whether it is hospitals or dispensaries or artificial insemination centres etc. Technically trained manpower is another constrains which we are trying to tackle.

As far as control of animal diseases is concerned, India has got freedom from rinderpest. Our major focus now is on control of foot and mouth disease which is causing severe economic losses to the country. We are running the programme of FMD in 54 districts but we need to take up the whole region in a compact manner. Like for Pulse Polio Campaign, we need very large amount of resources. We have prepared a Concept Paper which we will be posing to the World Bank and also to the NABARD for funding this Programme for Control of Animal Diseases.

I submitted for consideration that fodder availability is already a problem and this problem may get further aggravated. So, we are trying to work in various directions to improve the availability of fodder. For example, one area could be if we could utilise the wastelands or the common property resources for growing some fodder crops.

Another promising area which we have discussed is the treatment of de-oiled cakes, what we call bypass protein, which will help increasing the yield of animals. There are a number of areas in the fodder which we think will improve the availability of fodder.”

### **SOME PROJECTED IMPACTS OF CLIMATE CHANGE ON FISHERIES SECTOR**

47. (i) A rise in temperature as small as 1°C could have important and rapid effects on the mortality of fish and their geographical distributions. Oil sardine fishery did not exist before 1976 in the northern latitudes and along the east

coast as the resource was not available/and sea surface temperature (SST) were not congenial. With warming of sea surface, the oil sardine is able to find temperature to its preference especially in the northern latitudes and eastern longitudes, thereby extending the distributional boundaries and establishing fisheries in larger coastal areas.

(ii) The dominant demersal fish, the threadfin breams have responded to increase in SST by shifting the spawning season off Chennai. Whereas 35.3% of the spawners of *Nemipterus japonicus* occurred during the warm months (April - September) in 1980, the number of spawners gradually reduced and only 5.0% of the spawners occurred during the same season in 2004. During this period, the spawning activity reduced in summer months and shifted towards cooler months. A similar trend was observed in *Nemipterus mesoprion* too.

(iii) Recent Climatic patterns have brought about hydrological changes in the flow pattern of river Ganga. This has been one major factor resulting in erratic breeding and decline in fish spawn availability. As a result the total average fish landing in the Ganga river system declined from 85.21 tonnes during 1959 to 62.48 tonnes during 2004. In the middle and lower Ganga, sixty genera of phytoplankton was recorded during 1959, which declined to 44 numbers by 1996. In case of Zooplankton during the same period the number diminished from 38 to 26. A number of fish species, which were predominantly only available in the lower and middle Ganga in 1950s, are now recorded from the upper cold-water stretch upto Tehri.

(iv) In recent years the phenomenon of Indian Major Carps maturing and spawning as early as March is observed in West Bengal with its breeding season extending from 110-120 days (Pre1980-85) to 160-170 days (2000-2005). As a result it has been possible to breed them twice in a year at an interval ranging from 30-60 days. A prime factor influencing this trend is elevated temperature, which stimulate the endocrine glands and help in the maturation of the gonads of Indian major carp. The average minimum and maximum temperature throughout the State has increased in the range of 0.1 to 0.9°C.

(v) Corals in Indian Ocean will be soon exposed to summer temperatures that will exceed the thermal thresholds observed over the last 20 years. Annual bleaching of corals will become almost a certainty from 2050. Given the implication that reefs will not be able to sustain catastrophic events more than 3 times a decade, reef building corals are likely to start disappear as dominant organisms on coral reefs between 2030 and 2040 and the reefs are likely to become remnant between 2050 and 2060 in the Gulf of Mannar.

48. The Committee pointed out that the United Nations Climate Panel estimates that modern global warming could melt glaciers and raise world sea level up to two feet by 2100 and asked about the anticipated impact of rise of sea level in Indian sub-continent, especially with reference to agriculture and allied sectors and socio-economic life of Indian people. To these points, the Department of Agricultural Research and Education stated as under:

“Researches on these aspects fall in the area domain of the Ministry of Earth Sciences and National Institute of Oceanography, Goa, which conduct such studies. IPCC recently synthesized all available global information on this aspect in its recent assessment, and concluded that sea level will rise by 0.18 to 0.59 meters by 2100.

If such sea level rise takes place in India, impacts on the livelihood of coastal communities will be considerable. From agricultural perspectives, not many studies have been done in India. However, we can expect vast stretches of coastal lands to get submerged, making them unsuitable for upland crops; increased salinity in aquifers may lead to reduced crop production in coastal lands, and fish production will also get affected.

Increase in seawater temperature will affect the distribution, growth and reproductive cycle of marine fishes. The increase will be beneficial with likely positive effects on major pelagic fishery such as oil sardine, mackerel and Bombay duck. It is likely that the abundance and catch of adaptable fish species will increase. It is expected that there will be changes in the species composition of fish catch. Coral reefs will be affected and will indirectly affect

the reef-dependent fisheries. Sea level rise may inundate the coastal areas leading to salinization. The coastal aquaculture activities can be practiced in such areas.

For sustaining production and productivity, the fisheries sector may be able to adapt to Climate Change (i) by designing fuel efficient fishing craft & gear, (ii) by developing resources specific fish harvesting techniques for emerging new fishery, (iii) acclimatization of commercially available cultivable species to the Climate Change in freshwater, coastal and marine ecosystems, and (iv) identifying new candidate species for aquaculture having more adaptability towards changes in salinity and temperature regime. ”

49. When asked whether ICAR has started any research on the likely impact of Global Climate Change on marine and inland fisheries quantitatively and qualitatively along with the details of cost involved in all the agro-climatic zones/coastal zones of India, they replied as under:

“Research studies on the possible impacts of Climate Change on fisheries and aquaculture are in progress in the Central Marine Fisheries Research Institute (CMFRI), Kochi and Central Inland Fisheries Research Institute (CIFRI), Barrackpore, as collaborating centres under the ICAR Network Project on ‘Impact, Adaptation and Vulnerability of Indian Agriculture to Climate Change.

CMFRI is conducting research on the impact of Climate Change on marine fisheries. Further, the CMFRI has also taken up research programme on the impact and yield study of environmental changes on distribution shifts in small pelagics along the Indian coast.

Under the Network Project, CIFRI is conducting research on the impact assessment of Climate Change on Inland Fisheries covering 14 major river systems flowing through 13 agro-climatic zones of India. Further, the impact of Climate Change on fish breeding and aquaculture is in progress in the States of West Bengal and Orissa.

Pilot trials on advanced maturation and breeding of Indian major carps in the context of temperature rise are also being conducted.”

50. During evidence, the Committee were apprised that as temperature increases, some fish start migrating. For example, all sardines, instead of being restricted to Kerala coast, are now all over eastern coast and western coast. Similarly, their reproductive cycle gets affected and they start producing much faster. So, some of them could also be beneficial aspects which we have still to characterise adequately.

51. The Secretary, DAHD&F, further explained about their priorities as under:

“So far on fishery sector is concerned, our priority is for the inland fishery because we want to promote inland aquaculture. The productivity in various water bodies is very low. We are trying to tackle the problem of increasing the productivity in reservoirs, canals, tanks and ponds. You may be aware that we have set up a National Fisheries Development Board which will undertake a major programme for improving productivity in various inland areas.

The second focus area is this. You are aware that while the coastal areas have been over-exploited, there is hardly any exploitation of deep sea marine resources. We are trying to see what changes are required in our deep sea marine fishing policy so that we can exploit our Exclusive Economic Zone to a much better extent. We are undertaking various programmes. For example, tuna is a major priority area for us for exploitation of marine resources. We have embarked upon a programme of conversion of the traditional craft into long-line tuna vessels. It is because tuna will give us much better economic returns. There are many other schemes for the welfare of fishermen and also for promoting both marine fishery and the inland fishery.”

#### **REMEDIAL STEPS TAKEN PROPOSED BY ICAR TO MITIGATE THE NEGATIVE IMPACTS OF GLOBAL CLIMATE CHANGE**

52. (i) “ICAR launched in 2004 a National Network entitled ‘Impacts, Adaptation and Vulnerability of Indian Agriculture to Climate Change’. The major objectives of this Network are to quantify the sensitivity of crops including

horticultural crops and plantations, soils, water, fish and livestock to Global Climatic Changes. This project had 15 partner institutes during the Xth plan: Indian Agricultural Research Institute (New Delhi), Central Research Institute for Dryland Agriculture (Hyderabad), Central Soil and Water Conservation Research Institute (Dehradun), HP Krishi Vishwa Vidyalaya (Palampur), ND University for Agricultural and Technology (Faizabad), Indian Institute of Soil Science (Bhopal), Tamilnadu Agricultural University (Coimbatore), University of Horticulture and Forestry (Solan), ICAR Research Complex for Eastern Region (Patna), Central Marine Fisheries Research Institute (Kochi), Central Inland Fisheries Research Institute (Barrackpore), JN Krishi Vishwa Vidyalaya (Jabalpur), National Dairy Research Institute (Karnal), Central Plantations Crops Research Institute (Kasargod), and Indian Institute of Horticultural Research (Bangalore).

(ii) Several new centers are proposed to be added to this Network in the 11<sup>th</sup> plan. The objectives have been expanded to analyze options for adaptation and mitigation.

(iii) A Multi-Disciplinary Expert Group has been established in the ICAR to continuously review and monitor developments in Global Climate Change and to advise on issues relevant to agriculture.

(iv) Climate Change has been identified as a priority area under National Agricultural Innovations Project (NAIP). Grants are especially available for climate change related research and development projects.”

53. During evidence when asked about the development of various varieties of food item, the Secretary, DARE stated as under:

“Our Varietal Development Programme year after year has been developing varieties, breeds, and livestock befitting the climatic requirements, but it is much more pronounced now. Hon. Prime Minister has released documents on Management on Climate Change and has mentioned in the document, C<sub>3</sub> plant could be converted to C<sub>4</sub> plant which simply means that because carbon

dioxide is increasing in the environment and rice, which is being cultivated in 44 million hectares, is a C<sub>3</sub> plant and takes less carbon dioxide and converts it into photosynthets. Sugarcane is there which is a C<sub>4</sub> plant. It uses lot more carbon dioxide. If maize is there, it is a C<sub>4</sub> plant and takes lot of carbon dioxide. If we convert rice from C<sub>3</sub> plant to C<sub>4</sub>, then adversities could be converted into opportunities. If we convert wheat, which is a C<sub>3</sub> plant, to C<sub>4</sub> plant, it will help. So, it is not that it is being talked about, but a strategy has also been thought about. But results cannot be had in one year or five years; results will come after ten years or so because this is something which is indeed something basic and lot more efforts would be required.”

54. About extension and the information dissemination on Climate Change to farmers level, the witness stated:

“Virtual extension is essentially called for and total revamping in the extension system in this context is required not only with respect to Climate Change but taking technology to the doorstep of the farmers also is absolutely essential so that knowledge and technology can be judiciously and effectively utilised.”

55. The Committee asked about the adaptation strategies can help minimize negative impacts of Global Climate Change on Indian agriculture and allied sectors and the Department replied as under:

“There are several options that can help in increasing our adaptive capacity to Climate Change. The key ones are:

- § Augment production
- § Improve land-use management
- § Improve land-use and natural resource management policies
- § Improve risk management through early warning system and crop insurance
- § Establish regional food security programmes
- § Raise capacity in Global Climate Change assessments
- § Recycle waste water and solid wastes in agriculture.”

## **SOME RESULTS OF THE ICAR RESEARCH ON CLIMATE CHANGE**

56. (i) Several varieties with tolerance to heat, drought, cold and salinity have been developed in different crops. Superior genotypes possessing high temperature tolerance have been identified and are being used in breeding programmes for high temperature environments. In wheat, recently WH 730 has been registered as heat tolerant genetic stock and this variety has been distributed to different wheat breeding centres. DBW 14, a recently release genotype is gaining popularity for late sown environments because of thermal tolerance and productivity. In addition to this, popular varieties such as NIAW 34, RAJ 3765 and RAJ 4037 have also been found to have thermal tolerance.
- (ii) A set of advance genotypes of various crops are being screened at different locations to evaluate them for thermal tolerance. Controlled environmental facilities are being strengthened for investigations on thermal tolerance. Molecular marker approaches are being developed for this purpose.

## **POLICY SUPPORT FROM GOVERNMENT OF INDIA NEEDED TO COUNTER THE NEGATIVE IMPACT OF GLOBAL CLIMATE CHANGE**

57. When the Government was asked to give their opinion as to what policy support from the Government of India is needed to counter the negative impact of Global Climate Change on agriculture & allied sectors in India, the Department in their written reply stated as under:

“There are several areas where policy support from the Government of India will help in increasing our adaptive capacity. These include:

- Increased support for agriculture research.
- Climate change impacts and adaptations should be considered in all major developmental planning activities.
- Enhance investment in water harvesting and conservation options; and promote small farm mechanization and efficient water use technologies.
- Adoption of scientific and economic pricing policies, especially for water, land, energy, and other resources.

- Financial incentives and package for improved land management including resource conservation/ enhancement (water, carbon, energy), and fertilizer use efficiency.
- Establish ‘Green Research Fund’ for strengthening research on adaptation, mitigation and impact assessment on agriculture.”

## **MANAGING CLIMATE VARIABILITY TO DEVELOP AGRICULTURAL STRATEGIES**

58. The Committee asked the Department to elaborate as to how we can take care of Climate variability so as to develop agricultural strategies. To this point, they stated as under:

“The agricultural strategies to manage Climate variability should consist of both short term and long term strategies. The short term strategies include the use of available drought/ heat tolerant varieties, water harvesting and efficient use of rain water and irrigation water and proven agronomic practices that release minimum greenhouse gases, etc. The long term strategies include development of varieties of crops and improved breeds tolerant to extreme weather situations through use of frontier technologies, development of resource conservation technologies for different agro-climatic zones that use less water and energy and evolving socio-economic safety nets like weather insurance. In addition, an early warning system of climatic risks, and prior development of region specific responses will be useful.”

59. The Committee wanted to know the opinion of the Department for creating a force of ‘Climate Risk Managers’ at village level and in small towns and what kind of training should be provided to them. To this point, the Department replied as under:

“Climate Risk Managers are needed at all levels. At the village level/block level, they should be able to communicate the strategies required to manage climatic risks on a real-time basis to the farmers. At the same time they should be able to liaise with other related functionaries, including National Disaster Management Authority, Indian Meteorology Department and Department of Agriculture and Animal Husbandry, and insurance officials. He/she should be trained in these aspects by the NDMA. Such Climate Risk Managers would

also be useful at district and State levels to liaise with Government officials and other donor/relief agencies.”

60. On the impact of Climate Change on crossbred and indigenous milch animals, the representative of DARE/ICAR stated:

“Crossbreds were there; they were high productive; but they required a different kind of management and situations. There are a number of indigenous breeds which are indeed extremely tolerant to heat and extremely tolerant to different biotic stresses. Not only in case of cattle but in case of buffalo also it is there. Buffalo is one which is indeed extremely suitable for urban conditions and the consequent result is that it is not in the Indo-Gangetic alluvian but even in Rajasthan there are certain districts where buffalo population is increasing.”

61. As regards the importance of carbon credit, the Committee were apprised as under:

“Yes, carbon credit is indeed extremely important. But the farmer is not as much aware. Hardly a few people are aware about this carbon credits. Even educated people, a number of people are not much more aware of. But this is, indeed, extremely important – a plant species like bamboo is indeed extremely important. If you talk of carbon credit, a bamboo would be much more effective and the same could be true for forests, could be true for agro forestry and the same could be true for many other crops and commodities and probably we can capitalise on this.”

62. As regards the action plan for fertiliser and sustainable development, the Secretary, DARE submitted that:

“There is an action plan and it is in this action plan that the Government of India for the first time took some monumental decision. The first was that there would be nutrient-based subsidy. What is its implication? What ratio of fertilisers is essentially required to be applied is 4:2:1 of Nitrogen:Phosphate:Potash, but there in Punjab and Haryana today. It is almost 34:9:1. In certain cases, it is 47:13:1. It is because subsidy was tuned much more towards nitrogenous fertilisers. So, this monumental historic decision will correct the imbalances. Government’s second monumental decision was regarding fortification of fertilisers. The micro-nutrients like zinc, boron and sulphur were deficient and in

fertilisation, now these fertilisers could be enriched. Productivity is not declining. What is declining is rate of growth and what is declining is total factor productivity. You apply the same amount of fertiliser, but you will not get same response. It is because the ratio of 4:2:1 has become 34:9:1. So, this monumental decision was taken by the Government.

About neem-coated urea, it was stated that if you apply neem-coated urea, there will be slow release of the nitrogen and consequently better utilisation of that nitrogen. Whatever nitrogen we apply today, hardly 40 per cent of that is utilised by the plant and 60 per cent goes into environment and becomes a pollutant and the greenhouse gas emission takes place. Therefore, neem-coated urea is a right step in that direction.

As regards development of a sector-wise and crop-wise strategy, it was mentioned that there are 15 agro-climatic zones in the country. That is the reason that we are intensifying our efforts. That is the reason that in the Tenth Plan what we started at 15 or 16 centres, we are going to now undertake at about 26 centres so that we are able to have precise information befitting different regions, situations and systems so that we can respond to the likely Climate Change.

Sometimes adversities to the crop become helpful to other regions in the country. For example, wheat rust Ug99 came as a new race in Uganda in the year 1999, and 80 per cent of the wheat -- which is currently grown in the whole world -- was susceptible to that race. This race started moving to Kenya and came down to Iran last year, and we were expecting that next year it would be in India. But the temperature abruptly went up, and consequently the inoculum building up of rust was reduced. Therefore, something that was disadvantageous because of the temperature became advantageous because of inoculum load being less. On the other hand, for example, in the year 2003, when our estimate for wheat production were coming to about 70-73 million tonnes, it went to 69 million tonnes. The reason being the temperature went up in the month of March, and

consequently, productivity was considerably reduced. Almost, 4-5 million tonnes was the reduction in the country.

As regards poor technology dissemination, this is important and far more efforts are required to be made in it. Further, improved land use management is absolutely essential.

Shortage of water and water management, it is crucial. 16 tonnes of soil per hectare per annum is getting eroded. Out of this, 29 per cent is going to the sea, and the rest is getting deposited in the river beds/fields. This siltation is creating a problem. I think we will have to address this. I am much more worried not about this but the soil which goes to the sea -- 29 per cent of the soil, 16 tonnes per hectare, and the fertilisers, nutrients along with the soil which goes to the sea – is mind-boggling. We have almost 324 million hectares of land in this country. When we multiply 324 million by 16 tonnes per hectare per annum, out of which 29 per cent of the soil going into the sea along with the nutrients, it is a colossal loss.

About indigenous breeds, it was mentioned, particularly with respect to cows and buffaloes, and indigenous breed, yes, this is important. On 29<sup>th</sup> and 30<sup>th</sup> of August, 2008, we had a national conference on this.

I am in total agreement with concrete suggestions. If we are given an opportunity, we are crystal clear as to what is to be done. For example, at the moment we say conservation agriculture. I am quite conscious that if we go for zero-tillage for instance, seven to eight years back when we started there was zero hectareage in this country. Today, there is 3 million hectare in the Indo-gangetic region alone. If you follow zero tillage and immediately after the harvest of rice, if you go for sowing of wheat, not only you save time but also diesel and water. Also, per hectare you save Rs.2000. In Haryana, it is virtually a revolution and Dr. Malik of the Haryana Agriculture University paid a pivotal role in this endeavour.

When I say conservation agriculture, I am also quite conscious of laser levelling. Now, there is an attempt right in the Western U.P. where last year there were 22 laser levellers each costing about Rs.4 lakh. Farmers were going on custom hiring basis. Once you go for laser levelling of the land then saving in water is to the tune of about 30 per cent. There is more efficient utilisation of water. Also, actual crop area goes up by about 3%. So, laser levelling is another thing in conservation agriculture. Raised beds have been very-very important. If you go on the raised beds you save water, fertiliser and who knows better than the Haryana farmers that if you go on raised beds, Pha Paris Minor, which is a menace weed, because of the less moisture at the top of the seed will not germinate. So, weed menace will also be reduced. As about 80 per cent of the total weedicide of this country is used in Punjab, Haryana and Western Uttar Pradesh to control Pha Paris Minor. So, there will not only be water saving but also fertiliser saving and weed management will be effective. There are a large number of such technologies available.”

63. To a query about the behaviour pattern of clouds/rain as it is often talked about that it rains where the moisture is in the soil/vegetation and it does not rain where it is dry/deforested and crops like soybean also decreasing the moisture content in the soil and thus the clouds passes by the area without rain... and whether any study has been done to establish the same phenomenon. To this, the Witness replied as under:

“It can have a very large impact on Climate. It is like desertification. If you have less water in the soil or if you remove all the vegetation from the soil, then the rainfall tends to decrease. These are very small changes which occur over centuries scale. You will not see that if you have deforested a large patch, the rainfall will decrease in the next five years over that. There will be no discernable change at all. While as a problem in physics of atmosphere, it is known that this will lead to successive desertification and so on, as far as changes on the scale of five years, ten years and so on is concerned, you should not be able to see it. But it may be true that the rain distribution within a region may change. If you have a bigger water body, the cloud may tend to get attracted there *vis-a-vis* this. I think there have not been enough studies on this. We are in fact having a major programme of studying the soil as well as atmosphere. This is under the Indian Climate Research Programme. A major

five-year observational campaign is going to be launched to try and understand the links between land, vegetation and rainfall from small scale to large scale. It is again under frontier of science. We still cannot give you the answer.”

64. Dr. Suhas Wani, another expert Principal Scientist and Regional Coordinator for Asia, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh called by the Committee stated that:

“Main aim of our Institute is basically to improve the livelihood of the rural poor in the dryland agricultural areas and to enable them to cope with the climatic variability what we get because of the increased frequency of occurrence of drought and also scarcity of water which is looming over the world. As we know, by 2025 one-third of the developing countries will have the physical scarcity of water. Taking that into consideration, when we look at the climate change impacts which have been estimated by the IPCC, which are predicting that the main impact in the country like India is going to be under the scenario -- maximum temperature can rise by 4.5 degree centigrade and with the 50 per cent probability the temperature may rise by around two degree Celsius which brings in a lot of impact on our agriculture. Its soils are prone to severe degradation, and water scarcity which is there and that will be accentuated because of the impact of the Climate Change.

Although the problem is global, we need the local solutions, and particularly they are very important for a country like India where food security is a prime concern for our large population of one billion which already we are, and in the next few years our population will continue to be growing and we would be basically depending more on agriculture for achieving our food security.

Another impact which is going to come is the change in the pattern of rainfall. We are already experiencing it. For example, the drought year of 2002 was the very unusual year for the country, and the month of July which is supposed to be the wettest month in the country was the driest during that particular month in 2002. And since 1987 it had not occurred like that. In this year, most parts of the southern India had quite good rains in the month of April.

Looking at this impact, what we are expecting is that if the temperature increases, as we are saying that with 50 per cent probability by 1.5 degree temperature, the rice yield can go down by almost 15 to 20 per cent, by .75 tonnes per hectare, and in the winter when the minimum temperature goes it will have a major impact on the yields of wheat, chickpea. The impact will not only be in terms of change in the growing pattern but the length of growing period may also be cut down which will reduce the yield because of advancing of the physiological stages of the crop, the new insects, pests and diseases will come, which we need to tackle along with fighting the impact of Climate Change on the reduction on yield. Moreover, the frequency of drought will increase, and that affects us quite drastically because at the current levels, 60 per cent of our agriculture is rain-fed agriculture. Even when we reach our full potential, almost 50 per cent agriculture will remain rain-fed agriculture, and more occurrence of drought will affect us adversely.

Secondly, the rain-fed areas are the hotspots of poverty. More poor people are in the dryland areas or in the rain-fed areas. Malnutrition is prevalent in these regions. The lands which are there in these regions are more prone to degradation because of the nutrient depletion; erosion; water logging; and these impacts will be aggravated because of the Climate Change.

The technologies, which are there, clearly demonstrate that if we can take the available technologies on to the farmers' field, we can definitely double the agricultural productivity, enhance the water use efficiency, enhance the nutrient use efficiency; and this will give the resilience to the community as well as the resilience for our natural resources to bring in the efficiency so that our requirement for agriculture water will be minimum.

As an example, we have looked into the watershed approach in this country, which we have found, for your kind information, that only one per cent of the Watershed Programmes in the country are not beneficial economically. That means, if we are investing Rs. 100, we are not able to get Rs.100 back only from one per cent of the Watershed Programmes. However, only 35 per cent of the Watershed Programmes are performing above average; and we need to lift the

performance of 65 per cent of the Watershed Programmes and bring in the changes in the Watershed Programmes. But if the village has not developed watershed, then the share of total income from agriculture was reduced from 41 per cent to 18 per cent.

As regards glaciers, we can say that melting of glaciers, reduction in area or mass depletion is a fact. We will really have to manage the situation of excess water that will be coming in for some time, and then we will be facing water shortage in those areas. This is the point that the Climate Change is bringing in. As we have looked into Andhra Pradesh and some of the watershed analysis, we found that the areas that are semi-arid are really turned into arid areas. It means that the length of growing period of a crop has decreased from 120 days to about 90 days.

If this is happening in South, then similar type of situation will happen in other areas in the country, which we need to really assess and get ourselves and our researchers prepared for in the area of breeding saying that these are the areas that are going to change now. We need to change our crops, which will fit it into that system whether it is same crop different varieties or different appropriate crops. For example, maize may fail when there is less water, but there are other crops like sorghum, pearl millet, etc., which can give higher yield with the same rainfall. One can get higher grain production with less duration of the crop. Therefore, we need to look at those sorts of strategies.

I am worried about the mindset of the researchers, development workers and the policy makers. It is because everyone looks at his area as the most important area, and other areas as not so important. If I work on fertiliser supply, then I think that if I can supply maximum fertiliser then my job is best done. But when the farmer does not have the seeds of the improved variety, if he does not know how to protect his crops from insects and pests, and he does not know how to cope up with the shortage of water. Thereafter, this fertiliser supply does not help. Therefore, there is a need to bring in convergence of research instead of individual research.

I have worked in more than 350-400 villages in different States of India along with other countries, but I find that the farmers are one category of people who have no access to any new knowledge about rainfed agriculture. This is the most primary responsibility for all of us including researchers, development workers, extension workers and the policy makers, namely, to see that how we can take this knowledge that is available, and double the productivity with the existing research. We do not need to undertake anything new at this stage. We can definitely double it if we can increase the productivity.

The farmers basically lack the skills, I was dealing with the researchers, development workers and the departments which are working. If 'x' department deals with productivity, 'y' department deals with rural employment and 'z' department deals with water availability, there is no coordination at the ground level. One department does the policy which will undo the impact of another department's work. That is where we really need to bring in the convergence at least in the planning and execution at the district level. With *yojanas* like RKVY as well as the food security mission, we have a really good scope to put centrally coordinated mechanism to assess the impact and cope up with the impact of the Climate Change.

Cost of production with import technologies, as I have indicated, with an investment of Rs. 2000, a farmer can get Rs. 6000 extra. For that reason, when we have recommended the micro-nutrients, we have recommended at half the level than what the research plots are recommending so that farmer can invest small amounts and get the benefit. Once he gets the income, in the next two years, he can then go a level further up. Slowly, we need to build his capacity to invest in the agriculture. We have seen that if the farmers have the assurance of the water availability, that they will not lose their investment in agriculture, private investments come far, far more than what the Government does through the watershed programme.”

65. Dr. A.A.Nambi, Project Director (Climate Change), Research Foundation, Chennai gave his point of views and shared his experiences with the Committee as under:

"We all know that Climate Change is a reality and it is happening. There are very limited response options available – one is mitigation, and the other one is adaptation. While the whole world is obsessed with mitigation, India is no exception. What we need is adaptation to a larger extent because India is a country where we have a total of 141 million hectares of cultivable land out of which 85 million hectares, that is, 60 per cent falls under the rain-fed and dryland area category.

We have different kinds of adaptation. Majorly there are four kinds of adaptations -- farm level adaptation, technological adaptation, social adaptation and institutional adaptation. All these are to be taken care of in their own way. They have important roles to play in their own way.

My proposal for managing drought situation falls into some five larger categories. The first one is community food security measures by which I mean establishment of seed banks, water banks, grain banks and fodder banks.

Another important issue is cropping systems and agronomic interventions like soil conservation, crop rotation, intercropping, and zero tillage. We have to promote less water demanding crops. That is one of the important things particularly drought-tolerant crops or saline tolerant varieties have to be promoted depending on the kind of area where we work.

Livestock is another important thing. We know that India has one of the largest cattle populations in the world. What happens to humans also happens to livestock as well in terms of its health. We have wonderful breeds. But due to crossbreeding the local germplasm is really vanishing fast. So, it is important to save them. We have to have germplasm repository and also some fodder banks.

With regard to water management, under Climate Change situations we know that water is affected both qualitatively and quantitatively. Water storage structures should come handy. Rainwater harvesting is one of the traditional

methods of saving water which should be revived in a larger scale. Micro irrigation practices like drip irrigation and sprinkler irrigation will also come handy. When we talk about water another important thing is the problem of salt intrusion as a result of aggressive depletion of water table. It is important such a thing as well. This could be done through Pani Panchayats or such other institutions. The idea is to save water.

The next one is local level capacity building. We are in a situation where we need to go in for weather-based farming systems. We have set up the agro-meteorological labs in four or five villages where we are working. It is a small set up. It does not need big science to handle this. It just requires a small rain gauge, light intensity monitor and three or four such gadgets. A tenth class pass person could be trained in the use of those gadgets. That is what we have done and it has paid very rich dividends.

We also have set up groups called smart farmers clubs. It is just a kind of pooling up existing committees within village under one umbrella to discuss their own problems and come out with their own solutions. This is really working very effectively.

Those kinds of set up should be promoted. Education, training and social mobilisation are the key. Again, awareness is very critical at the rural level. Today, awareness is going up in India. Media is really focused on it. Everyday, you find something or the other reported on climate change. Climate risk managers should be empowered and should be playing different roles, particularly in training community in coping mechanism and in the context of different defects of Climate Change and managing local weather stations and early warning systems. Particularly, community level disaster management plans and promoting community food security systems. Again from the backward Climate Change perspective, what is happening at our own backyard that has to be strengthened first.

If we look into the ICAR structure again, it is wonderful institute we have a very good resources, knowledge. There is no dearth for knowledge, certainly. Research capabilities are also high but what is missing is, in our country, we have islands of excellence. There is no kind of synergy. The convergence should happen. Unless what we have demonstrated at our own level, at the village level, we cannot blame the Government. We can demonstrate certain things but those have to be taken up in a bigger way. For that, research institutes and the Government should come forward to handle this. When it comes to research priority, vulnerability assessment is one of the key areas. Unless we know as to what kind of people and how they are vulnerable and to what degree they are affected, it is impossible to come out with a good plan. The beginning point is the vulnerability assessment. So, one has to focus on that.”

### **BENEFICIAL IMPACTS OF GLOBAL CLIMATE CHANGE ON AGRICULTURE SECTOR**

66. The Government’s point of view on beneficial as well as negative impacts on agriculture sector is that there are likely to be some beneficial impacts on Indian agriculture. These are reduced frequency of frost damage in crops such as potato, peas, and mustard; possibly higher yields of coconut in west coast, and some improvement in chickpea, mustard, and rabi maize, sorghum and millets. However, these are preliminary results and need to be quantified with more research.

67. It is true that increase in CO<sub>2</sub> leads to higher photosynthesis in crops such as wheat, rice, legumes and oilseeds. An increase of CO<sub>2</sub> to 450 ppm leads to a 5-8% and increase in CO<sub>2</sub> to 550 ppm leads to a 10-15% increase in grain yields of cereal crops. These effects are still smaller when crops are grown in sub-optimal environments.

68. These small gains are neutralized by increase in temperature in wheat due to reduction in grain filling duration, and increase in crop respiration and evapotranspiration. Thus, the net effect of global warming is a reduction in wheat production.

## **FERTILISER REQUIREMENT IN GLOBAL CLIMATE CHANGE**

69. The Committee further pointed out that increasing temperature would increase fertilizer requirement for the same production targets; and result in higher greenhouse gas emissions and desired to know as to what can be done to tackle such situations. The Department in their reply stated as under:

“With increase in temperature N use efficiency decreases. The possible reasons are:

- Rate of hydrolysis of urea increases resulting into ammonical-N, which is lost by volatilization.
- Rate of nitrification and denitrification also increases resulting into gaseous N losses.

Site-specific precision nutrient application, and use of slow release fertilizers and some nitrification inhibitors could assist in reducing greenhouse gas emissions.”

## **CLIMATE CHANGE AND CHANGE IN POPULATION DYNAMICS OF PATHOGENS & INSECTS**

70. The Committee pointed out the Department in their background note, have stated that the increase in temperature and humidity will change the population dynamics of pathogens and insect population resulting in yield loss; and greater research is needed to understand this in relation to Climate Change and enquired about the steps ICAR has taken or propose to take and the expected cost-involved to have required greater research on this aspect at the earliest. To these points, the Department replied as under:

“ICAR is aware of the issues of the anticipated influences of various weather parameters on population dynamics and insects due to Climate Change and have taken several steps to address this issue:

- In order to strengthen the potentials of the existing plant protection research, during XIth five year plan, it is proposed to establish new institutes on biotic stress management. This institute is expected to take up research on basic and applied aspects of crop health management.
- It is also proposed to modify the mandate of the Project Directorate for Biological Control and make it National Bureau of Agriculturally Important

Insects. This Bureau along with the National Bureau of Agriculturally Important Micro organisms addresses the issue of bio-resource databank.

- Establishment of exhaustive data bank on pestilence in crops has been taken up by National Centre for Integrated Pest Management. This databank could carry out a comparative analyses between the historical as well as current trends in pestilence in crop fields.
- Ground-truth monitoring and surveillance of pests in All India Co-ordinated Crop Improvement Projects as well as by crop institutes would provide first-hand information on the trends of pestilence.
- Influence of weather on the variations in populations of pollinators including honeybees and emerging biotic stresses in commercial beekeeping to enable crop pollination is being carried out.
- A Network programme on various aspects of Blue Tongue including its epidemiology has been established. Further, a pentavalent vaccine covering all the major serotypes prevalent in India has been developed and undergoing field validation. The studies on ecto and endo parasites are also being undertaken.
- Surveillance and monitoring of livestock diseases on real time mode in different agro-climatic zone is also being strengthened.”

### **FINDING FOODS/FEED & FODDER TO REDUCE THE IMPACT OF HEAT STRESS ON HUMANS/ANIMALS/AVIANS**

71. The Committee pointed out that ICAR in their note “Climate Change and Agriculture” has stated that increase in temperature leads to higher distress in animals and also reduces feed and fodder availability. Similarly, higher distress levels are also experienced by the human due to increase in temperature. There is a common belief that Barley made beer is having cooling effects on consumers of it and wanted to know whether ICAR has done any research on cool effects giving foodgrains/foods/feed and fodder on humans/animals/avians/Aquarians and sought their suggestions with regard to foods to be consumed to counter effect the negative impacts of Global Climate Change. To these points, the Department in their written reply stated as under:

“Supplementing feeds which can provide readily fermentable carbohydrates (maize, molasses), providing salt and minerals, and provisioning shelter can reduce the impact of heat stress on animals.

No studies on the food mediated heat alleviation in humans have been done in ICAR.”

### **THE ACTION TAKEN/PROPOSED TO BE TAKEN BY VARIOUS MINISTRIES & PLANNING COMMISSION**

72. The Committee also had evidence of the representatives of Ministry of Earth Sciences. The Secretary, Ministry of Earth Sciences explained about the work done to offset the impacts of Climatic Change as under:

“...The Ministry of Earth Sciences basically looks at the collection of a large amount of data specifically related to ocean atmosphere and certain aspects of the cryosphere in the Arctic and Antarctica areas and try to integrate all these observations into a model about a couple of models for ocean atmosphere as well as a separate ocean atmosphere model at the various institutes.

Our institute looks into three different aspects of the modelling. One is to scientific enquiry. Basically, modelling is one for lot of enquiries about the understanding of the physics of our ocean or atmosphere, etc. This is being done at our place. The second is to understand the prediction or the forecast. Both the aspects are being done and also models are used in some cases We do not have sufficient observation on the ocean which we started only around 10 years or so. The long climatological record of the ocean is not available. But, at the same time, we have extremely good data available on the atmosphere. So, models are also used to understand the scarce data on the ocean to further prediction.

The second thing is that this Ministry has also a major mandate to provide various services like the weather, agro-climate for aviation, for fisheries – a variety of services which we provide. Our idea is that we will also need to develop services in future about the climate services based on the models which we will be developing. This has to get integrated into the existing

services. For example, like our agro-meteorological services which we have been doing along with the Ministry of Agriculture, ICAR and Agriculture Universities which provide next five days' forecast of the weather and what kind of agriculture practice would be adopted. This would be extremely useful in future when we introduce the climate services. Wherever we will be able to predict the extreme weathers, this is likely to happen. This will help the agriculture people.

So, our whole programme is ultimately guided towards providing services to the society. For that we have been making observations of the ocean and atmosphere, integrate them and modelling to provide services...”

73. The Commissioner, Policy and Planning, Water Resources during evidence briefed the Committee on Climate Change and water management as under:

“...The effect of Climate Change in the form of rising temperature is more or less studied. The temperature has a definite effect on various components of hydrologic cycle, particularly the process of evaporation from sea, the water bodies land masses or transformation from trees, etc. The process of condensation of water vapour into water drops, the process of formation of ice and the process of melting of snow and glaciers are there. Therefore, it is very likely that Climate Change would affect the water availability, particularly its feature in respect of variation in time and space.

Most of these studies indicate the impact of climate change on water resources qualitatively. Very reliable, quantitative projections of nature of change that could take place in respect of water and its features are yet to be fully established. This is more so when we talk in terms of river basin or sub-basin.

We are fully aware that there is considerable temporal and spatial variation in rainfall in our country. Almost 80 per cent of the rainfall occurs during the monsoon period. Further, there is considerable variation in the rainfall from one region to another. The average annual rainfall of India is about 1,170 millimetres; but it varies from less than 100 millimetres in the western part of Rajasthan to over 10,000 millimetres near Cherapunji in Meghalaya.

The various studies and the reports indicate that the Climate Change could result in further intensification of already considerable temporal and special variations. Such a scenario would require a more focused effort towards conservation of water resources with due emphasis on efficient management practices and efficient use of water and also improving the efficiency of the existing water resources facilities that have been created for utilisation of water resources.

The first and foremost task for us is to have a reliable assessment of the water resources, particularly its features as a result of impact of Climate Change. The Ministry of Water Resources has already initiated appropriate measures in this regard.

The Ministry of Water Resources has been assigned with the responsibility in respect of institutionalisation of National Water Mission envisaged under the National Action Plan on Climate Change.

I would like to specifically mention about the measures that have been taken in respect of the inter-linking of rivers. In August 1990, the then Ministry of Irrigation, now as Water Resources, formulated a national perspective plan for water resource development. National Water Development Agency was established in 1982 for carrying forward this work. The national perspective plan comprises of two components, namely, Himalayan River Development and Peninsular River Development.

The Himalayan River Development envisages construction of storages on the principal tributaries of Ganga and Brahmaputra of India, Nepal and Bhutan along with linking canal trans-system apart from linking the main Brahmaputra and its tributaries with Ganga and Ganga with Mahanadi.

The Peninsular River Development primarily comprises of four components, namely, inter-linking of Mahanadi, Krishna, Godavari Rivers and building sites

in this basin; second, inter-linking of west flowing rivers; third inter-linking of Kain-Betwa, Chambal Rivers; and fourth diversion of other west flowing rivers.

So far the feasibility reports of 16 links are under Peninsular component and two links under Himalayan component. All feasibility reports have been circulated to the concerned State Governments. Presently, the Minister of Water Resources is actively pursuing five links...”

74. Representative of Ministry of Water Resources gave further reply on the Members for Flood Management particularly in respect of the recent Kosi & Hirakud Floods as under:

“All measures in respect of flood management are implemented by respective State Governments. However, in view of importance of the issue, Ministry of Water Resources provides technical and limited financial assistance to the State Governments. Central Water Commission (CWC) a network of flood forecasting stations which provides valuable information about incoming flood, to enable the State Government and project authorities in taking advances preventive measures and also issuing appropriate flood warning.

Government of India provides financial assistance to the State Governments in respect of flood management through following Central schemes:

- a. Central Sector Schemes for ‘River Management Activities and work related to Border Areas’, and
- b. State Sector Scheme for ‘Flood Management programme’

Central sector scheme for ‘River Management Activities and Works Related to Border Rivers’ has provision for supporting Ganga Flood Control Commission and Brahmaputra Board for specific studies and preparation of master plan for flood management. Support is also provided to States for undertaking emergent flood management works on Border Rivers. Similarly, investigations of projects such as Pancheshwar, Sun Kosi and Sapt Kosi are also supported through the scheme. An allocation of Rs. 891 crore has been made for this scheme during XI Plan, Government of India has approved a state sector scheme ‘Flood Management Programme (FMP)’ for

implementation during XI Plan. Under the scheme, Central assistance is provided to the States in critical flood management and anti-sea erosion measures. Detailed guidelines for providing Central assistance to the State Governments have been issued in December 2007 and an Empowered Committee under the Chairmanship of Secretary (Expenditure), Ministry of Finance has been constituted for examining and approving the proposals submitted by State Governments to ensure cost effective solutions. Rs. 2715 crore have been allocated for the scheme during XI Plan. So far 266 proposals from 14 States with a total estimated cost of Rs. 1652 crore has been included under this scheme for providing central assistance to States. So far, Central assistance amounting to Rs. 353 crore have been released to 14 States.”

75. When asked about the effects of Climate Change on ground water due to changes in precipitation and evaporation, the Ministry of Water Resources replied as under:

“Changing climate is expected to influence both evaporation and precipitation in most areas of the world. While the quantum of observed annual monsoon rainfall at all-India level does not show any significant trend, regional monsoon variations have been recorded. Increasing/decreasing trends of seasonal monsoon rainfall have been shown in different areas of the country. Instrument records over the last 130 years, however, do not indicate any marked long-term trend in the frequencies of large scale droughts and floods.

Rainfall is the major source of ground water recharge in India. Hence, changes in precipitation and evaporation are likely to affect the soil moisture, ground water recharge and consequently, the ground water availability in different parts of the country. The magnitude of these effects will depend on the regional geomorphologic, hydrologic and hydro-geologic settings. As the studies carried out so far indicate changes in the intensity and duration of precipitation rather than the total quantum of rainfall, these may not result in significant changes in the ground water resources at the national level, but may alter the existing spatial and temporal distribution of ground water resources in the country to some extent for which studies have been undertaken.”

76. The Committee were keen to know about the effect of Climate Change on ground water quality due to saline intrusion in coastal & island aquifers in view of the projected sea level rise and due to projected increased frequency in severity of floods in alluvial aquifer. To these points, the representatives of Ministry of Water Resources replied as under:

“The impact of global warming-induced sea level rise due to thermal expansion of near-surface ocean water has great significance to India. The anticipated sea-level rise is likely to affect the dynamic fresh-saline water equilibrium in the coastal and island aquifer systems and may result in the extension of saline intrusion and ground water contamination. The effect is likely to be more in coastal areas like parts of Gujarat, Tamil Nadu and Puducherry which are already under threat of saline water intrusion. This is likely to result in problems related to supply of water for drinking/irrigation/industrial uses in coastal areas of the country.

Island areas of the Indian sub-continent are mostly dependent on ground water for meeting various requirements. Fresh water, in such islandic aquifers, occurs as lenses floating on saline water. In the event of sea level rise, the availability of fresh water in such aquifers is expected to get affected which could lead to scarcity of fresh water resources.

Increased precipitation and the consequent increase in runoff, resulting in floods is likely to result in the deterioration of surface water quality due to the increased load of nutrients, pathogens and pollutants. Projected increased frequency in the severity of floods due to Climate Change is likely to result in prolonged inundation of low lying alluvial areas and flood plains of major rivers in the country. These flood waters, recharging the aquifers in such areas, is likely to result in the deterioration of ambient quality of ground water stored in these aquifers. However, in areas where the alluvial aquifers are already saturated at the time of flooding, leaving little or no scope for recharge, the quality of ground water is not likely to be affected by the flooding.”

77. Regarding decline in ground water table and measures for checking it, the Ministry of Water Resources replied as under:

“Decline in ground water levels, reflecting depletion of ground water resources in aquifers has been observed in parts of the country as per analysis of data collected from a network of about 15500 observation wells being monitored by the Central Ground Water Board. As per the latest assessment of ground water resources carried out jointly by CGWB and the State Government Departments in 2004, out of 5723 assessment units (blocks/talukas/watersheds) in the country, 839 units are ‘Over-exploited’ where the stage of ground water development is more than 100% and there is significant decline in ground water levels during either pre or post-monsoon period. 226 units have been categorized as ‘Critical’, where ground water development is between 90 and 100% and significant decline of water levels is observed both in pre-and post-monsoon periods. There are 550 ‘Semi-Critical’ units where the ground water development is between 70 and 100 % and significant decline in ground water levels either in pre or post-monsoon period.

78. Several measures have been initiated by the Ministry of Water Resources to check the decline of ground water levels through augmentation of ground water resources. These include:

- (i) Preparation of manuals & guides on various aspects of artificial recharge to ground water.
- (ii) Preparation of concept report entitled ‘Master Plan for Artificial Recharge to Ground Water’- An area of about 4.5 lakh sq. Kms. has been identified as suitable for artificial recharge to recharge about 36500 million cubic meters of ground water.
- (iii) Implementation of 165 demonstrative artificial recharge schemes in 27 States/UTs during 9<sup>th</sup> Plan aimed at popularizing cost-effective recharge techniques suitable for different hydrologic/hydro-geological settings in the country.
- (iv) Demonstrative scheme on ‘Rainwater Harvesting and Artificial Recharge to Ground Water’ under implementation in identified areas in the States of Andhra Pradesh, Karnataka, Madhya Pradesh and Tamil Nadu.

- (v) Artificial recharge studies being taken up in the 9<sup>th</sup> Plan in priority areas such as over-exploited and critical assessment units, urban areas, etc.
- (vi) Scheme for Artificial recharge through dug wells in 1180 over-exploited/critical/semi-critical areas in the States of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Rajasthan to provide sustainability to the dug wells.
- (vii) Institutions of 'National Water Award and *Bhoomijal Samvardhan Puraskars* aimed at encouraging local bodies/non-governmental institutions for adoption of innovative practices of ground water augmentation through rainwater harvesting/artificial recharge through peoples participation."

79. As over one crore hectares of additional land is to be brought under irrigation under Bharat Nirman, whether there is any progress and what strategy MoWR has to bring that one crore hectares of land under irrigation. To this point, the MoWR replied as under:

"Irrigation is one of the six components for development of rural infrastructure under Bharat Nirman. The irrigation component of Bharat Nirman aims at creation of irrigation potential of 10 million hectare (Mha) in four years, i.e., from 2005-06 to 2008-09. The projects/schemes for creation of irrigation potential are taken up by State Governments from their own resources according to their priorities. Government of India has enhanced allocation for grants under Accelerated Irrigation Benefits Programme (AIBP) to provide support to State Governments. Keeping in view the present status, the target for creation of irrigation potential under 'Bharat Nirman' has been proposed to be met largely through completion of on going major and medium irrigation projects. Due emphasis has also been given to enhancing the utilization of completed projects/schemes. The targets of various activities under Bharat Nirman are shown in Table-1 and the State-wise progress for the year 2007-08 is shown in Table-2:

**Table 1 : Physical targets for various activities identified under Bharat Nirman for creation of Irrigation Potential**

(Irrigation Potential in million hectare)

	Components	2005-06	2006-07	2007-08	2008-09	Total
<b>I</b>	<b>Major &amp; Medium Irrigation</b>					
	Completion of on-going Projects	0.90	1.10	1.10	1.10	<b>4.20</b>
	Extension, Renovation. Modernisation of Major & Medium Irrigation Projects	0.25	0.25	0.25	0.25	<b>1.00</b>
	<b>Major &amp; Medium Irrigation Total</b>	<b>1.15</b>	<b>1.35</b>	<b>1.35</b>	<b>1.35</b>	<b>5.20</b>
<b>II</b>	<b>Minor Irrigation</b>					
	Surface Water	0.25	0.25	0.25	0.25	<b>1.00</b>
	Ground Water	0.45	0.75	0.80	0.80	<b>2.80</b>
	Repair, Renovation & Restoration of Water bodies/ERM of MI Schemes	0.05	0.05	0.45	0.45	<b>1.00</b>
	<b>Minor Irrigation Total</b>	<b>0.75</b>	<b>1.05</b>	<b>1.50</b>	<b>1.50</b>	<b>4.80</b>
	<b>Grand Total</b>	<b>1.90</b>	<b>2.40</b>	<b>2.85</b>	<b>2.85</b>	<b>10.00</b>

**Table 2: Bharat Nirman – Irrigation**

The State-wise progress for the years 2007-08 is given below:

Unit in Thousand Hectare

Sl.No.	State Name	Achievement upto March 2008
1.	Andhra Pradesh	271.433
2.	Arunachal Pradesh	7.000
3.	Assam*	15.212
4.	Bihar	31.750
5.	Chhattisgarh	36.273
6.	Goa	6.384
7.	Gujarat	119.632
8.	Haryana	10.356
9.	Himachal Pradesh	5.845
10.	J&K	19.443
11.	Jharkhand	8.482
12.	Karnataka	51.735
13.	Kerala	7.064
14.	Madhya Pradesh	126.200
15.	Maharashtra	NR
16.	Manipur	12.000
17.	Meghalaya	0.932
18.	Mizoram*	3.031
19.	Nagaland	4.195
20.	Orissa	63.427
21.	Punjab	26.202
22.	Rajasthan	93.590
23.	Sikkim	1.080
24.	Tamil Nadu	16.730
25.	Tripura	2.706
26.	Uttar Pradesh	544.503
27.	Uttaranchal	29.506
28.	West Bengal	7.683
<b>TOTAL</b>		<b>1522.394</b>

**NR : Not Reported**

**\* For the period April-September”**

80. When Committee enquired from Principal Adviser (Agriculture, Environment and Forests), Planning Commission on impact of Climate Change in agriculture and action the Planning Commission is taking to mitigate these adverse impact, he gave his views as under:

“...Sir, we, in the Planning Commission, are very much concerned at the adverse effect of the Climate Change which is going to have an effect on various sectors of development in our country. More particularly, we are concerned at three aspects, and three spheres. This adverse Climate Change is going to affect in a greater dimension than the others in these three spheres. We have land, which is going to be affected adversely. We have rivers and water. The third one is the frequency or the adverse effect that may come out from the natural calamities like drought and flood.

Most vulnerable section in all these will be the poor man in the country side. On the one hand, when we talk of economic growth that this country is achieving at a very fast rate of almost eight per cent from 2004 to 2008 but still we have this large size population today of about 27.5 per cent, which is still below the poverty line. These are the people most vulnerable and adversely affected by Climate Change. The women, the ladies, are going to be very adversely affected by the Climate Change, whether in terms of increase in scarcity of water, reduction in yield, mal-nutrition that comes up because of low productivity in the soil.”

81. The Committee were keen to know whether there was any interaction among the Ministries as to what was the mechanism by which this important challenge can be dealt within its totality. To this point, the Ministry of Environment & Forests replied as under:

“Under the aegis of PM Council on Climate Change eight Missions of the National Action Plan on Climate Change (NAPCC) envisage inter-sectoral consultation with a large number of Stakeholders including the relevant Ministries of Government. The Ministry of Environment & Forests has the role of coordinating these Missions. Each Nodal Ministry entrusted with the Mission is to report the progress to the PM’s Council on Climate Change.”

82. When the Committee pointed out that Climate Change may increase the frequency of extreme weather events and enquired about the preparation for tackling floods and various other things that have been learnt from the experience of this year’s flood and drought and high temperature, etc. and how are the Missions under

NAPCC addressing to these issues, the representative of Environment & Forests replied as under:

“India’s agriculture is subject to Climate variability which is likely to be exacerbated by Climate Change. Presently, extreme weather events such as floods and droughts are tackled by district authorities and Centre provides the additional relief. The Ministry has commissioned modelling studies on various aspects related to Climate Change with a view to assess the vulnerability of the various sectors to Climate Change and integrate these concerns in the planning system for tackling extreme weather events. Besides, the National Water Mission shall revisit the National Water Policy in consultation with the States with a view to conceive basin level management strategies that can deal with variability in rainfall and river flows due to Climate Change.”

83. On a query about our preparation to tackle sea level rise or more frequent coastal storms adequate, the representative of Environment & Forests replied as under:

“The Government of India has been implementing various adaptation related programmes as a part of planned economic development. Specific measures taken include coastal protection infrastructure and cyclone shelters, plantation of coastal forests and mangroves. Further, in coastal regions, restrictions have been imposed in the area between 200m and 500m of the high tide line while special restrictions have been imposed in the area up to 200m to protect the sensitive coastal ecosystems and prevent their exploitation.

The National Action Plan on Climate Change envisages, among many other actions, effective disaster management strategies, strengthening communication networks and disaster management facilities at all levels and protection of coastal areas through focusing on coastal protection and early warning system.”

84. When the Committee pointed out that Climate Change will impact adversely agriculture, animal husbandry and food security and enquired whether there is anything under consideration of the Eight National Mission constituted under the Prime Minister’s Council, the representative of E&F replied as under:

“The National Mission on Agriculture would devise strategies to make Indian agriculture more resilient to Climate Change. It would identify and develop new varieties of crops, and especially thermal resistant crops and alternative cropping patterns, capable of withstanding extremes of weather, long dry spells, flooding, and variable moisture availability.

Agriculture will need to be progressively adapted to projected climate change and our agricultural research systems must be oriented to monitor and evaluate Climate Change and recommend changes in agricultural practices accordingly.

This will be supported by the convergence and integration of traditional knowledge and practice system, information technology, geospatial technologies and biotechnology. New credit and insurance mechanisms will be devised to facilitate adoption of desired practices.

Focus would be on improving productivity of rainfed agriculture. India will spearhead efforts at the international level to work towards an ecologically sustainable green revolution.”

85. On a point, why so many agencies are involved in the preparation of National Action Plan on Climate Change, the Environment & Forests Ministry clarified as under:

“The preparation of National Action Plan on Climate Change was mandated by the Prime Minister’s Council on Climate Change. The PM’s Council decided that a draft of National Action Plan on Climate Change be prepared by a three member group consisting of Dr. R. Chidambaram, Principal Scientific Adviser to the Government of India, Dr. R.K. Pachauri, IPCC Chairman and DG, TERI and the Secretary (Environment and Forests) and submit it to the Prime Minister’s Council on Climate Change for consideration. The Three-Member Group submitted the draft National Action Plan on Climate Change in April, 2008. The Technical Document for preparing the National Action Plan was prepared by the Ministry of Environment & Forests.

The National Action Plan on Climate Change envisages a broad range of activities focused at adaptation to and mitigation of climate change. These are eight National Missions on specific areas of concern.”

86. On a point about the terms of reference of the Eight Missions under National Action Plan on Climate Change and the target set before them and the funding pattern of each and every Mission, the representative of Environment & Forests stated as under:

“There are Eight National Missions which form the core of the National Action Plan, representing multi-pronged, long-term and integrated strategies for achieving key goals in the context of Climate Change. The Missions are National Solar Mission; National Mission for Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission for Sustaining the Himalayan Eco System; National Mission for Green India; National Mission for Sustainable Agriculture; and the National Mission for Strategic Knowledge for Climate Change.

The objective of the Missions is to enable the nation to adapt to Climate Change and enhance the ecological sustainability of our development path. While several of these programmes are already part of our current actions, they may need a change in direction, enhancement of scope and effectiveness and accelerated implementation of time-bound plans.

The Mission details in respect of specific targets and funding pattern are being firmed up by the relevant Ministries. The Ministries would assess the requirement of funds and the ways and means of obtaining the necessary resources for implementation of the Missions in consultation with the Planning Commission.”

87. The Committee were keen to know whether any assessment has been with regard to impact of global warming on production of food, agriculture, livestock, fishery and also with regard to flood, drought, etc in the country. To this point, the nodal Ministry (E&F) replied as under:

"Few assessment studies were conducted under India's Initial National Communication (NATCOM-I) to the UNFCCC and further studies are being made under an Expert Committee headed by Dr. R. Chidambaram, Principal Scientific Adviser to the Government. Indian Council of Agricultural Research in its report on 'Global Climate Change and Indian Agriculture' stated that there is likely to be direct and indirect impacts on crops, soils, livestock and pests. There may be a loss of 4-5 million tonnes in wheat production with every rise of 1 degree C temperature. The likely loss is uncertain but smaller for Kharif crops. The yield loss from potato, peas, mustard in North-western India is likely to decrease due to reduction in the occurrence of frost events. The apple yield is likely to decrease at lower elevations and coconut yields are likely to be affected in plains of Karnataka, Eastern TN, coastal AP, Pondicherry, WB and Assam. Further the milk production is likely to decline by 1.5-2.0 million tonnes by 2020 and 15 million tonnes by 2050.

The projected Climate Change scenarios indicate increase in the variable trend of both rainfall and temperature into 21<sup>st</sup> century. It is projected that quality of surface run off due to Climate Change would reduce and vary across the river basins as well as sub basins. The initial analysis has revealed that climate change scenario may have adverse effects in terms of severity of droughts and intensity of floods in various parts of the country. Forest biomass in India seems to be highly vulnerable to the projected change in Climate. Coastal areas are also vulnerable to Climate variability in varying degrees."

88. When enquired about the role of States in Climate Change management, the representative of Environment & Forests replied as under:

"State Governments have been assigned an important role under the National Action Plan for Climate Change for building capacity and involving the local institutions in managing the Climate Change. Para 4.6 of the NAPCC deals with various steps envisaged to create appropriate capacity at different levels of Government. Ministry of Environment & Forests has already addressed the State Governments in this regard and requested them to initiate actions as per the NAPCC."

89. The Committee also enquired about any scheme for tackling climate change in the Himalayan States. To this point, the Ministry of Environment & Forests replied as under:

“National Action Plan on Climate Change envisages a National Mission for sustaining the Himalayan Ecosystem to evolve management measures for sustaining and safeguarding the Himalayan glacier and mountain eco-system. An observational and monitoring network for the Himalayan environment will also be established to assess freshwater resources and health of the ecosystem. Cooperation with neighbouring countries will be sought to make the network comprehensive in its coverage.

The Himalayan ecosystem has 51 million people who practice hill agriculture and whose vulnerability is expected to increase on account of Climate Change. Community-based management of these ecosystems will be promoted with incentives to community organizations and Panchayats for protection and enhancement of forested lands. In mountainous regions, the aim will be to maintain two-thirds of the area under forest cover in order to prevent erosion and land degradation and ensure the stability of the fragile eco-system.”

90. On a point, whether the present inter-Ministerial Coordination Committee is performing satisfactorily or it needs to be strengthened, the representative of Environment & Forests stated as under:

“The Ministry considers the current coordination mechanism satisfactory. With a view to enhance the knowledge of the impacts of Climate Change on India, and particularly to identify the measures necessary to address the vulnerability of the various sectors, an ‘Expert Committee on Impacts of Climate Change’ was set up by the Ministry of Environment and Forests under the Chairmanship of Dr. R. Chidambaram, Principal Scientific Adviser to the Government of India in May, 2007. Representatives of several concerned Ministries including the Ministry of Agriculture are the members of this Committee. In June, 2007, The Prime Minister’s Council on Climate Change was set up under the chairmanship of Prime Minister himself to evolve a focused and coordinated response to the issue of Climate Change. The Council has broad based representation from key-stake-holders including the Government (including the

Minister of Agriculture, Minister of Water Resources, Minister of Science and Technology, Minister of Finance), Industry, Eminent persons, Media and the Civil Society. The PM's Council sets out broad directions for National Actions in respect of Climate Change which involves several agencies and the Ministries of the Government.

The Ministries entrusted with various Missions are in constant communication with each other and other stakeholders for preparation of the National Missions. These Mission documents are to be submitted to the PM's Council by December 2008 for approval.”

91. The Committee wanted to know as to what strategy is going to be adopted to reduce emission of Greenhouse Gases in a developing country like India and whether India specific climate model will be developed to mitigate the Greenhouse Gases emissions also and whether any ocean atmosphere modeling strategy is being developed to study the temperature rise in sea surface and coastal region. To these points, the representative of DARE/ICAR replied as under:

“Options to reduce emissions from agriculture include:

- Carbon sequestration by residue management, restoration of degraded soils, conservation agriculture and agroforestry
- Modification of feeding strategies of ruminants
- Scientific water and nutrient management with special focus on rice paddies
- Site Specific Nutrient Management strategies.

The above mentioned technologies are promoting through different network programmes of the crop, horticulture, livestock and fisheries.”

92. Regarding the possibility to treat the industrial and sewage waste water for use in agriculture and whether ICAR and other concerned departments have made any progress in this direction and the steps being taken for resource conservation in different agro-climatic zones of the country, the representative of DARE/ICAR replied as under:

“Use of industrial and sewage waste water for raising tree crops has been demonstrated by Central Soil Salinity Research Institute, Karnal. In Metropolitan cities like Mumbai, Delhi and Kolkata, it is usual practice that the sewage waste water is used for growing the vegetables. In arid zone like Jodhpur, the waste water from textile industry is being used by vegetable growers in peri-urban areas. But there are limited studies to assess the impact of using the sewage waste water on soil and crop quality on a long term basis.”

93. When asked whether Ministry of Agriculture has taken up with the Planning Commission, its budgetary allocations shortage/requirements for adaptation and mitigation strategies such as Methane mitigation strategy, shelter management studies, allele mining for stress management, as proposed by them and the response of the Planning Commission in this regard and also how many Plans and Prospective Plans in all ICAR has made till date since its inception, cost and time factors involved and status of implementation of each plan, the representative of DARE/ICAR replied as under:

“The research activities on adaptation and mitigation strategies for reducing methane emission for different crop management practices and shelter management studies with livestock were initiated during X Plan period under NPCC and is continuing during XI Plan period also. Studies on Methane Mitigation Strategies were taken up by Central Rice Research Institute, Cuttack and NAIP Project was also funded to this Institute to conduct research in this direction. Allele mining for stress management is a new area to develop stress tolerant crops. Work in this direction was initiated at IARI/NRCPB. CRIDA is also formulating a program to take such work in coming years. ICAR has taken several steps for improved understanding of impacts, adaptation and mitigation strategies with reference to Climate Change. In addition to a Network Project on Climate Change, several new programmes have been initiated to address issues like methane production and mitigation; shelter management; feed & fodder quality; conversion of C<sub>3</sub> plants to C<sub>4</sub> plants; and coastal areas management. The amount approved for this as well as other ICAR projects and NAIP is more than Rs.75 crores.

The ICAR is proposing 3 new institutes on Abiotic Stress Management, Biotic Stress Management and Biotechnology during XI plan period. These institutes will work on the impact of Global Climate Change on different natural resources and its relationship with productivity. A number of institutes declaring with livestock and fisheries sector are also initiating research activities on impact of Climate Change. The major initiatives, which will make a significant progress in these studies, are the proposed National Institutes on Abiotic Stress, Biotic Stress and Biotechnology during XI plan period. An additional grant of Rs.500 crore would be required for this purpose.

The Perspective Plans are long term vision statements. Actionable plans are prepared for five years or annually based on resource availability taking into account the vision mentioned in the Perspective Plans. ICAR has a very intensive system of external review through Research Advisory Committees (RACs) and Quinquennial Review Teams (QRTs), besides being subject to Parliamentary oversight.”

94. The Committee enquired about whether any estimate has been made to make our country’s societies and economy “Climate Proof” by DARE/ICAR. To this point, the Department stated as under:

“ICAR and State Agricultural Universities have always taken this issue of ‘climate proofing’ seriously. However, we have no comprehensive estimates of costs associated with making our society and economy ‘climate proof’.”

## PART- II

### OBSERVATIONS/RECOMMENDATIONS

#### Recommendation No. 1

##### *Role and Responsibilities of DARE/ICAR in Global Climate Change & Indian Scenario*

The Committee observe that there is internationally accepted fact that climate is changing due to increased emissions of Greenhouse gases. Increased human activities in the last century, especially increased fossil fuel usage, industrialization and land use changes have caused the build up of Carbon Dioxide, Nitrous Oxide, Methane, Hydro-Fluoro-Carbons and other Greenhouse Gases in atmosphere and are changing the Climate of the earth and causing temperature rise, heat waves, droughts, floods, rapid snow melt and changes in rainfall distributions at several places.

The Committee note that the global average of sea level rose at an average rate of 1.8 mm per year over 1961 to 2003 and about 3.1 mm during 1993 to 2003. Projected global mean annual temperature by the end of 21<sup>st</sup> century is likely to be in the range of 2 to 4.5<sup>o</sup>C and even the values substantially higher than 4.5<sup>o</sup>C cannot be excluded. For Indian region, according to IPCC, projected temperature rise is 0.5 to 1.2<sup>o</sup>C by 2020; 0.88 to 3.16<sup>o</sup>C by 2050 and 1.56 to 5.44<sup>o</sup>C by 2080 depending on the future development. The temperature will be much higher in winter (for Rabi crops season) than in rainy season (Kharif crops season).

The Committee also note that Agricultural Nitrous Oxide Greenhouse Gas emissions are projected to increase by 35-60% up to 2030 due to increased Nitrogen fertilizer use and increased animal manure production.

The Global livestock-related Methane production is expected to increase by 60% upto 2030. About 2.5 to 10% decrease in crop yield is projected for parts of Asia in 2020s and 5 to 30% decrease in 2050s compared with 1990 levels. Projected changes in frequency and severity of extreme Climate events will have significant consequences for food production and food security. Small landholders and subsistence farmers, pastoralists and artisanal fisherfolk will suffer complex localized impacts of Climate Change. Food trade is expected to increase from developed to developing countries. In India, the agriculture

sector contributes 28% of the total Greenhouse Gases which primarily constitutes the Methane emission from paddy fields, enteric fermentation in ruminant animals.

The Committee are of the view that India will suffer Climate Change effects of both, the world over changes as well as India's contribution to it through emission of Greenhouse Gases. The Greenhouse Gases from paddy fields can be reduced, as has been observed by ICAR through its studies, by changing the watering pattern of this crop. By developing high temperature resistant seeds and by converting C<sub>3</sub> plants to C<sub>4</sub> plants and coastal area management.

The Committee also observe that the extreme rise in temperature and emission of Greenhouse Gases will be felt only if the conditions remain the same and no efforts are made to mitigate these environmental gases effects. Due to increase in Greenhouse Gases, the impact is felt in the areas of temperature rise, sea-level rise, time reduction in crop cycle, yield reduction, migration of fishes to other areas. Cattle breeding and milk production, poultry, irrigation problems, floods, glacier receding, and forests land reduction, etc. However, if the Government rises to its duties to develop strategies at international, national and local levels including Panchayat level, and do agro-climatic zonewise research work to know the ill-effects of global warming in a particular region and develop measures to contain the rise in temperature and to reduce the emission of Greenhouse Gases and farmers, self-help groups, fishermen and others at village levels are educated about the measures required to be taken by them to offset the impacts of Climate Change, increased policy support and financial support from Government of India for agricultural research and establishment of 'Green Research Fund' as envisaged by the Ministry of Agriculture, then the global warming can be contained in an effective manner.

The Committee strongly recommend that DARE/ICAR should develop a drought code, a flood code and a good weather code, at the earliest and should also come out with concrete, constructive and feasible contingency plan for all the agro-climatic zones. While preparing drought/flood/good weather codes, DARE/ICAR should take care that drought code has comprehensive details of all that needs to be done not only in human rehabilitation and relief but in terms of

relief for crops, animals, etc. Similarly, the flood code should explain all that needs to be done in case of floods and good weather code should explain how to maximize crop/allied sectors production in the places where there is good weather. The Committee also desire that Compensatory Production Programme needed to be developed for agri-allied sectors in case of droughts/floods/climate aberrations, etc. should be expeditiously done with considerable attention and detailed planning based on extensive/intensive/field/anticipatory/adaptation research to be done by DARE/ICAR.

### **Recommendation No. 2**

#### *National Climate and Water Management Policies*

The Committee note that the negative impacts of Global Climate Change on Agricultural & Allied Sectors and on natural resources/water availability, etc. are enormous. The negative impacts of Climate Change/global warming will be terrible on Himalayan Glaciers/Rivers/Water availability, frequent floods/droughts phenomenon.

The Committee learnt during evidence and on the spot Study Visits to Himalayan States that the Ministries of (i) Agriculture, (ii) Environment & Forests and (iii) Water Resources, etc. which are responsible for giving guidance to the Himalayan States, lack the positive approach/attitude towards these States/areas. These Ministries are mostly said to be telling only about don'ts and hardly explain about the do's and other positive things to the policy makers/implementing agencies at the States' level and at the level of the farmers and common people/other stakeholders engaged in the agrarian & allied sectors activities.

The Committee further observe that there is certainly lack of coordination and interaction between Central Government and State Governments of Himalayan States. The Committee, therefore, unanimously recommend that Central Government through their Ministries/Departments should immediately take necessary initiatives to associate the Himalayan State Governments with all schemes and programmes related to Global Climate Change, its implications and solutions. These States should have an active role to play in National

**Action Plan on Climate Change/Water Management practices implemented at State/grassroot level. They should actively participate in National Policy on Climate Management. The Central Government should help these State Governments financially and technically for better implementation of the Climate Control Policies/Action Plans.**

**The Committee note that agriculture is the backbone of our food security. Out of 75 million persons added world over to the 'Hungry' during 2007, over 30 million are from India. Since the problem of Climate Change is a current living reality, the Committee observe that Central and State Governments and their Departments have not learnt lessons from recent years' floods, droughts, high temperatures and changes in sea level, etc. due to Climate Change, as neither tsunami affected nor recent Kosi river floods' affected human beings have been found rehabilitated after the floods receded. The Government machineries have not been able to give sufficient help to rehabilitate the agriculture and allied activities of the affected areas. The frequent droughts/floods and other impacts of Global Climate Change on Agriculture can change the face of the Indian economy for worse.**

**The Committee, therefore, recommend that Ministry of Agriculture and all other concerned Central Ministries/Departments should make coordinated efforts to find solutions to the floods/droughts/high temperatures/climate variations, etc. for the ultimate welfare of the homo-environ systems of the country.**

### **Recommendation No. 3**

*Mass-Spreading of Climate Literacy and related Missions/Programmes among the Farmers/Commonmen*

**The Committee note with serious concern that the Climate Change and global warming extension services are at the lowest level among the farmers, people engaged in animal husbandry, fishery sectors and other stakeholders involved in agricultural and allied sectors.**

**The Committee observe that this poor awareness of the knowledge about the legal issues, rights and environmental or Climate Change and its negative impacts on agro-economic life and things to be done at grassroot level to overcome the negative impacts of Climate Change, not only create mistrust and**

misunderstanding among the farmers, fishermen and the Government authorities and private agencies, involved in implementing/executing the action plan, etc., but also generate strong opposition/objection from the masses/State Governments towards the Central laws or National Action Plans. With the result, it becomes extremely difficult to implement those laws or action plans which are designed and created for the ultimate welfare of the farmers, fishermen and other affected people, as happened with the recently announced notification of the Integrated Coastal Zone Management (ICZM). Almost all the State Governments and their coastal population are objecting to it saying the Coastal Zone Management is going to harm the fishermen, farmers and their livelihood and their lands may be taken away by some rich people. Thus, a law or scheme/plan which intend to protect them, get objections just because there is not enough legal, climate and environment literacy and awareness among farmers, fishermen and commonmen of the coastal areas.

Even if one goes to any tribal village or remote rural area, people there do not know about the Farmers' Rights Act or Biodiversity Act or the National Action Plan on Climate Change. So this lack of legal/envirom/climate literacy among commonmen has become a serious shortcoming in getting the positive outcome from such Acts and National Action Plans in the country.

The Committee, therefore, strongly recommend that all the Central Ministries & their Departments and other Government agencies should take initiatives and make sincere efforts to inform, educate and propagare about the Climate Change with all its positive and negative aspects, among the farmers, fishermen and commonmen, only then any action taken or intended to be taken against global warming by the Central/State Governments will be successful.

#### **Recommendation No. 4**

*Need to empower/equip the State Governments for Mainstreaming the Climate Change factors into various Missions/Schemes in Agriculture Sector*

The Committee observe that Rastriya Krishi Vikas Yojana (RKVY) and the National Food Security Mission (NFSM), etc. should be actually prepared and implemented at the district level and at the same time essentially require coordinated/integrated efforts among Ministries of Rural Development,

**Agriculture, Water Resources, Environment & Forests, Home Affairs and National Rain-fed Area Authority along with State Governments.**

**The Committee further observe that agriculture constitutionally being a State subject, the State Governments are always reluctant to implement the national missions/schemes of the Centre at the grass root level for reasons, such as lack of funds, technology awareness, appropriate infrastructure, manpower, proper guidance for practical implementation, etc.**

**The Committee, therefore, recommend that if these national missions/schemes as well as National Action Plan on Climate Change (NAPCC) with its eight missions including National Mission for Sustainable Agriculture, are to succeed, then the Central Government Ministries/Departments concerned not only should develop a coordination system with State Governments' authorities/agencies involved in all such missions but also empower them with funds, incentives, technological and management knowledge and skills/guidance, etc., so that, State level implementing authorities/agencies can handle the Climate Change/Global Warming related factors and implement RKVY/NFSM/NAPCC at the district/village level for ultimate success of National Mission for Sustainable Agriculture.**

#### **Recommendation No. 5**

*National Policy/Action Plan to control and manage Ever increasing Water Logging*

**The Committee observe that the problem of methane emissions get aggravated due to various reasons, such as, (i) Water-logged areas, and (ii) Marshy lands, apart from the industrial/agricultural pollutants, etc. The Committee further observe that in many States, Irrigation Department divert the flood waters through canal system to low lying areas. The water logging/inundation make these areas unproductive for months together, especially in Himalayan and Indo-Gangetic Plains and at present there is no clear cut national policy to check and control the contribution of methane emissions by these ever increasing water-logged areas.**

**The Committee, therefore, recommend that the Government should come out with clear-cut National Policy/Action Plan to check/control and manage (i)**

water-logged/inundated areas; (ii) Marshy lands, for Environment/Climate-friendly uses.

### Recommendation No. 6

#### *Right Kind of Trees Plantation for Better Environment/Climate/Water Management*

The Committee note that in many Himalayan States planting of wrong varieties of trees in the name of increasing forests cover are rampant in the country. Since Climate stabilizes the forests and the forests stabilize the Climate, vast denudation of forests and indiscriminate cutting of trees for human greed and needs, are causing greater problems of environment, Climate and present day humanity as well. For example, in Uttarakhand, Himachal Pradesh and most of the Himalayan region lot of eucalyptus, devadaru and pines have been grown in huge quantity. Pines are self-pollinated, expanding and multiplying trees. Pines and Eucalyptus have negligible role in Climate risk management but rather these trees are well known to cause lots of negative effects to the soil, water and micro-organisms of the area where these are grown. Similarly, in the State of Kerala, under a scheme of growing trees, the State authorities have bought eucalyptus, citorora and other African varieties and planted these trees, as a result, in areas such as Vynad in Kerala where a lot of water was there but owing to citorora and eucalyptus plantation, the water has been drained out. Moreover, even friendly bacteria have been reported to be missing in that soil.

The Committee, therefore, recommend the Central and State Governments to plant only those forest trees that can generate water, oxygen, attract clouds to rain, maintain balance of ecology and also work as non-human Climate risk managers to fight flood/drought conditions to help boost our agro-forestry economy. The non-glacier rivers originate from springs, which can't be saved without a thick forest coverage of the areas around their source of origin. The perennial flow of water in these rivers can only save our forests and irrigate food crops in their catchment areas and keep the ill effects of warm-climate at bay.

## Recommendation No. 7

### *Need for Interlinking of the Rivers*

The Committee note with serious concern that the majority of the people in the country get affected by frequent floods/droughts every year. These problems can be overcome to a greater extent by interlinking major rivers and their tributaries in the country and these proposals, viz, 'Interlinking of National Rivers' were envisaged about more than 50 years ago and even after the lapse of these years proposals still remain pending at the cost of sufferings/miseries/pains of the millions of Indian farmers/fishermen/commonmen year after year.

The Committee note that National Water Development Agency established in 1982 under the Ministry of Water Resources to carry out the work of National Perspective Plan for Water Resources Development comprising two components; namely (i) Himalayan Rivers Development; and (ii) Peninsular Rivers Development -- to create 35 MHa of additional irrigation potential and generation of 34 million KW of hydropower, had constituted a Task Force on Interlinking of Rivers Programme. Though the Task Force was wound up after giving its recommendations on 31<sup>st</sup> December, 2004, however, the process of study and finalization of feasibility reports of 16 link proposals by the affected States, is very slow and no concrete action is seen on the ground for interlinking of these Rivers. The earlier the interlinking process of rivers is completed, it will be easier to manage the flood-waters and river-bed erosions.

The Committee, therefore, strongly recommend that the Central/State Governments must execute all the work related to inter-linking of national rivers and their tributaries to divert the excess water which causes floods, to the drought areas on priority basis in the time bound manner and to overcome the problem of frequent floods/droughts as anticipated and already being experienced by the countrymen at large, owing to Global Climate Change.

## Recommendation No. 8

*Need to develop National Policy/Action Plan to encourage farmers to grow alternate crops alongwith Paddy Crops*

The Committee note that agriculture sector contributes 28% in Climate Change and out of that Paddy/Rice cultivation alone contributes 23% by releasing/ emitting Methane, one of the Greenhouse Gases into the environment and directly contributes to global warming.

The Committee are aware that in many areas of Uttarakhand, Punjab, Haryana, U.P., Bihar, West Bengal, Orissa and other paddy growing areas in the country, farmers are tempted to grow more and more paddy crop, even twice a year, because of the profit motives and has neither the back up knowledge or awareness to grow other alternate crops which can bring them economic prosperity nor has any motivational incentives from the Government to grow other than paddy crops, to avoid negative impacts of the paddy cultivation on environment/climate.

The Committee, therefore, recommend that Ministry of Agriculture should launch a nation-wide awareness campaign for the Indian farmers on watering system of paddy fields and also encourage them to grow other food crops to contain Methane emissions. The Government should come out with a National Policy/Action Plan, agro-climatic zone-wise suggesting/recommending alternate crops cultivation to bring economic prosperity to the farmers and at the same time avoid rise in global warming.

## Recommendation No. 9

*Need to prevent the Emission of Nitrous Oxides*

The Committee note that by 2025 more than double inorganic fertilizers would be essential for producing more food. More forestlands will be converted to farmlands and grasslands. This would lead to more Carbon Dioxide and Nitrous Oxide (GHGs) emissions in the environment. Mitigation is unlikely to occur without action; achieving the increase in food production will require more use of Nitrogen Fertilizers leading to further increase in N<sub>2</sub>O emissions

and there will be more increase in Methane emissions from enteric fermentation if livestock numbers increase in response to demands for milk, meat and other livestock products. ICAR, at present, has knowledge to prevent only small part of this emission by the use of nitrification inhibitors, slow release fertilizers and integrated nutrient management practices.

The Committee, recommend that ICAR should intensify their research to find out ways and means to further prevent/mitigate the Nitrous Oxide and Methane gas emissions from application of higher inorganic fertilization and enteric fermentation by increased number of livestock, respectively, to avoid greater harm/damage to environment/climate.

#### **Recommendation No. 10**

##### *Impacts of Climate Change on Agriculture/Allied Sectors due to Sea Level Rise*

The Committee note that IPCC recently in their assessment report has pointed out that modern global warming could melt glaciers and raise world sea level by 0.18 to 0.59 meters by 2100. If such rise in the sea level and rise in high-tidal level, cyclones and storms takes place in India, with a coastline of 7500 kms, impacts on the livelihood of coastal communities will be considerable. But from agricultural perspectives, not many studies have been done in India by ICAR. However, it is expected that vast stretches of coastal lands may get submerged, making them unsuitable for upland crops and increased salinity in aquifers may lead to reduced crop production in coastal lands, and fish production will also get affected.

The Committee, therefore, recommend that DARE/ICAR should gear up their research efforts on all the pros and cons of the impact of Climate Change on all the agriculture & allied sectors due to rise in sea level. Its impacts on the agro-economic life of farmers/fishermen, etc. should also be studied with practical & feasible solutions/remedies. Development of salinity-tolerant crop cultivars should be given priority. The fishermen should get timely and advance forecasting about weather and cyclones in the high seas.

The Committee also recommend that Government should give more attention towards coastal forests & mangroves. Building public awareness and

other extension programmes on various aspects of Climate Change in vernacular language is the need of the hour.

#### **Recommendation No. 11**

*'Deep Water Rice'/'Boat Rice' and developing 'Sea Water Cultivation' as a Science in ICAR/SAUs*

The Committee note that there is going to be more flooding in the Indo-Gangetic plains owing to Global Climate Change. From Kanyakumari to Kashmir, from Gujarat to Tripura, rice is the only crop which is grown everywhere; wheat cannot grow because of night temperatures being very sensitive, wheat yield is a gamble in temperature, if the night temperature goes up, the wheat yield will come down. The Committee are aware that already some work is going on in the flood prone areas, which is called 'Deep Water Rice or the Boat Rice'. In Thailand, farmers harvest the rice on the boat and as the water level rises, the plants also grow up.

The Committee, therefore, strongly recommend that DARE/ICAR should intensify their research on 'Deep Water Rice or Boat Rice' and should find out solutions to make Deep Water Rice varieties to be more resistant even in case these are submerged in muddy waters for more than two weeks. ICAR should also do extensive mapping for the likely flood prone areas in wake of Global Climate Change.

The Committee further recommend that DARE/ICAR should undertake 'Sea Water Cultivation' as a Science in all their concerned institutes as well as in curriculum of State Agricultural Universities (SAUs).

#### **Recommendation No. 12**

*Dryland Agriculture & Global Warming*

Since 60% of our agriculture land is rainfed, the focus should be given for improving the techniques for enhancing the productivity of rainfed agriculture. The Committee are of the firm opinion that dryland farming or rainfed agriculture needs special attention to prevent the decline in agricultural produces under Climate Change due to temperature rise. The ICAR should

develop the seeds for drought and pest-resistant crop varieties for rainfed area agriculture. Methods for conservation of soil and water of these dryland areas should be undertaken on priority basis. The Government should provide the financial support on easy terms to the farmers of dryland areas to invest in and adopt requisite technologies to tide over the impacts of Climate Change.

#### **Recommendation No. 13**

*Need to preserve, conserve and maintain Pedigrees/Local Breeds of Livestock*

The Committee observe that there is going to be nefarious consequences of Global Climate Change/Warming on Indian Livestock and Milk Revolution/White Revolution in India which was to a large extent successful because of the cross-bred cows, the Jerseys, etc. Since, these cows are extremely vulnerable to high temperatures, it is feared that these cows would slowly become unproductive and there is nothing like returning back to normalcy for these cross-bred cows jeopardizing the success of the White Revolution in India.

The Committee, therefore, strongly recommend that DARE/ICAR should treasure our indigenous cows such as 'Sahiwal', 'Tharparkar', 'Rathi', 'Ongole', 'Nellore', etc. and buffalo breeds, like 'Badavari', 'Murrah', etc. and maintain on priority basis all local breeds which can withstand the heat and vagaries of the Climate Change and adapt themselves to such local situations without jeopardizing or compromising with the successes of our White Revolution.

#### **Recommendation No. 14**

*Climate Risk Managers*

The Committee note that the Task Force of Climate Risk Managers(CRMs) in all the States & UTs at Districts & local panchayat levels, have potential to be the real saviours of the farmers, fishermen and other rural folks alike and can play a pivotal role in executing National Action Plan on Climate Change at grassroot level.

The Committee further note that the Climate Risk Managers till date figure only at conceptual and intellectual levels and still far away from becoming a reality in a professional manner at grassroot level.

The Committee, therefore, unanimously recommend that since the negative impacts of Global Climate Change are ill-affecting and will continue to do so, more intensely in times to come, all the agricultural and allied sectors, it is most essential need of the hour to create and develop a nation-wide Task Force of Climate Risk Managers. These CRMs should be made well versed in prevalent agricultural practices and systems of the areas they have to work/serve in. They should be intensively trained in a professional manner on a host of issues about agricultural and allied sectors' activities, and have practical knowledge to educate the farmers and local people all about Climate Change and its impacts with a view to face & help in diverting natural disasters at grassroot level. They should be able to mitigate the sufferings of the farmers, fishermen and commonmen in the village, due to adverse impacts of Climate Change and at the time of floods, droughts, climate variability, natural disaster and technology failure, etc., they should have the ability to convert a disaster into an opportunity for better survival of humanity, as well as flora and fauna of the local areas under their jurisdiction. Since "Climate Risk Managers" are needed at both, village level & block level, they should be able to communicate the strategies required to manage climatic risks on a real-time basis to the farmers. At the same time they should be able to liaise with other related functionaries, including National Disaster Management Authority(NDMA), Indian Meteorology Department and Department of Agriculture and Animal Husbandry, and insurance officials. He/she should be trained in these aspects by the NDMA. Such Climate Risk Managers would also be useful at district and state levels to liaise with Government officials and other donor/relief agencies.

The Committee further recommend that in addition to creating an extension cadre of professionals, the Government should train at least one female and one male member in every Panchayat to act as Climate Risk Managers. Moreover, Panchayati Raj Training Institutes in the country should introduce climate related literacy/knowledge and Climate Risk/Disaster Management subjects/issues in their own curriculum for training the Panchayati Raj members and others who are coming for training. Ministry of Agriculture should ensure that all their extension workers/whosoever has the responsibility to liaise with farmers, fishermen, livestock managers, etc. to educate them, must be trained

as Climate Risk Managers and each one of them, should have a specific annual physical target to educate and interact with farmers and allied sectors clientele on all aspects of Climate Risk Management in the area of their jurisdiction.

#### **Recommendation No. 15**

##### *Intensify the R&D on Climate Change*

The Committee note that Climate Change is likely to impact negatively on many aspects of agriculture, including, irrigation availability, soil health, pests, and crops and livestock production. Preliminary calculations to quantify the decrease in production of wheat suggest a likely decrease of 4 to 5 million tonnes with an increase of 1<sup>0</sup>C increase in temperature throughout the growing season. ICAR stated that work on other crops is being done and at present, comprehensive estimates of costs of abating these damages due to Climate Change has already started on Indian agri-allied sectors.

The Committee recommend that DARE/ICAR should expedite and intensify their research & development work on all the major foodgrains, coarse grains, pulses, cash crops, oilseeds, horticultural/medicinal & aromatic plants, tuber and fodder crops, etc., with regard to likely negative as well as positive impacts of Climate Change and should also come out successfully with remedial solutions/packages/technologies/practices which can be conveniently and feasibly practised and adopted by all the Indian farmers/livestock producers in all the agro-climatic zones of the country. Agriculture should be supported by the convergence of traditional practical knowledge of the farmers about the farming system and new technological innovations, biotechnology and in case of failure of the crops effective insurance mechanisms need to be created.

The Committee also recommend that DARE/ICAR should take expeditious steps to work out the comprehensive estimates of costs/funds required to abate the challenges emerging out of Climate Change scenario as has been done by many other countries.

## Recommendation No. 16

### *Research Grants to DARE/ICAR*

The Committee note that ICAR has initiated research and development programmes on several aspects of Global Climate Change impacts on crops/livestock/fisheries, etc. The Committee are of the view that the pace of ICAR research is not satisfactory and is very slow. This snail pace progress can be accelerated only if the grants for Climate Change research are enhanced.

The Committee, therefore, urge upon the Planning Commission/PM's Council on Climate Change/Ministry of Finance to help ICAR to accelerate their pace by doing useful R&D on the impacts of Climate Change by immediately providing more grants to them to put an end to unending sufferings of the Indian farmers/fishermen/livestock keepers, etc. The Committee also advise the DARE/ICAR to make their comprehensive estimates of funds/grants requirement and place the same before Planning Commission/PM's Council on Climate Change fora/meetings for getting the approval for the funds for their research on Climate Change impacts on agriculture & allied sectors.

## Recommendation No. 17

### *Green Research Fund*

The Committee observe that there is a need to establish 'Green Research Fund' for strengthening research on adaptation, mitigation and impact assessment on agriculture/allied sectors, of Climate Change in Indian context. They strongly recommend that DARE/ICAR should come out with comprehensive details/blue print of this 'Green Research Fund' at their earliest and place the same before the Planning Commission/PM's Council on Climate Change for favourable consideration and implementation and the Committee be apprised of the outcome within three months from the date of presentation of this Report to the Parliament. The Committee are also of the view that although the main beneficiary of this 'Green Research Fund' will be ICAR, yet this Fund should have ample scope and opportunities to encourage and inspire financially the private scientists/NGOs/non-governmental research organizations,

institutions, societies, etc. throughout the nation to put in sincere R&D efforts on the impact assessment of Climate Change and to come out with feasible adaptive/mitigational remedies for the agriculture and allied sectors.

#### **Recommendation No. 18**

*Financial Incentives and Packages for improved Land Management/Resource Conservation*

The Committee are well aware of the alarming facts/impacts of the Global Climate Change on agriculture and allied sectors in India as well as the endless ongoing sufferings of Indian farmers/fishermen/livestock managers, etc.

The Committee, therefore, unanimously recommend that it is high time when the Government of India should make a healthy policy to provide and extend financial incentives and packages to States and UTs to improve land management, natural resource conservation/enhancement, i.e. (Water, Energy, Carbon) as well as man-made resources such as equipment/machinery, etc. conservation/enhancement and fertilizer use efficiency, to individual farmers, fishermen and livestock managers, etc. who proved to be a successful practitioner in achieving the desired goals. This will really help the individuals and the society as whole to get motivated and encouraged to indulge in improved land management/resources conservation/enhancement and efficient use of fertilizers/resources.

#### **Recommendation No. 19**

*Developing Capacity for Understanding the Real Time Climatic Variability*

The Committee note that ICAR requires to share weather data with Indian Meteorological Department (IMD) in order to develop capacity for understanding the real time climatic variability on a priority basis and recommend that for achieving the above purpose ICAR and IMD should explore the possibility of signing an MoU in this regard.

The Committee further recommend that in order to generate the right kind of information/data which is critical and wanted, for the ground level beneficiaries such as, farmers, fishermen, livestock managers, etc. on climatic

variability. Scientists have to go to the farmers and the agriculture experts and ascertain from them about their actual requirements and accordingly should generate the required information on weather conditions.

The Committee also note that several ICAR institutes collect data on Crops/Livestock/Fisheries response to climatic variables. The Committee recommend that this data from different institutes should be compiled, streamlined and put on ICAR Web for greater utilization and understanding impacts of Climate Change by the farmers and other interested people.

### **Recommendation No. 20**

#### *Making the Society and Economy Climate Proof*

The Committee note that Climatic variability has always been an important issue in Indian Agriculture. It has caused frequent events of droughts, floods, heat and cold stresses, causing widespread impact on food production. Climate Change is likely to increase such risks in future. Although ICAR and State Agricultural Universities (SAUs) are reported to have always taken this issue of 'Climate Proofing' seriously, yet, they have no comprehensive estimates of costs associated with making our Society and Economy 'Climate Proof'.

The Committee, therefore, recommend DARE/ICAR to understand the gravity of the negative impacts of Global Climate Change on Agriculture and Allied Sectors. It should come out with comprehensive estimates of costs and best management practices for making our agro-socio-economy climate proof at the earliest as this will help the research institutions to get the required funding from the MoF/Planning Commission. Such comprehensive estimates of costs will also help the appraisal agencies to allocate funds appropriately among various Ministries/Departments considering the priority of the issues/matter involved. This will also help the Central Government to negotiate India specific concerns with the various international financial institutions/agencies who can be instrumental in helping us with required funding to combat the whole issue of Global Climate Change in its totality.

## Recommendation No. 21

### *Development of Safe Biotechnological Interventions*

The Committee observe that one of the item of the National Action Plan on Climate Change is use of bio-technology. Although the Government has announced that it would set up National Bio-Technology Regulatory Authority, there are lot of controversies and concerns in this regard, particularly, on the agricultural side. There are serious concerns among the masses about the safety aspects of food bio-technology.

The Committee, therefore, strongly recommend that DARE/ICAR should intensify and strengthen their research on the generation of the novel genetic combinations, drought, flood, salinity, sodicity and biotic stress tolerant varieties and at the same time they should also develop their capacity to ensure safe and responsible use of bio-technology.

Moreover, DARE/ICAR should review their performance as ICAR is yet to come out with their first indigenous bio-technological breakthrough in agricultural/allied sectors which can be happily and economically grown by Indian farmers to come out of the slavery of imposed monopoly of multinational companies selling them genetically modified seeds at a very high price every time they use their seeds.

## Recommendation No. 22

### *Bharat Nirman—Irrigation Programme*

The Committee note that Irrigation is one of the components for development of rural infrastructure under Bharat Nirman. Ground water irrigation is suffering immensely due to depletion of underground water-table. The irrigation component aims at creation of irrigation potential of 10 million hectare (MHa) in four years, i.e., from 2005-06 to 2008-09. The projects/schemes for creation of irrigation potential are taken up by the State Governments from their own resources according to their priorities.

Government of India has enhanced allocation for grants under Accelerated Irrigation Benefits Programme (AIBP) to provide support to State Governments.

The physical achievements/progress under Bharat Nirman—Irrigation Component is stated to be 1676.916 thousand hectare for the year 2005-06; 1943.346 thousand hectare for 2006-07; and 1522.394 thousand hectare for 2007-08. It is evident from these figures that about less than 50 per cent target has been achieved in initial three years and in the last/final year, i.e., 2008-09, more than 50 per cent target is left to be achieved.

The Committee, therefore, strongly recommend that it is high time to develop right kind of strategies and action plan, reviewing the past performances, to convert the big failure of irrigation component of Bharat Nirman into a bigger success in wake of man-made Global Climate Change.

#### **Recommendation No. 23**

##### *Prevention of Higher Greenhouse Gases (GHGs) Emissions by Food Processing Industries*

The Committee observe that Food Processing Industry have been to a large extent dependent on technologies like refrigeration, cold storages, etc. which are abhorred by environmentalists since these technologies are productive of Greenhouse Gases (GHGs).

The Committee visualizing the negative impacts of Global Climate Change on Food Processing Industry recommend that refrigeration/cold storage technologies based on emission of more GHGs in environment needed to be modified/alterd to an extent that no or very low emissions of GHGs go in the air as pollutants to the environment. The Committee further recommend that DARE/ICAR should develop and come out successfully with modified alternative packages for Food Processing Industry as they have an important role in finding technological possibilities and developing varieties of agro-allied produces which can sustain higher temperatures, drought resistant or which can sustain skewed precipitations, etc. for securing a healthy future for our Sun-rising Food Processing Industry.

**NEW DELHI;**  
**25 February, 2009**  
**6 Phalguna, 1930 (Saka)**

**MOHAN SINGH**  
**Chairman,**  
**Standing Committee on Agriculture.**

## APPENDIX I

### MINUTES OF THE FIFTH SITTING OF THE STANDING COMMITTEE ON AGRICULTURE HELD ON WEDNESDAY, THE 6<sup>TH</sup> FEBRUARY, 2008 AT 1500 HRS. IN COMMITTEE ROOM NO. '139', FIRST FLOOR, PARLIAMENT HOUSE ANNEXE, NEW DELHI

The Committee sat from 1500 hrs. to 1630 hrs.

#### PRESENT

**Prof. Ram Gopal Yadav – Chairman**

#### MEMBERS

##### **LOK SABHA**

2. Shri Ranen Barman
3. Shri Anil Basu
4. Shri Manoranjan Bhakta
5. Shri Girdhari Lal Bhargava
6. Shri Gadakh Tukaram Gangadhar
7. Shri Deepender Singh Hooda
8. Shri Mahendra Prasad Nishad
9. Shri Prabodh Panda
10. Smt. Rupatai D.Patil Nilangekar
11. Shri K.J.S.P. Reddy
12. Shri M.P. Veerendra Kumar
13. Shri Baleshwar Yadav

##### **RAJYA SABHA**

14. Shri Harish Rawat
15. Smt. Mohsina Kidwai
16. Shri Vikram Verma
17. Shri Vinay Katiyar
18. Shri Sk. Khabir Uddin Ahmed
19. Shri Datta Meghe
20. Shri M.Rajasekara Murthy
21. Prof. M.S.Swaminathan

## **SECRETARIAT**

- |    |                 |   |                  |
|----|-----------------|---|------------------|
| 1. | Shri A.K. Singh | - | Joint Secretary  |
| 2. | Shri N.S. Hooda | - | Deputy Secretary |
| 3. | Ms. Amita Walia | - | Under Secretary  |

## **WITNESSES**

- |     |                      |   |  |
|-----|----------------------|---|--|
| 1.  | Dr. Mangala Rai      | - | Secretary (DARE) & DG (ICAR)             |
| 2.  | Dr. P.K. Aggarwal    | - | National Prof., IARI, New Delhi          |
| 3.  | Dr. A.K. Singh       | - | Deputy Director General (NRM), ICAR      |
| 4.  | Dr. K.M. Bujarbaruah | - | Deputy Director General (AS), ICAR       |
| 5.  | Dr. S. Ayyappan      | - | Deputy Director General (Fy.), ICAR      |
| 6.  | Dr. S.P. Tewari      | - | Deputy Director General (Edn.), ICAR     |
| 7.  | Dr. P.L. Gautam      | - | Deputy Director General (CS), ICAR       |
| 8.  | Dr. H.P. Singh       | - | Deputy Director General (Hort.), ICAR    |
| 9.  | Shri A.K. Upadhyay   | - | Addl. Secretary(DARE) & Secretary (ICAR) |
| 10. | Dr. Nawab Ali        | - | Deputy Director General (Engg.), ICAR    |
| 11. | Dr. K.S. Khokhar     | - | Assistant Director General (PIM), ICAR   |

At the outset, the Chairman welcomed the representatives of the Ministry of Agriculture (Department of Agricultural Research and Education) and read out contents of Direction 55(1) of the 'Directions by the Speaker, Lok Sabha'.

2. After the introductions, the Secretary (DARE) along with Dr. P.K. Aggarwal, National Professor, IARI, New Delhi and also on the international panel on climate change, briefed the Committee on various aspects of the subject, 'Impact of Global Climate Change on Agriculture and Allied Sectors in India' through a power point presentation. The representatives of the Ministry also replied to the various points raised by the members of the Committee during the interactive session.

3. In view of the importance of the subject and its predicted impact on Indian agriculture, hon. Chairman encouraged and motivated the scientists to do the needful research in time to find out the solutions to the grave problems the nation

is likely to face in future due to Global Climate Change and assured them full support of the Committee for the same.

4. A verbatim record of the proceedings of the sitting has been kept.
5. The witnesses then withdrew.

*The Committee then adjourned.*

## APPENDIX II

MINUTES OF THE SECOND SITTING OF THE STANDING COMMITTEE ON  
AGRICULTURE HELD ON WEDNESDAY, THE 27 AUGUST, 2008 AT  
1500 HRS. IN COMMITTEE ROOM NO. '139', FIRST FLOOR,  
PARLIAMENT HOUSE ANNEXE, NEW DELHI

The Committee sat from 1500 hrs. to 1745 hrs

### PRESENT

**Prof. Ram Gopal Yadav - Chairman**

### MEMBERS

#### LOK SABHA

2. Shri Anil Basu
3. Shri Manoranjan Bhakta
4. Shri Girdhari Lal Bhargava
5. Shri Khagen Das
6. Shri Gadakh Tukaram Gangadhar
7. Shri Deepender Singh Hooda
8. Shri Mahendra Prasad Nishad
9. Shri Prabodh Panda
10. Smt. Rupatai Diliprao Nilangekar Patil
11. Shri K.J.S.P. Reddy
12. Shri M.P. Veerendrakumar
13. Shri Baleshwar Yadav

#### RAJYA SABHA

14. Shri Harish Rawat
15. Shri Ishwar Singh
16. Smt. Mohsina Kidwai
17. Shri Vikram Verma
18. Shri Vinay Katiyar
19. Dr. Janardhan Waghmare
20. Shri Sharad Anantrao Joshi
21. Prof. M.S. Swaminathan
22. Shri M. Rajasekara Murthy

### SECRETARIAT

- |    |                  |   |                      |
|----|------------------|---|----------------------|
| 1. | Shri S.K. Sharma | - | Additional Secretary |
| 2. | Shri A.K. Singh  | - | Joint Secretary      |
| 3. | Ms. Veena Sharma | - | Director             |
| 4. | Shri Raj Kumar   | - | Deputy Secretary     |
| 5. | Shri N.S. Hooda  | - | Deputy Secretary     |
| 6. | Ms. Amita Walia  | - | Under Secretary      |

### WITNESSES

- |    |                        |   |  |
|----|------------------------|---|--|
| 1. | Prof. Sulochana Gadgil | - | Honorary Professor & Former<br>Chairman, Centre for<br>Atmospheric and Oceanic<br>Sciences, Indian Institute of<br>Science     |
| 2. | Dr. Suhas Wani         | - | Principal Scientist & Regional<br>Coordinator for Asia,<br>International Crops Research<br>Institute for the Semi-Arid Tropics |
| 3. | Dr. A.A. Nambi         | - | Project Director (Climate change)<br>M.S. Swaminathan Research<br>Foundation   |

At the outset, the Chairman welcomed the members of the Committee and called in Prof. Sulochana Gadgil, Honorary Professor and former Chairman, Centre for Atmospheric and Oceanic Sciences, Bangalore. She was welcomed and apprised of the contents of Direction 55 (1) of the 'Directions by the Speaker, Lok Sabha'. Thereafter, Prof. Gadgil briefed the Committee about her views on various aspects of 'Impact of Global Climate Change on Agriculture and Allied Sectors in India' and also replied to the queries raised by the members of the Committee. She told the Committee that observation over the Indian region shows that the temperature does show an increasing trend over 100 years, but there is no increasing trend in the temperature of the monsoon season, June to September, the *Kharif* season. The increase in temperature seems to be observed primarily in the winter & in the post-monsoon months. She suggested that we have to mitigate against or adapt our strategies for the variability of the

Climate between droughts and very good monsoon years. She also pointed out that more work is required in promoting inter-disciplinary research.

2. The Chairman thanked her for briefing the Committee.

*(Prof. Gadgil then withdrew)*

3. Thereafter, Dr. Suhas Wani, Principal Scientist & Regional Coordinator for Asia, International Crops Research Institute for the Semi-Arid Tropics, Pattancheru, Andhra Pradesh, was called in and was welcomed and apprised of the contents of Direction 55(1) of the 'Directions by the Speaker, Lok Sabha'. Dr. Wani briefed the Committee about his views on various aspects of 'Impact of Global Climate Change on Agriculture and Allied Sectors in India'. He suggested that we need to conserve our biodiversity, promote alternate rural enterprises to have the farming system approach, which would diversify the source of income. For that, we need to improve policies and institutions for the efficient use of natural resources and also improve risk management through various early warning systems so that the farmers are able to cope with the Climate Change. We need to enhance the plantation of trees. In all the systems, we need to reduce the methane emissions from the paddy lands by bringing in water use efficiency and minimising the water logging; need to increase water use efficiency for agriculture as 80% of water is consumed by agriculture. We need to build shelter belt and alternate source of renewable energy, need to be put together to really build our strategy for Climate Change. He also replied to the queries raised by the Members.

4. The Chairman thanked him for briefing the Committee.

*(Dr. Suhas Wani then withdrew)*

5. Thereafter, Dr. A.A. Nambi, Project Director (Climate Change), M.S. Swaminathan Research Foundation, Chennai was called in and was welcomed and apprised of the contents of Direction 55(1) of the 'Directions by the Speaker, Lok Sabha'. Dr. Nambi briefed the Committee about his views on the subject. He pointed out that although ICAR is having very good resources, knowledge and research capabilities, yet it required to have dedicated research centre for Climate Change. Research institutes should design certain tools which are helpful in assessing the specific vulnerability at specific places by having regular and good monitoring framework and based on that we have to evolve the

adaptation and mitigation strategies. He also mentioned that there are ample trading and economic opportunities from Climate Change but how to tap these things and take it to rural level is the important thing and for that a good policy support would always be helpful. He also replied to the queries raised by the members.

6. The Chairman thanked him for briefing the Committee.

*(Dr. Nambi then withdrew)*

7. A verbatim record of the proceedings of the sitting has been kept.

*The Committee then adjourned.*

## APPENDIX III

MINUTES OF THE THIRD SITTING OF THE STANDING COMMITTEE ON AGRICULTURE HELD ON MONDAY, THE 8 SEPTEMBER, 2008 AT 1500 HRS. IN COMMITTEE ROOM 'D', GROUND FLOOR, PARLIAMENT HOUSE ANNEXE, NEW DELHI

The Committee sat from 1500 hrs to 1745 hrs

### PRESENT

**Prof. Ram Gopal Yadav - Chairman**

### MEMBERS

#### LOK SABHA

2. Shri Anil Basu
3. Shri Manoranjan Bhakta
4. Shri Girdhari Lal Bhargava
5. Shri Khagen Das
6. Shri Prabodh Panda
7. Shri Danve Raosaheb Patil
8. Shri K.J.S.P.Reddy
9. Shri Y.S. Vivekananda Redddy
10. Shri Baleshwar Yadav

#### RAJYA SABHA

11. Shri Harish Rawat
12. Shri Ishwar Singh
13. Smt. Mohsina Kidwai
14. Shri Vikram Verma
15. Shri Vinay Katiyar
16. Dr. Janardhan Waghmare
17. Shri Sharad Anantrao Joshi
18. Prof. M.S.Swaminathan
19. Shri M.Rajasekara Murthy

## SECRETARIAT

1.	Shri A.K. Singh	-	Joint Secretary
2.	Ms. Veena Sharma	-	Director
3.	Shri Raj Kumar	-	Deputy Secretary
4.	Shri N.S. Hooda	-	Deputy Secretary
5.	Ms. Amita Walia	-	Under Secretary

## WITNESSES

1.	Dr. Mangala Rai	Secretary (DARE) & Director General (ICAR)
2.	Shri A.K. Upadhyay	Additional Secretary (DARE) & Secretary (ICAR)
3.	Dr. A.K. Singh	Deputy Director General (NRM)
4.	Dr.P.L. Gautam	Deputy Director General (CS)
5.	Dr. H.P. Singh	Deputy Director General (Hort.)
6.	Dr. S. Ayyappan	Deputy Director General (Fy.)
7.	Dr. K.M. Bujarbaruah	Deputy Director General (AS)
8.	Dr. P.K. Aggarwal	National Professor, IARI
9.	Dr. K.S. Khokar	Assistant Director General (PIM)

At the outset, the Chairman welcomed the representatives of the Ministry of Agriculture (Department of Agricultural Research and Education) and read out contents of Direction 55(1) of the 'Directions by the Speaker, Lok Sabha'.

2. After the introductions, the Secretary (DARE) explained to the Committee that estimates are being made regarding the impact of global warming on agriculture, horticulture, fisheries and on livestock and there is unanimity that climate change is certainly going to affect in different proportions in different regions. He pointed out that this continuous increase in temperature is not as big a problem as the swings in temperature, precipitation, distribution in space and time, that is probably creating a lot of problem for scientists in ICAR. He further explained about some aspects of climate change and on use of transgenic technology for insulating crops, livestock and fisheries to weather vagaries. The representative of the Department also replied to the various points raised by the members of the Committee during the interactive session.
3. The Committee unanimously decided to hear and interact with some of the directly involved Ministries and Departments and to be apprised about their collective

and coordinated efforts to tackle the impacts of Global Climate Change on agriculture and allied sectors in India.

4. A verbatim record of the proceedings of the sitting has been kept.
5. The witnesses then withdrew.

*The Committee then adjourned.*

## APPENDIX IV

### MINUTES OF THE FOURTH SITTING OF THE STANDING COMMITTEE ON AGRICULTURE HELD ON TUESDAY, THE 30 SEPTEMBER, 2008 AT 1100 HRS. IN MAIN COMMITTEE ROOM, GROUND FLOOR, PARLIAMENT HOUSE ANNEXE, NEW DELHI

The Committee sat from 1100 hrs. to 1530 hrs.

#### PRESENT

**Prof. Ram Gopal Yadav - Chairman**

#### MEMBERS

#### LOK SABHA

2. Shri Ranen Barman
3. Shri Anil Basu
4. Shri Manoranjan Bhakta
5. Shri Girdhari Lal Bhargava
6. Shri Khagen Das
7. Shri Prabodh Panda
8. Shri Danve Raosaheb Patil
9. Shri M.P.Veerendrakumar

#### RAJYA SABHA

10. Shri Harish Rawat
11. Shri Ishwar Singh
12. Smt. Mohsina Kidwai
13. Shri Vikram Verma
14. Shri Vinay Katiyar
15. Dr. Janardhan Waghmare
16. Prof. M.S. Swaminathan
17. Shri M. Rajasekara Murthy

## SECRETARIAT

1.	Shri S.K. Sharma	-	Secretary
2.	Shri A.K. Singh	-	Joint Secretary
3.	Ms. Veena Sharma	-	Director
4.	Shri Raj Kumar	-	Deputy Secretary
5.	Shri N.S. Hooda	-	Deputy Secretary
6.	Ms. Amita Walia	-	Under Secretary

## WITNESSES

### *MINISTRY OF AGRICULTURE (DAC)*

1.	Shri T. Nanda Kumar	Secretary (A&C)
2.	Dr. S.M. Jharwal	Principal Adviser
3.	Dr. N.B. Singh	Agriculture Commissioner
4.	Shri N.K. Das	Additional Secretary
5.	Shri P.K. Basu	Additional Secretary
6.	Shri R.C. Ray	Economic & Statistics Adviser (ESA)

### *MINISTRY OF AGRICULTURE (DARE)*

1.	Dr. A.K. Singh	Deputy Director General (NRM)
2.	Dr. P.L. Gautam	Deputy Director General (CS)
3.	Dr. H.P. Singh	Deputy Director General (Hort.)
4.	Dr. S. Ayyappan	Deputy Director General (Fy.)
5.	Dr. K.M. Bujarbaruah	Deputy Director General (AS)
6.	Dr. K.S. Khokar	Assistant Director General (PIM)

### *MINISTRY OF AGRICULTURE (DAHDF)*

1.	Dr. Pradeep Kumar	Secretary (ADF)
2.	Dr. S.K. Bandyopadhyay	Animal Husbandry Commissioner (AHC)
3.	Shri Dilip Rath	Joint Secretary (A&DD)
4.	Shri Tarun Sridhar	Joint Secretary (Fy.)
5.	Dr. Batobyal	Joint Secretary (LP)

### *MINISTRY OF WATER RESOURCES*

1.	Shri M.E. Haque	Commissioner (PP)
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### *PLANNING COMMISSION*

1.	Shri L. Rynjah	Principal Adviser (Agriculture, Environment & Forests)
2.	Dr. V.V. Sadamate	Adviser (Agriculture)
3.	Dr. Indrani Chandrasekharan	Adviser (E&F)
4.	Shri M. Ravindranath	Joint Adviser (E&F)

### *MINISTRY OF ENVIRONMENT & FORESTS*

1.	Shri Vijai Sharma	Secretary (E&F)
2.	Shri J. M. Mauskar	Additional Secretary
3.	Shri R. R. Rashmi	Joint Secretary (Climate Change)

4. Shri Subodh Kumar Sharma Adviser (Climate Change)

MINISTRY OF EARTH SCIENCES

1. Dr. Shailesh Nayak Secretary (ES)  
2. Dr. Ajit Tyagi DG, IMD  
3. Dr. L.S. Rathore Scientist 'G' (Advisor)

At the outset, the Chairman welcomed the members of the Committee and called in the representatives of the following six Ministries/Departments and the Planning Commission and apprised them of the contents of Direction 55 (1) of the 'Directions by the Speaker, Lok Sabha':

- (i) Ministry of Agriculture (Department of Agriculture and Cooperation);
- (ii) Ministry of Agriculture (Department of Agricultural Research and Education);
- (iii) Ministry of Agriculture (Department of Animal Husbandry, Dairying & Fisheries);
- (iv) Ministry of Earth Sciences;
- (v) Ministry of Environment & Forests;
- (vi) Ministry of Water Resources; and
- (vii) Planning Commission.

2. In his opening remarks itself, the Chairman asked to enlighten the Committee on some specific points on the various aspects of the subject, 'Impact of Global Climate Change on Agriculture and Allied Sectors in India', such as affectation of ground water table due to change in precipitation and evaporization, extent of saline intrusion into coastal and inland aquifers due to rising sea level, methane discharge of rice fields in India & European Countries, need of financial and policy support from Government of India, need to set up time frame for interlinking of rivers for proper utilization of water in deficient regions, the benefited and non-benefited food crops due to increased CO<sub>2</sub> in the atmosphere, strategy to be adopted to reduce emission of greenhouse gases, need to develop ocean atmospheric and climate model strategies, need to discuss the budgetary requirement with Planning Commission for adaptation and mitigation strategies and their implementation meant for Climate Change, etc., etc. Being the nodal Ministry to oversee and coordinate with Inter-governmental Panel on Climate Change (IPCC) and inter-ministerial efforts as well within India to counter the

ill-effects of Global Climate Change in India, the Secretary, Ministry of Environment & Forests was asked to lead the briefing of the Committee. In his introductory remarks, the Secretary (E&F) gave a brief account of various measures on research, policy and planning side, which have been taken domestically, taking into account the threats, challenges and opportunities coming up due to Global Climate Change. He also informed the Committee that in the year 2007, Prof. R. Chidambaram, the Principal Scientific Advisor to the Government of India was asked to look into some relevant aspects of the impacts of Global Climate Change and very recently he has finalised six reports on six areas. He further mentioned about the eight missions set up under National Action Plan on Climate Change which was released on 30<sup>th</sup> June, 2008.

3. Thereafter, the representative of the Ministry of Earth Sciences was asked to give his presentation. He gave a brief account of their mandatory activities and programmes specifically related to ocean atmosphere, which he claimed, are guided towards providing services to the society like the weather, agro-climate for aviation, for fisheries and for that they have been making observations of the ocean and atmosphere and integrate these observations and modelling to provide service.

4. After that, the representatives of the Ministry of Water Resources informed the Committee that their first and foremost task is to have a reliable assessment of the water resources, particularly its features as a result of impact of Climate Change. He also explained that their Ministry has been assigned the responsibility in respect of institutionalization of National Water Mission envisaged under National Action Plan on Climate Change and for that six sub-committees have been constituted to address the related issues in a coordinated manner and by associating the various stakeholders.

5. Subsequently, representatives of the Ministry of Agriculture, Department of Agriculture & Cooperation; Department of Animal Husbandry, Dairying & Fisheries; Department of Agricultural Research & Education; and Planning Commission also briefly presented their views on the subject and their envisaged role in this regard.

6. Thereafter, Members raised several points/queries and Chairman asked the representatives to send within 10 days, the written replies to all the points raised by the Committee during discussion to which the representatives of respective Ministries responded in affirmation.

7. The Chairman thanked all the representatives for briefing and expressing their views in a free and frank manner before the Committee.

8. A verbatim record of the proceedings of the sitting has been kept.
9. The witnesses then withdrew.

*The Committee then adjourned.*

## APPENDIX V

**MINUTES OF THE ELEVENTH SITTING OF THE STANDING COMMITTEE ON  
AGRICULTURE HELD ON WEDNESDAY, THE 25 FEBRUARY, 2009  
AT 1000 HRS. IN COMMITTEE ROOM NO. '139', FIRST FLOOR,  
PARLIAMENT HOUSE ANNEXE, NEW DELHI**

The Committee sat from 1000 hrs. to 1100 hrs.

### PRESENT

**Shri Mohan Singh - Chairman**

### MEMBERS

#### LOK SABHA

2. Shri Ranen Barman
3. Shri Girdhari Lal Bhargava
4. Shri Khagen Das
5. Shri Prabodh Panda
6. Smt. Rupatai D. Patil Nilangekar
7. Shri K.J.S.P. Reddy
8. Shri Y.S. Vivekananda Reddy
9. Shri Baleshwar Yadav

#### RAJYA SABHA

10. Shri Vikram Verma
11. Shri Vinay Katiyar
12. Shri M.Rajasekara Murthy

## SECRETARIAT

- |    |                  |   |                  |
|----|------------------|---|------------------|
| 1. | Ms. Veena Sharma | - | Director         |
| 2. | Shri N.S. Hooda  | - | Deputy Secretary |
| 3. | Ms. Amita Walia  | - | Under Secretary  |

At the outset, the Chairman, Standing Committee on Agriculture welcomed the Members and apprised them that the Draft Report on the Subject has already been circulated to them and is ready for their consideration. The Report was then taken up for consideration. The Report was unanimously adopted with minor modifications suggested by the members. The Committee also put on record their appreciation of strenuous efforts put in by the Committee Secretariat for reflecting Committee's concern and observations in drafting the Report.

2. The Committee authorized the Chairman to finalize the report and present the same to the Parliament.

*The Committee then adjourned.*