39

STANDING COMMITTEE ON AGRICULTURE
(2016-201)

SIXTEENTH LOK SABHA

MINISTRY OF AGRICULTURE AND FARMERS WELFARE
(DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION)

THIRTY NINTH REPORT

"Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country"

LOK SABHA SECRETARIAT
NEW DELHI

August, 2017/Shravana, 1939 (Saka)

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"Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country"

Presented to Lok Sabha on 10.08.2017
Laid on the Table of Rajya Sabha on 09.08.2017

LOK SABHA SECRETARIAT

NEW DELHI

AUGUST, 2017/SHRAVANA, 1939 (SAKA)

COA No. 359

Price : Rs.

Published under Rule 382 of the Rules of Procedure and Conduct of Business in Lok Sabha (Fourteenth Edition) and Printed by

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COMPOSITION OF THE STANDING COMMITTEE ON AGRICULTURE

(2016-17)

Shri Hukm Deo Narayan Yadav - Chairperson

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3.	Smt. Juby Amar	-	Additional Director
4.	Shri Sumesh Kumar	-	Under Secretary

INTRODUCTION

I, the Chairperson, Standing Committee on Agriculture (2016-2017) having been authorized by the Committee to submit the Report on their behalf, present this Thirty Ninth Report (Sixteenth Lok Sabha) on the subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country" pertaining to the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education).

2. The Committee took briefing of the representatives of Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education), Ministry of Water Resources, River Development and Ganga Rejuvenation on the subject at their Sittings held on 19.10.2015 and 06.11.2015 respectively. The Committee held seven sittings in connection with the examination of the subject and received memoranda from individuals/experts/organizations.

3. The Committee also took evidence of the representatives of the following Ministries/Departments/Organizations during examination of the subject:-

I. Indian Agricultural Research Institute, Pusa, New Delhi, ICAR Research Complex for NEH Region, Bara Pani, Meghalaya and ICAR Research Complex for Eastern Region, Patna on 08.04.2016.

II. Watershed Organization Trust (WOTR), Pune, BAIF Development Research Foundation, New Delhi, Dr. Anil K. Singh, Vice-Chancellor, Rajmata Vijayrajescindia Krishi Vishwavidhalaya, Gwalior and Director of ICAR- Central Research Institute for Dryland Agriculture on 08.04.2016.

III. Department of Agricultural Research and Education, Department of Agriculture, Cooperation and Farmers Welfare and Crop Care Federation of India on 31.08.2016

IV. Department of Agricultural Research and Education on 05.10.2016.

V. Ministry of Environment, Forest and Climate Change and Ministry of Earth Sciences on 28.10.2016.

4. The Committee wish to express their thanks to representatives of the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education and Department of Agriculture, Cooperation and Farmers Welfare), Ministry of Water Resources, River Development and Ganga Rejuvenation, Ministry of Environment,

Forest and Climate Change, Ministry of Earth Sciences for furnishing requisite information to the Committee in connection with examination of the subject. The Committee also express their gratitude to the Organisations/Individuals for enabling the committee to understand various dimensions of the subject through their submission of 45 Memoranda and deposition before the Committee.

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

6. The Report was considered and adopted by the Committee at their Sitting held on 03.08.2017.

7. For facility of reference, the observations/recommendations of the Committee have been printed in bold at Part-II of the Report.

NEW DELHI;
07 August, 2017
16Shravana, 1939 (Saka)

HUKM DEO NARAYAN YADAV
Chairperson,
Standing Committee on Agriculture

CHAPTER–I

INTRODUCTION

1.1 Climate have pre-eminent role in the evolution of Human species and shaping of various human civilization across the world. Racial classification of human species reveals impact of climate on body morphology and growth pattern as these are patterned on climate zones. Similarly, Impact of climate can also be seen on kinds of flora and fauna of distinct geographical area. Each Geographical area can easily be identified by the unique combinations of varieties of species of trees, crops, animals, birds etc. Historically, these restrictions of climate on availability of fauna and flora have also shaped the emergence and develpment of human culture and civilization.

1.2 Every society have structured their culture around historical and current climate conditions. Human culture is basically a byproduct of locally available resources and local climate. Human societies are accustomed to a normal range of climatic conditions and may be sensitive to extremes that fall outside of this range. Climate change could affect our society through impacts on a number of different social, cultural, and natural resources. Various studies have shown that average global temperature has enhanced due to increase in average global CO_2 level in Post industrialization era. Anthropogenic sources of pollutants have led to a situation which has potential to destablize critical climatic balance of atmospheric system of our planet Earth. Any major deviation of current climatic pattern may have disastrous consequences for human culture and civilization. Climate change and its variability are emerging as major challenges facing agriculture across the globe which can have consequences for food security for global community.

1.3 Intergovernmental Panel on Climate Change (IPCC) in their Fifth Assessment Report (AR5) has stated that warming of the climate system is unequivocal. IPCC in this report has stated that since the 1950s, many of the observed changes are unprecedented over decades to milennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.The AR5 report suggests that each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was verly likely the warmest 30-year period of the last 800 years in the Northern Hemisphere and likely the warmest 30-year period of the last 1400 years. Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass. Glaciers have continued to shrink almost worldwide. Northern Hemisphere spring snow cover has continued to decrease in extent. Over the period 1901-2010, global mean sea level rose by 0.19 (0.17 to 0.21) meter. The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia. The fifth IPCC report clearly brought out the global and regional impacts of climate change on agriculture, water resources, natural eco-systems and food security.When asked to furnish summary of global and regional impacts of climate change on agriculture, water resources, natural eco-systems and food security as brought out in above mentioned

IPCC Report, the Department in their submission before the Committee have stated as under-

"Crop yields and changes in productivity due to climate change will vary considerably across regions and among localities, thus changing the patterns of production. Productivity is projected to increase in some areas and decrease in other areas especially in the tropics and subtropics. Similar assessments indicate that yields of some crops in tropical locations would decrease generally with even minimal increases in temperature, because such crops are near their maximum temperature tolerance and where dryland/rainfed agriculture predominates. There will also be a large decrease in rainfall and tropical crop yields would be even more adversely affected. With autonomous agronomic adaptation, crop yields in the tropics tend to be less adversely affected by climate change than without adaptation, but they still tend to remain below levels estimated with current climate.Climate change is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions (robust evidence, high agreement). This will intensify competition for water among agriculture, ecosystems, settlements, industry, and energy production, affecting regional water, energy, and food security (limited evidence, medium to high agreement). In contrast, water resources are projected to increase at high latitudes. Proportional changes are typically one to three times greater for runoff than for precipitation. The effects on water resources and irrigation requirements of changes in vegetation due to increasing GHG concentrations and climate change remain uncertain. Impacts from recent climate-related extremes such as heat waves, droughts, floods, cyclones and wildfires reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability. Impacts of such climate-related extremes include alteration of ecosystems, disruption of food production and water supply, damage to infrastructure and settlements, morbidity and mortality and consequences for mental health and human well-being. For countries at all levels of development, these impacts are consistent with a significant lack of preparedness for current climate variability in some sectors."

1.4 The Department while further elaborating about regional impact as mentioned in fifth IPCC report with specific reference to tropical Asia have submitted as under:-

"Agriculture: For India, the prediction is that the stress on staple wheat crop would increase negatively affecting the overall food security of the continent. Post 2030, the overall food production will decrease but certain regions could also see a small rise in food production.

Soils: The regional impact of Climate Change will have adverse effect on soil processes and properties important for restoring soil fertility and productivity. Increase in temperature will reduce the soil carbon storage due to increased decomposition of soil organic matter by carbon dioxide emission and ultimately leading to low water holding and nutrient supplying capacity.

Water resources: Runoff and groundwater recharge are both likely to decline dramatically in these areas. Where rainfall volume increases and becomes more intense (Indian monsoon, humid tropics), a greater proportion of runoff will

occur as flood flow that should be captured in dams or groundwater for recycling. Climate projections developed for India for the 2050s indicate an increase in the average temperature by 2-4°C during that period, an overall decrease in rainy days by more than 15 days in Western and Central India and an increase by 5-10 days near foothills of Himalayas and North -East India..."

Climate Change Models

1.5 Modeling studies indicate that changing climate will decrease yields in major crops like wheat, rice maize, on the other hand the impacts could be neutral to positive in others like groundnut, soybean and chickpea. When asked about the ways modeling studies on climate change predicted changes in average global temperature and its consequences on global climate and weather pattern, the Department have stated as under:-

"..Modelling studies indicated warming of atmosphere and ocean, accelerated melting of snow and ice and rise in sea level. Each of the last three decades has successively been warmer at the surface than the preceding decade since 1850. The period from 1983 to 2012 was likely to be the warmest 30-year period of the last 1400 years in the Northern Hemisphere. The globally averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85 [0.65 to 1.06] °C over the period 1880 to 2012.

At regional scale, the mean surface temperatures have increased by 0.3-0.8°C over past 100 years but there is no definite trend for precipitation in the region, However, South West monsoon in India has shown definite changes in the period during 1961-1990 in comparison with either 1901-1930 or 1931-1960, although no consistent long-term trend is detectable. No identifiable changes in the number(frequency)or intensity of tropical cyclones or depressions have been observed in the northern Indian Ocean cyclone region (Bay of Bengal and Arabian Sea) over the past 100 years. An increase is predicted in annual mean maximum and minimum surface air temperatures of 0.7°C and 1.0°C over the land regions in the decade of the 2040s with respect to the 1980s. This warming would be less pronounced during the monsoon season than in the winter months. A significant decrease in the winter diurnal temperature range is also projected. Moreover, projected warming of the land region of the Indian subcontinent is likely to be relatively lower in magnitude than that of the adjoining ocean resulting in a decline in the land-sea thermal contrast which is the primary factor responsible for the onset of summer monsoon circulation**..."**

1.6 On the query of the Committee regarding study done by the ICAR or Indian Meteorological Department or any other Indian agencies on impact of global warming on Climate and weather pattern in India, the Department have stated as under:-

"..ICAR is not conducting research on the impact of global warming on climate change and weather pattern, but its research focus is on the impact of climate change in the agriculture including animal husbandry, fisheries and poultry.

Other institutes such as IMD and CSIR are conducting basic climate change research.."

1.7 The Department have further stated that Ministry of Earth Sciences carry out scientific studies on climate change and variability under Global and Regional Climate Change (GRCC) programme. Under GRCC programme, the Ministry of Earth Sciences has established a dedicated Centre for Climate Change Research (CCCR) under the Indian Institute of Tropical Meteorology (IITM), Pune. Although, monsoon rainfall varies on different spatial and temporal scales, but some recent studies hint at an increasing frequency and intensity of extreme in rainfall during the past 40-50 years.Moreover, the report of the Inter-Governmental Panel on Climate Change and our country's own assessment using regional climate models indicate that the extreme rainfall events are likely to be more frequent in the later part of the 21st century in the world including India. As regards other extreme weather phenomena, there are many other reasons for their occurrence which cannot always be related to climate change.

1.8 When asked about research being done on climate change in the country, the Ministry of Earth Sciences has stated as under:-

"..Past observations from instruments and proxy data suggest that there are changes in our climate system on different time scales. There are some natural variations and there are some long term trends which can be attributed to human activities. Analysis of past instrumental data suggests the following facts:

1. The all-India southwest monsoon rainfall does not show any long-term trend, but it exhibits significant multi-decadal variability.
2. However, there are significant regional trends in southwest monsoon rainfall. Monsoon rainfall in the meteorological sub divisions of Jharkhand, Chhattisgarh and Kerala has shown significant decreasing trends. However, monsoon rainfall over Gangetic West Bengal, West Uttar Pradesh, Jammu and Kashmir, Konkan and Goa, Madhya Maharashtra, Rayalaseema, Coastal Andhra Pradesh and North Interior Karnataka showed increasing trends.
3. Monsoon rainfall in the month of July has shown decreasing trends over most parts of central India. However, June and August rainfall has shown increasing trend over the central and southwestern parts of the country.
4. Annual mean, maximum and minimum temperatures averaged over the country as a whole showed significant warming trend of 0.60^{o}C, 1.0^{o}C and 0.18^{o}C per hundred years respectively. The rate of warming trend in the annual mean temperatures since 1980s is much sharper, 0.2^{o}C per decade.
5. On the seasonal scale, the highest increasing trend is observed in the post-monsoon and winter seasons. Monsoon season shows the lowest increasing trend.
6. The warming is mostly confined to the northern, central and eastern/north-eastern parts of the country. Peninsular India experienced the least warming.
7. Frequency of very light rain and light to moderate rain events during the monsoon season has decreased over most of the country.

8. However, frequency of very heavy and extreme rainfall events over northern parts of the country has increased significantly.
9. During the period, 1901-2010, heavy rainfall events (rainfall exceeding 15 cm in 24 hours) over northern parts of the country show an increasing trend of about 6% per decade.
10. Significant increasing (decreasing) trends in heat waves (cold waves) are observed during the hot (cold) weather season over most parts of the country.
11. The all-India droughts are observed almost once in five years. More intense droughts are mainly observed over north and northwest India.."

1.9 On the above issue, representative of the Ministry of Earth Sciences has stated as under:-

"Sir, one of the mandates of our Ministry is to study the climate change issues. So, we have data in respect of climate change for last 100 years. We have done a detailed analysis on climate change. We have very clear evidence of change in climate in our country. In respect of rainfall, the Monsoon season is the main season when we get 70 to 90 per cent rainfall annually. But for last few years, the monsoon rain is increasing at some places like Gangetic West Bengal, West Uttar Pradesh, Jammu & Kashmir, Konkan and Goa, central Maharashtra, Rayalaseema, Coastal Andhra Pradesh and north Karnataka. These are the places where increasing trend of rainfall has been observed. At some places like Jharkhand, Chhattisgarh, Kerala a decreasing trend of rainfall has been observed during last 50 to 60 years. But on all India average, there is not much change. Monsoon is a very stable and robust system. Every year we get a good amount of rainfall. Year to year there are some variations. But there is no long term trend. If we see it sub-division wise, as I told earlier, there has been observed some changes. In some areas there has been an increasing trend in rainfall whereas in some other regions there are decreasing trends of rainfall. The second thing that has been analysed is that there has been decrease in rainfall in the month of July. But there has been increase in rains in June as well as August. So, there is a temporary change in rainfall. The agriculture people should note down these changes so that agricultural practices could be changed accordingly. In respect of rainfall, I would mention one thing that characteristic of rainfall is changing. There is a decrease in light and moderate rainfall. Frequency of heavy rainfall is increasing. These are the observed facts, which we have found out while doing research on 100 years' of data.

If you ask as to what will happen in future, in next 20 or 30 years, I would say that we have done some experiments. We have certain climate models which we have developed in our institute at Pune. Using that model we try to predict what will happen into the future climate. After 30 or 40 years, two things are very certain to happen. Heating frequency will increase more than what we are experiencing now. Then, frequency of heavy rainfall and associated flood will increase. But number of rainy days will decrease. Of all 122 days, we will not get rain on all days. Only on few days we will get rain. The days when we get 2.5 ml of rain are called rainy days. So, the rainy days will decrease. There would be

only 30 to 40 days in a season. There will be small increase in the Monsoon rainfall. So, these are the future expectations from the model.

1.10 Further elabotrating on the above issue, the representative has further stated as under:-

"In respect of temperature, there has been a lot of change. The whole India is warming. There has been increase in warming in all parts of the country. The data in respect of warming shows that there has been an increase of 0.6 degree for last 100 years. At some places it has increased more than two degree and at some other places the increase in warming is less than one degree. But all India average is 0.6 degree. Trend of increase in global warming is similar to that of our country. So, it is of the same magnitude. Warming is more in northern, central, eastern and north-eastern parts of the country than south Peninsula India. Increase in heat wave has been observed in the whole country, especially in the northern parts like Rajasthan, Punjab, Delhi, Madhya Pradesh and in some parts of Uttar Pradesh and Andhra Pradesh. This year also we have experienced a lot of heat waves.

1.11 When asked about kind of changes in climatic/weather pattern observed in India in recent years, the Department of Agricultural Research and Education have furnished following details:-

"...Summary of the observed long term changes in climatic/weather patternobserved by IITM, Pune and ICAR (AICRPAM)so far include:

a) Mean annual surface air temperatures show a significant warming of about 0.7^0 C/100 years during the last century.
b) Heavy rain events (>10 cm/day) over central India are increasing while weak and moderate events (1-5cm/day) are decreasing at about the same rate over the past 50 years.
c) No significant long-term trends are reported in the frequencies of large-scale droughts or floods in the summer monsoon season.
d) The average seasonal rainfall over India has shown decline in the last five decades especially after 1970. However, the trend was statistically non-significant. Furtherover core monsoon zone, the contribution from increasing heavy rain events is offset by decreasing moderate events and hence in the long term, the change is not appreciable. However, the south-west monsoon rainfall over the country has decreased by nearly 4.7% during the period 1965-2006 as compared to the earlier period (1931-1964).
e) The total frequency of cyclonic storms that form over the Bay of Bengal has remained almost constant.
f) Analysis of past tide gauge records for the Indian coastline regions gives an estimate of sea level rise of 1.30 mm/year.
g) Studies on hailstorm frequency indicated that more than 61 per cent of the districts have experienced at least one hail event in the 38-year period. Highest frequency is noticed over districts in the northern Vidarbha region of Maharashtra adjoining to Madhya Pradesh.

h) The highest frequency of hailstorms exceeding 30 events was noticed in only three districts of India-Nagpur district of Maharashtra (40), Shimla district of Himachal Pradesh (35) and the Kamrup district of Assam (32). The frequency ranged between 25-30 in Akola and Amravati district of Maharashtra. The severity of the damage they cause to the agriculture sector depends on the timing of the episodes and size of hailstones..."

1.12 When asked to furnish details of districts affected by drought and floods in India during the last five years, the Department have stated as under:-

"The nodal agency at central level to notify / compile details of drought affected districts in India is Drought Cell under the Ministry of Agriculture. Based on information received from Drought Cell under the Ministry of Agriculture, the statement indicating drought affected districts during last 5 years is given at Annexure-I.Further, information related to flood affected districts is not compiled in CWC at present. However the information available from NRSC (Bhuvan) is enclosed at Annexure–II.

Flood affected areas and damages in India (1953 to 2004)

Sl No.	Item	Unit	Average During (1953- 2004)	Years	Maximum Damage (Year)
1	Area Affected	Million Hectare	7.63	1978	17.50
2	Population affected	Million	32.92	1978	70.45
3	Human Lives Lost	No.	1597	1977	11316
4	Cattle Lost	In thousands	94	1979	618
5	Cropped Area Affected	Million Hectare	3.56	1988	10.15
6	Value of Damage Crops	₹ Crore	708.57	2000	4246.6
7	Houses Damaged	Th. No.	1235.61	1978	3508
8	Value of Damage Houses	₹ Crore	251.05	1995	1307.9
9	Value of Damage Public Utilities	₹ Crore	813.69	2001	5604
10	Value of total Damage to Houses, Crops and Public Utilities	₹ Crore	1817.07	2000	8864

Source: Central Water Commission (FMP Directorate)

1.13 When asked about efforts being made by the Government to improvise system of flood warning in the country, the representative of Ministry of Earth Sciences have submitted as under:-

"..Sir, we are also developing more flood-warning systems so that we can help the Central Water Commission to issue the relevant warnings with regard to how the flood will move, etc. Accordingly, we can give information to the Central Water Commission so that they can warn and help people. We are helping them in doing this.Last year we had a severe drought. It has been noticed that drought happens in every five years. Though we are not able to predict as to when next drought will occur, it has been noted that it happens once in five years. So, these

changes have been observed in climate change in our country. Temperature is increasing in most of the parts. With an increase in temperature, heat waves are also increasing. There is a change in pattern of rainfall, as I have already mentioned.."

Greenhouse Gas Emmission from Agriculture and Allied Sector

1.14 Paddy fields and Rumen fermentation are major sources of Green House Gases (GHGs) in farm sector. On the query of the Committee about study made by the ICAR to assess the quantum of greenhouse gases emission from paddy fields and rumen fermentation in India, the Department have stated as under:-

"..ICAR has conducted studies to assess the quantum of GHGs emission from paddy fields and rumen fermentation. The inventories have also been submitted to Ministry of Environment Forest and Climate Change, Govt. of India for preparation of National Communications of the country for submissions to the United Nations Framework Convention on Climate Change (UNFCCC). Studies showed average methane emission of 40-70 kg/ha from rainfed rice field and 100-180 kg/ha from irrigated rice fields. The nitrous oxide (N_2O) emission having high Global Warming Potential (GWP) ranged 0.6-0.9 kg/ha under lowland irrigated conditions. In contrast, rice fields were found beneficial for CO_2 sequestration. The average quantum of CO_2 absorption in rice field ranged from 0.59-0.91 tonnes carbon per season per hectare. In total, 3.5-4.7 Tegagram (Tg) methane and 0.05 Tg N_2O emission per year from rice fields was estimated from India. It is important to note, the methane emission from rice fields in India is negligible in comparison to other rice growing countries like America, China, eastern and far-eastern Asian countries where it ranged from 20-100 Tg per year.

Livestock constitutes an integral component of Indian agriculture sector and also a major source of GHGs emissions. The studies pertaining to quantification of methane emissions through rumen fermentation are being conducted at CIRG Makhdoom, CSWRI Avikanagar and DPR Hyderabad. The quantitative data being generated on GHG's under different management practices and environments would help in a great way to work out the strategies to reduce the emission and to enhance the input use efficiency and productivity. However, studies conducted by Chhabra *et al.* (2012) estimated total methane emission including enteric fermentation and manure management of livestock is 11.75 Tg/year out of which almost 91% is due to enteric fermentation. Dairy buffalo and indigenous dairy cattle together contribute 60 % of the methane emissions. The total nitrous oxide emission from Indian livestock for the year 2003 is estimated at 1.42 Gg/year with 86.1% contribution from poultry.. "

1.15 When asked about ways by which GHGs emission can be reduced/minimized from paddy fields and rumen fermentation, the Department have stated as under:-

"..The emissions of GHGs from paddy fields can be reduced by modifying water, nutrient and tillage management. Climate resilient technologies to reduce GHG

emission from rice fields include direct-seeded rice, intermittent irrigation, modified SRI, use of nitrification inhibitors and sulphate containing fertilizer, demand-driven nitrogen application, Leaf Colour Chart (LCC) based application of fertilizer and growing of short duration rice cultivars etc. For example, studies showed that under conventional method of transplanting, substitution of prilled urea with sulphur coated urea reduced the methane emission by 9.9% and N_2O emission by 11.8%, while substitution with neem coated urea reduced methane emission by 19.2% and N_2O emission by 23.7%. Similarly, in comparison to conventional puddled rice, adoption of direct seeded rice (dry) practices could reduce methane emission by 27.9% and N_2O emission by 1.3%, while adoption of direct seeded rice (wet) could reduce methane emission by 26.6% and N_2O emission by 4.6%. Further, adoption of Aerobic Direct Seeding Rice (ADSR) reduced the flux of CH_4 to 0.07 to 1.8 mg m^{-2} h^{-1} in comparison to 0.77 to 4.8 mg m^{-2} h^{-1} in Continuous Flooded Transplanting Rice (CFTR). Besides, conversion of rice straw into biochar and its application in rice fields could also significantly decreased the GHG emission.

Based on the studies conducted on reductions of emissions in ruminants, it has been found that the reduction in the emissions can be made by adopting the i) high productive breeds, ii) minimizing the use of agro-industrial by-products, iii) use of high density feed, iv) use of certain natural methane inhibitors containing feeds, v) adoption of good management practices in livestock, vi) proper manure management, etc. Still studies are in progress to generate more options for mitigating methane emission from ruminants.

The cluster analysis of greenhouse gas emissions in relation to farm income showed that majority of farms had high emission but low income while some farms had high income and low emissions. Efforts are being made to identify and promote technologies and farm practices that result in high income and low emissions..'

1.16 When asked about development of any varieties of rice which can minimize emission of GHGs, the Department have stated as under:-

"..Studies showed that methane flux significantly varies with different rice cultivars. In one study conducted at ICAR-IARI, seasonal emission was maximum for Pusa 933 and minimum for Pusa 169 with intermediate values decreasing in the order of Pusa 1019, Pusa Basmati, Pusa 834 and Pusa 677. Pusa Basmati 1509. In general, a short duration rice variety has the potential to reduce GHG emission. Similarly, ICAR-NRRI Cuttack grouped rice varieties into low (CR-674-1, Ratna, Annada), medium (IR-36, IR-50, Annapurna, Swarnaprabha) and high (Rasi, R-745-1, Sarasa) methane emitters. Among the rice varieties released by NRRI, the methane emission was highest in Varshadhan (4.19 µg $m^{-2}h^{-1}$) and was the lowest in Annada (0.46 µg $m^{-2}h^{-1}$). Among the lowland cultivars methane emission was greater in Varshadhan followed by Durga, Gayatri, Ranidhan, CR 1014, Pooja, Swarna, Swarnaprabha, Lalat, and Naveen, whereas among upland cultivars methane emission was

greater in CR Dhan 201 followed by CR Dhan 204, Sahabhagidhan, Kalinga 1, CR-143-2-2 and Annada.."

Burning of Crop Residue

1.17 Burning of crop residue in agricultural field has emerged as one of the important challenge in recent times which is adding to already heavy level of pollutants in the environment. These practices are also banned in several States. When asked about assessment made by the ICAR on burning of crop residue in fields, the Department have stated as under:-

"..ICAR has made assessment of crop residue which is burnt in the fields. Crop residues generated in India are around 679 million tonne (Mt) out of which 226 Mt residues are available in surplus. The nutrient potential (N, P_2O_5, K_2O) of these crop residues is about 5.6 Mt. But, instead of using it as potential source of plant nutrients, a large portion of the residues (approximately 130-140 Mt) is burnt annually in field. Rice straw contributed 40% of the total residue burnt followed by wheat straw (22%) and sugarcane trash (20%). Burning of crop residues emitted 8.57 Mt of CO, 141.15 Mt of CO_2, 0.037 Mt of SO_x, 0.23 Mt of NO_x, 0.12 Mt of NH_3.."

1.18 When asked about technique/method developed by the ICAR whereby crop residue can be converted into useful farm manure in shortest possible time, the Department have stated as under:-

"..ICAR-Indian Institute of Soil Science has developed a technique called "Rapo-compost Technology" for faster decomposition of biodegradable waste. This technology converts biodegradable waste to quality compost in 30-45 days with the help of bio-inoculum consortia (bacteria, fungi and actinomycetes) having ligno-cellulolytic potential. In-situ decomposition technique is also doing in farmers field.."

1.19 When asked to explain alternative uses of crop residue, the Department have stated as under:-

"..Crop residues are used as cattle feed, for making cupboard in small scale industries. However, the residues can be used in conservation agriculture (as mulching, retention, incorporation, no tillage). In-situ decomposition of crop residues is the best alternative. This eco-friendly practice will enhance crop productivity and also improve soil physical, chemical and biological health. In addition, technologies are also available to use the crop residues effectively for the production of mushroom and lingo-cellulose ethanol.."

Influence on Agriculture due to Ingress of Sea Water

1.20 Rise in sea surface due to effect of global warming is expected to cause depletion of significant portion of land in areas near sea in many parts of the country.When asked about assessment made by the Government on quantum of

agriculture land which may be submerged under sea water due to rising sea surface due to impact of global warming in future, the Department have stated as under:-

> "..Though comprehensive study on assessment of agricultural land which may be however, submerged due to sea level rise in the Coastal region has not been carried out, study of long term tide gauge data under ICAR funded NICRA project indicated that the sea levels at three stations Diamond Harbour, Garden Reach and Haldia in Sundarbans are increasing at the rate of 4.85, 8.22 and 3.0 mm/yr. A 2007 report by UNESCO "Case Studies on Climate Change and World Heritage" has predicted 45 cm rise in sea level likely by the end of the 21st century due to anthropogenic activities in the Sundarbans. In Indian Sundarbans, out of total 3500 km of embankment, 800 km is vulnerable to breach during high intensity weather events leading to sea water intrusion. Already, Lohachara Island and New Moore Island/South Talpatti Island have disappeared under the sea, and Ghoramara Island in the Sundarbans is half submerged. A work carried out by IIT, Kharagpur (Current Science, vol. 104, no. 5, 10 March 2013) revealed that during the 20th century 34.906 sq. km of area along the Indian coast went under the sea due to the rise in sea level.."

1.21 On the query of the Committee regarding impact on agriculture productivity in coastal areas due to submergence of land or ingress of sea water in river, the Department have stated as under:-

> **"..**In the coastal region, many of the agricultural lands are flat in topography and lie below the sea or river bed levels resulting in perennial drainage problem in this region. The high salinity in the soil as well as acute shortage of fresh water for agricultural uses pose serious problem leading to low productivity. Ingress of sea water into agricultural fields would lead to devastating consequences. For example, thousands of hectares of fertile agricultural land and adjoining mangrove forests were turned in to a vast wasteland due to ingress of saline sea water during cyclone Aila in West Bengal (2009), super cyclone in Orissa (1999), and Tsunami in eastern coast (2014). Due to ingression of sea water during 2009-11, the total food production in North and South 24 Pargana districts of West Bengal reduced by 11% amounting to 363 thousand tonnes of total food grain.."

1.22 When asked to furnish solution envisaged for safeguarding agriculture near coastal areas due to submergence of land or ingress of sea water in river, the Department have stated as under:-

> "..ICAR institutes especially Central Coastal Agriculture Research Institute (CCARI) Goa and Central Soil Salinity Research Institute (CSSRI), Regional Research Station, Canning Town West Bengal have developed several technologies for enhancement of agricultural productivity (agriculture + fisheries) under degraded (saline) coastal soils and poor water qualities (saline) conditions. Some of the technologies recommended for safeguarding agriculture in the coastal areas from submergence or ingress of sea water:

- Protective embankments with one way sluice gate to prevent sea water entry and at the same time allow the inland excess water to drain to the sea. The embankments should be protected against the erosive action of sea waves by planting suitable shelter trees or grasses.
- The surface drainage system of the area may be developed/ renovated to drain out the standing saline water through sluice gate.
- Placing pumping stations in vulnerable areas to pump out standing saline water from the low-lying area/ ditches when the natural drains fails to drain out the water.
- Growing salt tolerant and water logging resistant crop varieties.
- Wherever possible paddy-cum-fish culture may be adopted. For paddy-cum-fish culture the rice field should be linked with contiguous pond/ ditch/ channels.
- If the river embankment fails to prevent entry of tidal water into the fields, brackish water fish cultivation in the area can be done on community basis or individually by protecting the land area with nylon net or suitable bamboo structure.
- Salt tolerant grass such as Para grass, Coix (Job's tears) etc. may be grown on unutilized land like opposite of river side which may be used as fodder for cattle.
- Providing alternative livelihood options through promotion of duckery, piggery, mushroom cultivation, nursery raising for trees and fish seed.
- As part of the disaster management strategy construction of rural godown for seed storage is utmost important. Strategies might be, to produce seeds of salt resistant and high yielding rice varieties through community participation or promotion of seed village concept by active engagement of government machinery.

  Adoption of land shaping techniques developed by ICAR-CSSRI, RRS, Canning Town, West Bengal such as farm pond, deep furrow and high ridge, shallow furrow and medium ridge and paddy-cum-fish cultivation to alleviate the issues of water logging and increased salinity of soil in coastal areas which are predicted to be further aggravated due to sea level rise following climate change/ global warming.."

1.23 When asked about approach of ICAR for research for development of varieties of crops which can be grown in saline water, the Department have stated as under:-

"ICAR is taking an active role in development of crop varieties that are tolerant to high soil salinity. Crop improvement programmes involving various stakeholders are being taken up to identify salt tolerant varieties. The following activities are being taken up at ICAR-CSSRI, RRS, Canning Town.

- Augmentation and maintenance of salt tolerant germplasms of rice for resistance breeding.
- Evaluation of rice varieties/germplasm under ICAR-IRRI collaborative project -Stress tolerant rice for Africa and South Asia (STRASA).
- Evaluation of rice varieties/germplasm under Coastal Saline Tolerant Variety Trial (CSTVT) and Salinity Tolerant Breeding Network (STBN).
- Evaluation of jute varieties/germplasm under saline conditions

  Evaluation of barley lines for coastal salinity under ICAR-All India Coordinated Wheat and Barley Improvement Project."

Pest Severity and Disease Proliferation

1.24 Climate changes associated with global warming are expected to affect types of pest and intensity of pest attack on crops. It is also expected to affect disease proliferation among crops. When asked about changes in types and intensity of pest attack expected to affect crops in the country due to changes associated with global warming, the Department have stated as under:-

> **"**Variation in temperature, precipitation, humidity, wind speed and CO_2 level besides frequent extreme weather events are major factors that influence the incidence of pests and diseases in a crop. Eelevated CO_2 and temperature due to climate change and global warming is likely to increase the incidence of insect pests and proliferation of diseases on field crops. Due to global warming nutritional quality of the crop plants is expected to decline, and thus the insect pests are expected to go for higher compensatory feeding to meet the nutritional requirement. This may lead to higher yield losses in different crops which in turn may affect the food security. Further, more number of generations of insect pests are expected to occur during future climate change periods because of increased temperatures."

1.25 On the above issue, the Indian Agricultural research Institute-Pusa has submitted as under:-

- "..There may be alteration of agricultural insects and diseases because of more pathogen and vector development, rapid pathogen transmission and increased host susceptibility.
- There will be extension of geographical range, changes in population growth rates relative abundance and effectiveness of pest.
- It is projected that there will be changes in pathogen/insect-pest x host x environment interactions, and loss of resistance in cultivars containing temperature-sensitive genes.
- Emergence of new pest problems may take place with increased risk of invasion by migrant pest.."

1.26 When asked about study to assess impact on agriculture production in country due to changes in types and intensity of pest attacks and disease proliferation in crops due to climate changes in future, the Department have stated as under:-

> "..Under NICRA, ICAR has initiated studies to quantify the Real Time Pest Dynamics (RTPD) in 5 crops (Rice, Pigeon pea, Groundnut, Tomato and Mango). The major objective is to study crop-insect pests/pathogen relationships under changing climate at the field level besides develop pest forecast systems. Presently 25 centres from 11 States representing 12 agro ecological regions of the country are studying on real time pest dynamics (RTPD). Further, several studies on quantification of impacts of eCO_2 and temperature on insect pests and diseases are in pipeline and prediction of pest scenarios during future climate change periods is being attempted.."

1.27 On being asked about plan of the Government to offset impact of pest attack and disease proliferation on Indian agriculture, the Department have stated as under:-

> "..Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW) is implementing various schemes on plant protection under “Strengthening and Modernization of Pest Management Approach in India” (SMPMA). In addition, ICAR through its National Crop institutes spearheads research to evolve and implement climate resilient plant protection technologies. State Department of Agriculture across States are implementing IPM at various levels ranging from digital (ICT based) monitoring real time pest status across crops and issue of pest management advisories (SMS) on area-basis to farmers and supply of critical inputs under extremes of pest events.."

CHAPTER-II

AGRO-CLIMATIC CLASSIFICATION

2.1 Concept of agro-ecological regionalization helps to address concerns pertaining to agricultural production in the Country. The regionalization in terms of agro-ecological regions and agro-ecological sub-regions (in particular) has helped to delineate geographical conditions suitable for particular genotype so that optimum production potential of the genotype is achieved. On the query of the Committee about number of agro-climatic zones and sub-zones in the country as per classification done by ICAR, the Department have stated as under:-

> "..The delineation of Agro Ecological Regions (AERs)was an important step as it took into accounts climatic conditions, LGP, landform and soils. Twenty AERs were identified (NBSS & LUP, 1992). The Agro Ecological Sub Regions (AESRs) is a further refinement of AERs through addition of parameters to delineate LGP and Bio-climate with details of soil texture, depth and mineralogy. In all, 60 AESRs were identified by ICAR – NBSS –LUP (1999)..."

2.2 When asked to furnish details of crops grown in different agro-climatic zones and sub-zones of India, the Department have submitted following details:-

"..Major rainfed crops grown under different agro-climatic zones

Agro-climatic zone (Domain districts)	**Major rainfed crops**	
	Kharif	***Rabi***
North Bank Plain Zone of Assam (Dhemaji, Lakhimpur, Sonitpur and Darrang)	Rice, maize, blackgram, jute	Toria
Western Plateau Zone of Jharkhand (Palamu, Garhwa, Latehar, Chatra, Lohardaga, Gumla and Simdega)	Rice, maize, pigeonpea, blackgram	Chickpea, wheat
Eastern Plain Zone of Uttar Pradesh (Faizabad, Gonda, Ambedkarnagar, Barabanki, Basti, Sultanpur and Jaunpur	Rice, pigeonpea	Maize, chickpea, mustard
Bastar Plateau Zone of Chhattisgarh (Bastar, Narayanpur, Kondagaon, Bijapur, Sukma and part of Kanker (excluding Charama, Narharpur & Kanker Blocks)	Rice, little millet, fingermillet, maize, pigeonpea, niger, greengram, blackgram, horsegram, sesame	Chickpea, mustard
North East Ghat Zone of Odisha (Kandhamal, Ganjam, Gajapati, Boudh part of district and Rayagada)	Rice, maize, fingermillet, greengram, blackgram, pigeonpea	Mustard, greengram, horsegram
Eastern Plain and Vindhyan Zone of Uttar Pradesh (Varanasi, Chandauli, Mirzapur and Sonbhadra)	Rice, maize, pearlmillet, greengram, pigeonpea, sesame	Chickpea, linseed, lentil, mustard
Northern Dry Zone of Karnataka (Vijayapur, Bagalkote, Davangere, Gadag, Koppal, Bellary, parts of Raichur (Lingsuguru and Sindhanuru taluks), Belagavi (Athani, Gokak, Raibag, Ramadurg, Savadatti taluks) and Dharwad (Navalagund taluk)	Greengram, pearlmillet, pigeonpea, sunflower	Sorghum, chickpea
Scarcity Zone of Maharashtra	Pearlmillet, pigeonpea,	Chickpea, sunflower

(Solapur, Ahmednager, eastern part of Satara, Sangli, Kolhapur, Pune, Osmanabad, Beed, Aurangagbad, Dhule, Jalgoan and Nandurbar)	sunflower, sorghum	
Southern Zone of Rajasthan (Bhilwara, Chittaurgarh, Rajsamand, Sirohi, Dungarpur, parts of Udaipur, Banswara and Ajmer)	Maize, sorghum, soybean, groundnut, blackgram, greengram, clusterbean, sesame	Chickpea, mustard, taramira
Kandi region of Punjab (Roopnagar, Hoshiarpur, Nawan Shehar and Gurdaspur)	Maize, blackgram, greengram, sesame	Wheat, raya, taramira, lentil, chickpea
Low Altitude Subtropical Zone of Jammu and Kashmir (Parts of Jammu, Kathua and Udhampur)	Maize, pearlmillet, greengram, blackgram, sesame	Wheat, mustard/ gobhi sarson, chickpea, barley, lentil
South-West Semi-Arid Zone of Uttar Pradesh (Agra, Mathura, Mainpuri, Aligarh, Hathras and Etah)	Pearlmillet, sesame, clusterbean, greengram, backgram, pigeonpea	Mustard, chickpea, Barley, lentil, wheat
South-Western Dry Zone of Haryana (Sirsa, Fatehabad, Hisar, Bhiwani, Mahendergarh, Rewari, Jhajjar and Gurgaon)	Pearlmillet, clusterbean, greengram	Mustard, chickpea
Northern Gujarat Zone of Gujarat (Sabarkantha, Gandhinagar, Ahmedabad, Banaskantha, Mehsana and part of Patan)	Pearlmillet, castor, clusterbean, greengram, cowpea	-
Eastern and Southern Dry Zone of Karnataka (Mysore, Chitradurga, Tumkur, Kolar, Ramanagara, Bengaluru (Rural and Urban) and Mandya)	Fingermillet, maize, pigeonpea, horsegram, cowpea, groundnut, sunflower, sesame, castor	Sorghum, maize, sunflower
North Saurashtra Zone of Gujarat (Jamnagar and major part of Amreli, Bhavnagar, Rajkot and Surendranagar)	Groundnut, cotton, castor, Sesame, pearlmillet, greengram, blackgram	-
Scarce Rainfall Zone (Rayalasema) of Andhra Pradesh (Anantapuram and Kurnool)	Groundnut, castor, pigeonpea, sunflower	Groundnut, chickpea, sunflower
Malwa Plateau of Madhya Pradesh (Mandsaur, Ratlam, Ujjain, Rajgarh, Shajapur, Indore, Dewas, part of Dhar (Badnawar and Sardarpur tehsils), Jhabua (Petalawad Tehsil) and Sehore (Aasta tehsil)	Soybean, maize, sorghum	Chickpea, wheat, mustard
Keymore Plateau and Satpura Hill Zone of Madhya Pradesh (Satna, Sidhi, Rewa, Panna, north-eastern parts of Katni, Jabalpur and Seoni)	Rice, soybean, pigeonpea, Blackgram, sesame	Wheat, chickpea, Lentil
Western Vidarbha Zone in Maharashtra (Akola, Washim, Buldana, Yavatmal, Amravati, Wardha and part of Nagpur)	Cotton, soybean, pigeonpea, greengram	Sorghum, chickpea
Southern Zone of Tamil Nadu (Thoothukudi, Tirunelveli, Madhurai and Virudhnagar)	-	Cotton, maize, sorghum, blackgram, Greengram, pearlmillet
Central Maharashtra Zone of Maharashtra (Parbhani, Hingoli, Nanded, Beed, Latur, Osmanabad, Aurangabad and Jalna)	Soybean, cotton, sorghum, pigeonpea, blackgram	Greengram, chickpea, sorghum

2.3 On the query of the Committee regarding use of agro-climatic classifications for cultivation of crops in India, the Department have stated as under:-

"..Agro-climatic classifications are not strictly followed by the farmers in cultivation of crops. However, the crops are grown in different AERs mainly depend on favourable climate and soil factors, farmers' preferences, consumption patterns and resources available with the farmers. Besides these factors, socio economic conditions, market prices, government supports in the form of MSPs and subsidies also decide the kind of crop grown in different locations.."

2.4 When asked about steps being taken by the Government of India to promote agriculture based on agro-climatic classification, the Department have stated as under:-

"..The government is giving advisory to states to educate farmers for growing crops that are suitable to a given agro-climatic situation so that risk is minimized and incomes are maximized.."

2.5 On issue of impact of climate change on cultivation of crops as per agro-ecological region, the representative of JAU, Gwalior has stated as under:-

'मध्य प्रदेश में एग्रो क्लाइमेटिक के दो जोन हैं, लेकिन हमने पूरे राज्य को 11 एग्रो क्लाइमेटिक जोन में बांटा हुआ है और हिसाब से हर जोन के लिए अलग-अलग टेक्नोलॉजी विकसित कर रहे हैं। हमने पिछले तीस साल के मौसम को एनलाइज किया है और हमने लोकल वेरीएशन को क्वांटीफाई करने की कोशिश की है। हमारे यहां मालवा पठार है जहां लगभग 0.04 डिग्री प्रतिवर्ष तापमान बढ़ रहा है, लेकिन यहां मिनिमम टेम्परेचर घट रहा है। इस तरह से हमारे यहां कहीं-कहीं मिनिमम टेम्परेचर बढ़ रहा है, कहीं घट रहा है और कहीं समान है। हमने पिछले दस साल का डेटा एनलाइज किया है, जिससे यह पता चलता है कि इसमें तीव्रता आयी है। टेम्परेचर अब बढ़ रहा है। हम पिछले तीस साल के टेम्परेचर के हिसाब से स्ट्रेटजी बना रहे हैं कि किस जोन में कितना टेम्परेचर अगले दस-बीस साल में बढ़ेगा क्योंकि लोकल वेरीएशन बहुत ज्यादा हैं। इसी तरह से हमने वर्षा का देखा है। मध्य प्रदेश के अधिकतर जिलों में यह देखा गया है कि वर्षा बढ़ रही है। रेनी डेज का जो एक क्राइटीरिया होता है, कहा जाता है कि आगे वर्षा ज्यादा होगी, लेकिन कम दिनों में होगी। मतलब इंटेन्सिटी बढ़ जायेगी तो रन ऑफ ज्यादा होगा, फ्लड्स ज्यादा होंगी, ड्राई स्पैल्स होंगे। लेकिन कुछ हिस्सों में हमने देखा कि यहां पर नम्बर ऑफ रेनी डेज भी बढ़ रहे हैं, जो कि जनरल ऑब्जर्वेशन से फर्क है। तीसरा हमने यह आब्जर्व किया है कि जिसे मैक्सिमम पीक रेन फाल कहते हैं, वह अगस्त में होती थी, अब वह धीरे-धीरे जुलाई में शिफ्ट हो रही है तो अब जो हमारी सोइंग ऑफ क्राप्स है, हम अपनी जो प्रजाति विकसित कर रहे हैं, अब हमें उस हिसाब से करनी पड़ेगी और अब हमें उसकी बुवाई जल्दी करनी पड़ेगी। ये चीज हमने क्वांटिफाई की है, हर एक जोन का अलग-अलग है और इसके हिसाब से हम लोग अब अपनी टैक्नोलोजी विकसित कर रहे हैं।'

CHAPTER-III

IMPACT OF CLIMATE CHANGE ON AGRICULTURE

3.1 Climate change and global warming are issues that impact all sectors of human life. Agriculture is particularly vulnerable to climate change. Climate change and its variability are emerging as major challenges facing Indian agriculture. The high inter and intra-seasonal variability in rainfall distribution, extreme temperature and rainfall events are causing crop damages and huge losses to farmers. The fifth IPCC report clearly brought out the global and regional impacts of climate change on agriculture, water resources, natural eco-systems and food security. Among the several highly populated regions of the world, South Asia is categorized as one of the most vulnerable. Countries like India are more vulnerable due to huge population dependent on agriculture, excessive pressure on natural resources and poor coping mechanisms.

3.2 Key impacts of climate changes include changes in productivity, in terms of quantity and quality of crops; changing trends in agricultural practices like changes in water use and inputs such as fertilizers, insecticides and herbicides; environmental effects, particularly in relation to the frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion and reduction of crop diversity. The main direct impact of climate change include effect on crop duration, reproduction, pollination and fertilization processes. The indirect effects operate through changes in water availability and water demand due to inadequate or excess rainfall and warming effects on pest and disease proliferation.

3.3 Modeling studies indicate that changing climate will decrease yields in major crops like wheat, rice maize, on the other hand the impacts could be neutral to positive in others like groundnut, soybean and chickpea. The important impacts on Indian agriculture are described below:

- Increase in CO_2 to 550 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%.
- A 1°C increase in temperature may reduce yields of wheat, soybean, mustard, groundnut and potato by 3-7%.
- Productivity of most crops likely to decrease marginally by 2020 but by 10-40% by 2100.
- Significant impacts on food quality- basmati rice, wheat, etc.
- Possibly some improvements in yields of chickpea, rabi maize, sorghum and millets; and coconut in west coast.
- Less loss in potato, mustard and vegetables in North-Western India due to reduced frost damage.
- Climate change may increase production of potato in Punjab, Haryana and western and central UP by 3.46 to 7.11% during 2030s, but in rest of India,

particularly West Bengal and southern plateau region, potato production may decline by 4 - 16%.

3.4 When asked about kind of shifts in agricultural activities has been observed in the country due to change in climatic pattern or weather fluctuation, the Department have stated as under:-

"...The important crops in which there was a decline in cultivated area between 2004-05 and 2014-15 were sorghum (3.5 mha), pearlmillet (1.3 mha) and groundnut (1.2 mha). On the other hand, sown area increased in soybean, wheat and cotton (more than 4 mha). The other crops which gained area during the period were chickpea (2.3 mha), maize (1.9 mha) and rice (1.7 mha). Examination of area dynamics hint that besides climate change, government policies, technology development, irrigation potential created and market demand are the key drivers for shift in agricultural activity. Nutrient use through fertilisers has increased substantially during the last decade. Consumption of fertilizer nutrients viz., nitrogen, phosphorous and potassium together increased from 17 to 25 mtons. There was about 10 mha rise in net irrigated area (between 2002-03 and 2012-13). Net irrigated area as a % net sown area also rose from 40 to 46. The increase in gross irrigated area is about 15 mha..."

3.5 While elaborating on the need of R & D on climate change and preparedness of ICAR, the representative of DARE stated as under:-

'हमारा प्रथम प्रयास जलवायु परिवर्तन को समझने का है और इस परिवर्तन की वजह से फसलों पर क्या असर पड़ रहा है, पशुओं के ऊपर क्या प्रभाव पड़ रहा है, मछली पर क्या प्रभाव पड़ रहा है, इसे समझने का है। अगर इसी तरह से तापमान में परिवर्तन होता रहेगा तो भविष्य में इसका क्या असर पड़ेगा, इसे भी समझने की जरूरत है। हमारे प्रयास से अभी हम जितना उत्पादन कर पा रहे हैं, क्या उतना भविष्य में भी होगा, यह भी हमारे शोध का एक विषय है। हमारे पास विभिन्न फसलों तथा पशुओं के बारे में इस विषय में काफी तथ्य उपलब्ध हैं। दूसरी दिशा यह है कि इसे ध्यान में रखते हुए हमारी टेक्नोलोजी क्या होनी चाहिए, ताकि इसके असर को कम किया जा सके। हम इस असर को पूरी तरह से खत्म तो नहीं कर सकते हैं लेकिन इसके असर को कैसे कम किया जाए, यह जरूर किया जा सकता है ताकि खाद्य सुरक्षा और स्वास्थ्य को हम ठीक रख सकें।'

3.6 When the Committee asked to furnish details about fluctuation in production of Wheat, Rice and other important crops grown in the country during the last ten years, the Department have submitted as under:-

"...There has been a significant fluctuation in production in important crops grown in the country during last 10 years (between 2005-06 and 2014-15). Rice production (89 mt) had a big dip in drought year 2009-10. Wheat, rapeseed & mustard and chickpea production suffered an adverse impact in 2014-15 (89, 6.3 and 7.2 mt, respectively). Production of Pearl millet was affected badly in 2009-10 (6.5 mt) and 2012-13 (7.3 mt). Maize production was robust enough except in year 2009-10 (16.7 mt). Groundnut production experienced lot of fluctuations throughout the period. Soybean production witnessed a declining trend from 2012-13..."

3.7 On the query of the Committee regarding assessment of loss suffered by the farmers due to destruction of agriculture produce caused by abrupt weather pattern such as drought, flood, hailstorm, cyclones etc, the Department have stated as under:-

> "...National Institute of Disaster Management under the Ministry of Home Affairs, Government of India is publishing the "India Disaster Report" every year based on all the disasters happened in India and also tabulating the losses accumulated to Agriculture and allied sectors besides Human causalities and infrastructure. The ICAR-Indian Agricultural Statistical Research Institute (IASRI) also compiled the information on disasters and crop losses (Some major disaster in India since 2011 are appended.

Year-wise damage caused due to floods, cyclonic storms, landslides etc. during last ten years in India

Year	Live Lost Human (in No.)	Cattle Lost (in No.)	Houses Damaged (in No.)	Cropped areas affected (in Lakh hectares)
2001-02	834	21,269	3,46,878	18.72
2002-03	898	3,729	4,62,700	21.00
2003-04	1,992	25,393	6,82,209	31.98
2004-05	1,995	12,389	16,03,300	32.53
2005-06	2,698	1,10,997	21,20,012	35.52
2006-07	2,402	4,55,619	19,34,680	70.87
2007-08	3,764	1,19,218	35,27,041	85.13
2008-09	3,405	53,833	16,46,905	35.56
2009-10	1,677	1,28,452	13,59,726	47.13
2010-11	2,310	48,778	13,38,619	46.25

Source: Ministry of Home Affairs (MHA)

Development of Varieties of Crops with Enhanced Abiotic Stress Tolerance

3.8 When asked about efforts being taken by the Government of India to promote research and development in agriculture universities for development of varieties of crops which can withstand climatic fluctuation, the Department have stated as under:-

> "..Developing abiotic stress tolerant crop varieties is the major breeding objectives of all crop improvement programmes of NARS (ICAR and SAUs). However, the efforts got further momentum with the launch of NICRA especially for climate change driven abiotic stresses viz. drought, heat, high temperature, salinity, water logging. Over past five years, considerable efforts have been made towards development of varieties/hybrids for different abiotic stresses by ICAR institutes and SAUs. Few varieties for submergence and hybrids for high nitrogen efficiency have been released for commercialization.."

3.9 While elaborating about efforts being taken to development of varieties/hybrids for different abiotic stresses, the IARI has submitted as under:-

- "..The field and Horticulture Corp Improvement groups of institute are engaged in research on genetic improvement of field crops viz., wheat, rice, pearl millet, maize [cereals], chickpea, pigeon pea, munghean, lentil [pulses], mustard, soybean [oil seeds] tomato, palak, radish, turnip, bottle gourd, bitter gourd, cucumber and cowpea. Both conventional and modern tools/ techniques are routinely used for breeding genotypes suitable for specific agro-climatic conditions and for tolerance to heat, drought and water logging. The improved genotypes are evaluated in multi-locations over years, and promising entries are identified and released for cultivation. During last 15 years (2001-2015), a total 92- varieties of various mandate field crops and a number of vegetable have been released and notified for different agro-climatic conditions of the country which are in seed chain and performing excellently in their areas of recommendation The details are enclosed in Annexure-III.
- These also include Identification of suitable cauliflower varieties. Hybrids viz., DC-76 and DCH-1076, dc-309 and DCH-1001 for summer production in hills at 4 different elevations in hills, namely Katrain, solan, Bajaura and Almora and promising selection of sarda melon (DHM-159) that can be successfully grown under net house in north Indian plans having yield potential of 5-5.5 q in 100 m2 area of net house.
- Besides this, the Institute screened large number of germplasm and identified Nerica L44 and N22 as noval sources of heat tolerance in rice, which is being used in breeding program. In a effort to generate recombinant inbred line and for mapping population for mapping QTLs governing heat tolerance, different crosses were made with heat tolerant genotypes namely L44 and N22, which are in F4 generation.
- Market assisted backcross breeding was carried out using molecular marker linked to the QTL governing drought tolerance into Pusa Basmati 1 and in Pusa 44 and 41 (under Pusa Basmati 1 background), 36 (under Pusa 44 background). Desirable progenies have been identified in BC3F2 generation and BC3F3 families have been frown at off-season nursery at IARI's regional station at Aduthurai for further selection.
- Standardized physiological trait-based phenotyping protocol for screening for heat and drought tolerance in wheat was also developed. Introgression of QTL's for physiological traits for imparting drought and heat tolerance in the background of popular wheat varieties are in progress.
- Thermo-stable enzymes of key biosynthetic pathways from wheat, which can maintain the metabolic processes of the plants even under high temperature were identified. Also identified and validate heat-responsive microsatellite markers, which can be utilized for screening large germplasm of wheat for the development of climate smart corp.

- Maize genotypes tolerant to low and high temperature tolerance were identified and Maize genotypes in each of the tolerant and susceptible group are further being advanced for more detailed analysis.
- Two wild species i.e., L. peruvianumand L. pimpinellifoium crossable to cultivated tomato have been identified for temperature stress tolerance. Among cultivated genotypes (Pusa sadabahar and TH-348) and hybrids (DTH-9 AND DTH 10) were identified for heat stress tolerance.
- The institute also developed Yellow Mosaic Virus (YVMV) free okra varieties viz., DOV 66 and DOV-12 that 100% free from YVMV up to 90 days after sowing and recorded average yield of 18.5 t/ha and 17.8 t/ha, respectively, Hybrid DOH-1 that recorded 19.1 t/ha yield and was associated with just 1% YVMV incidence was also developed.
- The institute has also identified five mango hybrids, H-1-11, H-8-11, H-1-5, H-13-4 and H-11-2 having over 200 g fruit weight, red peel colour and acceptable quality and has initiated rootstock breeding for dwarfness and salinity tolerance.
- In lime, clone ALC-2 having summer fruiting with desired fruit weight was identified and in citrus, rootstock improvement has been initiated to mitigate soil salinity and biotic stresses under changing climatic conditions.
- In grape, 5-extra-early (last week of May) maturing hybrids with higher TSS (20-22 degree Brix) have been identified.
- In papaya, 2 advance gynodioecious lines (P-7-15, P-7-9), having desired fruit weight and field tolerance to papaya ring spot virus have been developed.
- In Kinnow, hatti Khatti rootstock showing meritorious characteristics for its commercial cultivation in semi-arid regions, lemon for cultivation under environmental stress and sour orange in drought prone areas have also been developed.

Pomegranate varieties viz; Ichakdana, Ganesh, Kandhari Hansi, Kandhari Kabuli, Jodhpur Red, P-23, P-26 with capability to perform well under changing climate of Shimla, were also developed.."

3.10 On the above issue, the representative of DARE has stated as under;-

'महोदय, जैसा माननीय सदस्यों ने बताया Early maturing varieties जो किस्में जल्दी पक जाती हैं, हर फसल में ऐसी किस्मों का विकास करने का काम जारी है ताकि जलवायु परिवर्तन का जो प्रभाव है, जैसे गेहूं में अगर कोई किस्म जल्दी पक जाएगी वह इसके असर से बच जाएगी।महोदय, तापमान बढ़ने की बात भी कही गई है। तापमान बढ़ने पर कैसे रोक लगाई जाए, यह अलग विषय है। देसी किस्म को हम ढूंढकर लाएंगे कि किसमें सहनशीलता है। उत्तर प्रदेश में नागिना एक जगह है और वहीं देसी किस्म की धान नागिना-22 है। उसकी ज्यादा तापमान सहन करने की क्षमता है, जो हमें ढूंढने पर मिला है और इसमें पानी भी कम लगता है। उसमें एक जीन हमने ढूंढा है, जिसे अगर दूसरी किस्म के में ब्रीडिंग के तहत डाल दिया जाए तो कोई जीएम टैक्नोलोजी की जरूरत नहीं है, बस अगर ब्रीडिंग के तहत डाल दिया जाए और हमारा उसका प्रयास भी है तो उसकी दूसरी किस्म में भी कम पानी लगेगा। वह ज्यादा तापमान पर भी हमें फसल दे सकता है। इसी तरह से सरसों की किस्म में भी है, जो ब्रासीका केरानाटा किस्म है।'

3.11 On the query of the Committee regarding kinds of support are being provided by the Government of India to encourage use of heat/ water logging tolerating seed varieties among farmers, the Department have stated as under:-

> "..The Government is encouraging use of location specific climate resilient crops varieties including heat/ water logging tolerating seed varieties among farmers by ensuring availability of quality seeds of desirable varieties; developing, demonstrating and disseminating complete package of practices to stakeholders; seed subsidies, capacity building besides bringing convergence among public and private agencies in seed chain. The seeds are also popularised through KisanMela, KisanGosthies and mass media. Further, Innovative farmers can also be trained and given financial support to produce seeds at their own farms. Further, other innovative approaches such as village seed bank by involving self-help groups/farmers are being adopted. Still some more comprehensive programme efforts are required to be initiated by the Government to meet the challenges of supplying quality seeds of heat and water logging tolerating varities.."

Availability of Seed

3.12 Availability of good quality seed at reasonable price is one of important factor for ensuring high productiviy in agriculture and to ensure remunerative prices to the farmers. Climatic changes associated with global warming will necessiate development of seed varieties which can withstand climatic fluctuation. In our country, ICAR through its network of institute has been able to develop good quality seeds for farmers of the country. However, there is need to plan for massive investment and thrust for taking steps for R & D for devlopment of varieties of seeds which will required by the farmers in coming decades. When asked about success achieved by the ICAR in development of short duration, heat resistant, salinity resistant, and draught resisting varieties of seeds which will be able to withstand climatic fluctuations considered to be associated with the climate changes due to global warming, the DARE has stated as under:-

> "..Indian Council of Agricultural Research (ICAR) undertakes comprehensive assessment of crops and traits required in different agro-ecological zones on a regular basis as part of the ongoing programmes of the Crop Institutes and All India Coordinated Research Projects on different crops. The important traits for undertaking research include blast, blight resistance and drought tolerance in rice, rusts resistance and heat tolerance in wheat, stem borer resistance and drought tolerance in maize, wilt and pod borer resistance in pulses, yellow mosaic virus, pod shattering and drought tolerance in oilseeds. National Agricultural Research System comprising ICAR, central agricultural universities and SAUs are taking adequate steps in development of high yielding varieties suitable for biotic and abiotic stresses including deficient rainfall/drought. Short duration varieties have also been released to escape or overcome the vagaries of weather condition. The research efforts for breeding climate resilient varieties was further strengthened at some core ICAR institutes (IARI New Delhi, NRCPB

New Delhi, IIHR Bengaluru, CRIDA Hyderabad, IIVR Varanasi, NRRI Cuttack, IIRR Hyderabad, IIPR Kanpur) under National Innovations in Climate Resilient Agriculture (NICRA). Over the past few years considerable efforts have been made towards development of varieties/hybrids for different abiotic stresses by these institutes. Many more such varieties and hybrids are under different stages of development. The high yielding varieties that can withstand severe change in weather pattern including deficient rainfall/drought and varieties suitable for biotic and abiotic stresses are attached in Annexure IV"

3.13 On the query of the Committee about steps being taken by the ICAR for making available seeds developed by them for commercial exploitation, the DARE has stated as under:-

"Realizing the importance of seed, ICAR mounted serious efforts to streamline country's seed programme by launching AICRP-NSP (Crops) in 1979-80 aimed at production of basic seed with a separate project coordinating unit dedicated exclusively for nucleus and breeder seed production and to carry out seed technological research. This was elevated to Directorate paving the way for establishment of Directorate of Seed Research (DSR) in 2004 envisioning the referred mandate. Another milestone project in quality seed production was 'ICAR Seed Project – Seed Production in Agricultural Crops and Fisheries' launched in 2005 aiming at provision of infrastructural facilities in seed domain under National Agricultural Research System (NARS) throughout the country. Since inception, DSR strived towards achieving excellence, which is clearly manifested in the form of surge in quality seed production and enhancement in the horizons of seed technological research. ICAR seed Project, lead to infrastructure establishment in seed domain under NARS. DSR generated valuable information and contributed significantly to seed technological research.

Launching of AICRP-NSP (Crops) was a phenomenal milestone in Indian seed sector which has led to sea change, as witnessed by increase from a meagre breeder seed production of 3914 quintals during 1981–82 to a level of 89266.23 quintals during 2013-14, which has surpassed the indents received both from DAC as well as state governments. The breeder seed availability has improved the quantity/ quality of seeds in subsequent generations in the seed multiplication chain which has resulted in increasing seed replacement of different crops. Ample scope exists to augment agricultural production in almost all crops in near future simply by capitalizing the benefits of quality seeds. During 2013-14, total production of quality seed including all classes was 648325 quintals against the target of 475179 quintals. Production comprises 94953 quintals of breeder seed, 144369 quintals of foundation seed, 163465 quintals of certified seeds, 172351 quintals of truthfully labelled seed and 73185 quintals of planting material of field crops. In addition, 155.59 lakhs planting material and 5.60 lakh tissue culture plantlets of field crops were produced against the targets of 94.80 and 2.07 lakhs. Similar results for 2014-15 are presented in following table:

(in qtl.)

S. No.	Particulars	In University/ Institute		Participatory Seed Production		Total	
		Target	Production	Target	Production	Target	Production
1	Breeder seed	70812.41	96703.66	1217.75	1278.47	72030.16	97982.13
2	Foundation seed	60796.01	86571.32	33288.50	89051.07	94084.51	175622.39
3	Certified seed	27481.00	44432.01	86748.00	84033.27	114229.00	128465.28
4	TFL seed	54732.93	66251.60	48739.00	73754.66	103471.93	140006.26
5	Planting material	15360.00	34176.30	-	-	15360.00	34176.30
	Total	**229182.35**	**328134.88**	**169993.25**	**248117.47**	**399175.60**	**576252.35**

Source: IISR Mau,

3.14 On the query of the Committee regarding average time taken by the ICAR for development of new seed varieties and their availability in market for farmers, the DARE has stated as under:-

> "..The average time taken to develop new varieties depends upon the breeding objectives, breeding methods, availability of desired source, number of genes governing desired character and complexity of gene transfer. In general development of new seed variety of annual crops takes 5 to 15 years. It may be still longer for perennial crops. Further, depending upon the nature of the crop, the seeds of identified/notified news varieties take 3-5 years to become commercially available to the farmers.."

3.15 When asked about Government agencies responsible for making quality seeds available to the farmers in the country, the DARE has stated as under:-

> "..The Indian seed programme largely adheres to the limited generations' system for seed multiplication in a phased manner. The system recognizes three generations namely breeder, foundation and certified seeds and provides adequate safeguards for quality assurance in the seed multiplication chain to maintain the purity of the variety as it flows from the breeder to the farmer.
>
> Breeder Seed is the progeny of nucleus seed of a variety and is produced by the originating breeder or by a sponsored breeder. Breeder seed production is the mandate of the Indian Council of Agricultural Research (ICAR) and is being undertaken with the help of ICAR Research Institutions, All India Coordinated Research Project of different crops, State Agricultural Universities (SAUs), Sponsored breeders recognized by selected State Seed Corporations, and Non-Governmental Organizations. ICAR also promotes sponsored breeder seed production programme through the National Seeds Corporation (NSC) / State Farms Corporation of India (SFCI), State Seeds Corporation (SSCs), Krishi Vigyan Kendras (KVKs) etc. The indents from various seeds producing agencies are collected by the State Departments of Agriculture and submitted to the

Department of Agriculture and Cooperation (DAC), Ministry of Agriculture, Government of India, which is turn compiles the whole information crop wise and sends it to the Project Coordinator/Project Director of the respective crops in ICAR for final allocation of production responsibility to different SAUs/ICAR institutions.

Foundation Seed is the progeny of breeder seed and is required to be produced from breeder seed or from foundation seed which can be clearly traced to breeder seed. The responsibility for production of foundation seed has been entrusted to the NSC, SFCI, State Seeds Corporation, State Departments of Agriculture and private seed producers, who have the necessary infrastructure facilities. Foundation seed is required to meet the standards of seed certification prescribed in the Indian Minimum Seeds Certification Standards, both at the field and laboratory testing.

Certified Seed is the progeny of foundation seed and must meet the standards of seed certification prescribed in the Indian Minimum Seeds Certification Standards, 1988. In case of self pollinated crops, certified seeds can also be produced from certified seeds provided it does not go beyond three generations from foundation seed stage-I.

The production and distribution of quality/certified seeds is primarily the responsibility of the State Governments. Certified seed production is organized through State Seed Corporation, Departmental Agricultural Farms, and Cooperatives etc. The distribution of seeds is undertaken through a number of channels i.e. departmental outlets at block and village level, cooperatives, outlets of seed corporations, private dealers etc. The efforts of the State Governments are being supplemented by NSC and SFCI which produce varieties of national importance.."

3.16 When asked about planning in place for adequate production and availability of quality seeds to face climatic fluctuation in future, the DARE has stated as under:-

"..The Department of Agriculture, Cooperation and Farmers Welfare is implementing a Central Sector Scheme as 'Development and Strengthening of Infrastructure Facilities for Production and Distribution of Quality Seeds' since 2005-06 for the whole country. The objective of the ongoing scheme is to ensure production and multiplication of high yielding certified/quality seeds of all crops in sufficient quantities and make the seeds available to farmers, including those in remote areas, not easily accessible by rail/road on time and at affordable price.

The requirement of certified/quality seeds is assessed by State Governments on the basis of the area sown under different crop varieties, area covered by hybrid and self-pollinated varieties as well as the seed replacement rate achieved. The availability of seed is ascertained by the State Departments of Agriculture on the basis of the production of seed in government farms and production of seeds by State Seeds Corporations and other agencies. The Government of India periodically assesses the requirement and availability of seeds through detailed interaction with State Governments and seed producing agencies in the bi-annual Zonal Seed Review Meetings and the National Kharif and Rabi

Conferences. DAC&FW facilitates tie-up arrangements with seed producing agencies to ensure that the requirement of seeds is met to the maximum extent possible. Besides, under the national seed project ICAR-Indian Institute Seed Research, MAU is coordinating the quality seed production of different crops through various ICAR institutes/SAUs based on the target fixed by DAC & FW, Min. of Agriculture & Farmers Welfares (Govt. of India).."

3.17 When asked about average requirement of seeds in the country as of now, the DARE has stated as under:-

"..The seed requirement of farmers is mainly met by farm saved seed, i.e. still 65 % of the farmers are using their own saved seed or seed distributed among them. Making the quality seed available at right time is greater challenge rather than production per se. Seed, being the principal input in determining productivity, seed replacement should be given utmost priority. Amelioration of skewed SRR, i.e. the percentage of area sown out of total cropped area by using certified/quality seeds other than farm saved seed is the major challenge. Even though there is slight improvement recently, still a long way ahead in making the quality seed available at farmers' doorsteps and for achieving 100% SRR, which will herald the era of quality seed driven growth in agriculture sector.

Seed Replacement Rate in different crops and its variation across states

Crop	National Average SRR (%)	Highest SRR (%)		Lowest SRR (%)	
Paddy	37.5	82.0	Andhra Pradesh	9.0	Uttarakhand
Wheat	32.6	42.0	Maharashtra	11.0	Jammu & Kashmir
Maize	54.1	100.0	Karnataka	5.0	Odisha
Jowar	25.9	65.0	Andhra Pradesh	11.0	Tamil Nadu
Bajra	61.4	100.0	Gujarat	29.0	Karnataka
Bengal gram	18.4	78.0	Andhra Pradesh	4.0	Rajasthan
Black gram	29.2	77.0	Haryana	3.0	Chattisgarh
Green gram	26.7	94.0	Uttar Pradesh	1.0	Odisha
Red gram	17.5	55.0	Andhra Pradesh	2.0	Odisha
Groundnut	24.5	50.0	Andhra Pradesh	0.5	Madhya Pradesh
Mustard	63.6	78.0	Rajasthan	13.0	Odisha
Soybean	35.9	100.0	Andhra Pradesh	11.0	Rajasthan
Sunflower	61.2	100.0	Andhra Pradesh	8.0	Madhya Pradesh
Cotton	10.4	100.0	Andhra Pradesh	2.0	Odisha

Source: Directorate of Economics & Statistics, MoA&FW, GOI {2012},

Quality seed requirement of major crops in the country (Assuming 100% SRR)

Crops	Gross cultivated area (m ha)	Seed Rate (kg/ha)	Certified seed require. (000 tonnes)	SMR	Foundation seed requir. (000 tonnes)	Breeder seed requirement (tonnes)
Rice	45.6	50	2280.0	100	22.8	228.0
Wheat	27.2	125	3400.0	20	170.0	8500.0
Sorghum	7.7	15	115.5	160	0.7	4.5
Pearl millet	8.7	5	43.5	200	0.2	1.1
Maize	8.0	20	160.0	80	2.0	25.0
Pigeon pea	3.4	15	51.0	100	0.5	5.1
Chickpea	8.2	80	656.0	10	65.6	6560.0

Groundnut	6.2	100	620.0	8	9.7	1210.9
R&M	6.3	5	31.5	200	0.2	0.8
Soybean	8.9	75	667.5	16	41.7	2607.4
Sunflower	1.9	10	19.0	50	0.4	7.6
Cotton	9.5	12	114.0	50	2.3	45.6
Jute	0.8	5	4.0	100	0.04	0.4
Total	142.4		8162.0		316.1	19196.4

3.18 On the query of the Committee regarding share of public as well as private sector in the market for seed in the country, the DARE has stated as under:-

> "..The private sector has started to play a significant role in the seed industry over the last few years. However, the main focus of private seed companies has been on the high value low volume seeds. Market for low value high volume seeds, seeds of cereals, pulses and oilseeds is still dominated by the public sector seed corporations. Private sector companies have a significant place mainly in the case of maize, sunflower, cotton and vegetable seeds. The overall contribution of private sector seed companies in total seed production of the country is presently 50-57%.."

Conservation of Indigenous Varieties of Seeds

3.19 Our country is bestowed with rich bio-diversity. The flora of India is one of the richest in the world due to the wide range of climate, topology and habitat in the country. There are estimated to be over 16,000 species of flowering plants in India, which constitute some 6-7 percent of the total plant species in the world. India is home to more than 45,000 species of plants, including a variety of endemics. Further, India being one of the earliest civilization in the world has also contributed to cultivation of various varieties of crops and majority of these arewhich are still being preserved by the farmers in different parts of the country. When asked about the policy of the government to conserve indigenous varieties of seeds in the country, the DARE has stated as under:-

> "..National Bureau of Plant Genetic Resources (NBPGR), New Delhi is the national institute for conservation of seeds, all germplasm collection, genetic stocks and varieties of different crops in the country. Apart from NBPGR various ICAR institutes as well as SAUs are also maintaining an active collection of indigenous varieties, germplasm, elite breeding materials and utilization for developing improve varieties of respective crops, especially the crop based institute of Crop Science Division.."

3.20 On the query of the Committee regarding policy of the Government to identity unique characteristics of indigenous seeds and germplasm available in the country in order to utilize these traits for development of new seeds which can withstand climatic fluctuations, the DARE has stated as under:-

> "..In order to identify suitable donors, germplasm collection at NBPGR are being evaluated and characterized for different traits time to time under different

project. Up till now, about 2.62 lakh indigenous accessions have been collected, more than 60 thousand accessions repatriated, 6.26 lakh accessions imported and tested for quarantine clearance, and more than four lakh accessions have been supplied to breeders and researchers within the country. Nearly 1.9 lakh germplasm accessions have been characterized and more than two thousand cultivars have been DNA fingerprinted. Total of 4.14 lakh accessions are presently conserved for long term in the National Genebank. Intellectual property rights (IPRs) on genetic resources were facilitated by registering about 1100 unique accessions and by filing over a thousand applications with Protection of Plant Varieties and Farmers' Rights (PPV&FR) Authority for varietal registration. Further, the entire wheat collection of >20000 wheat accessions conserved at NBPGR was screened at multi-location for identifying donors for various traits including biotic and abiotic stresses under a flagship project. Similar efforts are going on evaluation of pulses. Under NICRA project specific set germplasm, breeding lines, varieties are being evaluated for tolerance to abiotic stresses such as heat, drought, water logging etc, which is being used in hybridization for developing new cultivars.."

3.21 When asked about policy/programmes of the Central and State Governments for creation of seed banks at Village or Panchayat level in entire country, the DARE has stated as under:-

"..In order to ensure that seeds are available to the farmers at the time of natural calamities like floods, droughts, etc., a need was felt to establish a Seed Bank to maintain stocks of foundation and certified seeds of different crops/varieties which can be utilized for such contingent requirements. Under this component, crop-wise targets of seeds are fixed for each participating organization for maintenance in the Seed Bank every year. Further, Under the national seed project quality seed are being produced under village seed bank programme and are distributed to farmers for cultivation.."

Impact of Climate Change on Horticulture

3.22 Horticulture is going to be one of the sector which will be severely affected due changes relating to flowering and pollination and yield losses caused by unseasonal rains and temperature variations. India is one of the pioneer in horticulture sector, will have to bear the losses caused due to climate change leading to loss of livelihood for scores of farmers. When asked about efforts being taken by the Government of India for research and development on horticulture sector due to impact of elevated temperature, CO_2 on the flowering behaviour, pollinators and yield losses due to variable climate including flooding due to heavy rains, the Department have stated as under:-

"..Research and dissemination of technologies for various stresses on horticultural crops is already embedded and mainstreamed into ongoing mandate and efforts of various horticulture related ICAR institutes and AICRP centres spread across different SAUs. However, the efforts were further strengthened

and streamlined under NICRA to develop location specific technologies for addressing climate change issues especiallyimpact of elevated temperature, CO_2 on the flowering behaviour, pollinators and yield losses due to variable climate including flooding and heavy rains. The proven technologies including varieties are disseminated among farmers/villages through Technology Demonstration Component (TDC) of NICRA. The technology is further up-scaled through the support from developmental agencies of central and state Governments.."

3.23 On the query of the Committtee regarding efforts being taken by the Government of India to identify and improve varieties of horticulture crops which has inherent potential to withstand abiotic stress associated with the climate change, the Department have stated as under:-

".. The ICAR through its network of horticultural institutes and network of All India Coordinated Research Projects is continuously engaged to identify and improve varieties of horticulture crops which has inherent potential to withstand abiotic stress associated with the climate change. Breeding objectives include varieties for various agro-climatic conditions, earliness, off-season and historical biotic stresses viz. moisture, high temperature, frost, heat waves etc. Efforts were also made under National Innovations in Climate Resilient Agriculture (NICRA) on new emerging climate change related stresses on horticultural crops. Under the programme, many ICAR institutes such as ICAR-IIHR Bangalore, ICAR-IIVR Varanasi, ICAR–CITH Srinagar, ICAR-CPRI Shimla, ICAR-DOGR Pune etc. are actively working on different crops. Recently, a water logging resistant germplasm of tomato has been developed by grafting on brinjal root stock. This technique of grafting tomato scion over brinjal root stock has been tested in different farmers' fields for water logging conditions. Efforts are under way to scale up this technique through various Government agencies. Agro-techniques have been developed to overcome alternate bearing in mango. Environmentally safe protocols were developed and tested successfully for induction of synchronized flowering in rejuvenated Alphonso mango trees in the age group of 25-40 yrs..."

Effects on Livestock

3.24 The Department in their background note have stated that a temperature rise of 1.0 or 1.2^{o} C with minor change in precipitation during March-August for India will marginally affect milk production. Both milk production and reproductive function of cattle and buffaloes will be adversely affected by projected temperature rise of 2-6^{o}C over existing temperature during the period 2070-2099. The partitioning of milk production impact indicated that high producing crossbred cows and buffaloes will be affected more, accounting 0.4 million and 0.89 million respective annual decline by 2020. When asked about impact observed on milk production in the country during the last ten years, the Department have stated as under:-

".. Some of the studies in India indicated that warming will negatively impact the productivity of indigenous cows and productivity loss will be about 0.33 million tons. The Northern India is likely to experience more negative impact of climate change on milk production. The decline in milk production will be higher in crossbreds (0.63%) followed by buffaloes (0.5%) and indigenous cattle (0.4%).Time to time, Government has launched several programmes in the past to improve the productivity of milk production. These programmes include improvement of breeds, vaccination and veterinary measures, better fodder production etc. Under National Innovations in Climate Resilient Agriculture (NICRA) project, several livestock based ICAR institutes such as ICAR-NDRI, Karnal, ICAR-IVRI, Izathnagar, ICAR, NIANP, Bengaluru and others have taken research projects to develop technologies to offset negative impact of climate change on milk production of both cattle and buffaloes due to rise in temperature by way of i) development of tolerant/resistant breeds, ii) improved feeds and supplements, iii) improved shelter management etc. It is expected that several technologies could emerge from these studies to address the problems..."

3.25 On the query of the Committee about steps being taken by the Government to improve indigenous varieties of cattle in order to enhance their heat tolerance and milk production capacities, the Department have stated as under:-

"..The GOI programmes like National Program for Bovine Breeding (NPBB), National Dairy Plan (NDP), National Livestock Mission (NLM) and Sub-Missions on Livestock Development, Pig Development in North-Eastern Region etc., are being under implementation by state department of Animal husbandry to improve indigenous varieties of livestock. Though, the researches on improvement of breeds of cattle for higher milk production have started since long. State Governments have started very effective programmes of improvement breeds in cattle through artificial insemination. A significant impact has been seen on improvement of breeds and their milk yielding capacity. Specifically, from the view point of climate change, more focussed research studies pertaining to improvement of indigenous varieties of cattle in order to enhance their heat tolerance and milk production capacities have been initiated under National Innovations in Climate Resilient Agriculture (NICRA) project at Institutes such as ICAR-NDRI, Karnal and ICAR-IVRI, Izathnagar. Once the technology is emerged from these studies, Govt. has to take active role in supporting and financing the dissemination of these technologies to the farmers through animal husbandry departments..."

3.26 While elaboraing on the above issue, the representative of DARE has stated as under:-

'लाइवस्टॉक में देशी नस्ल की गायों या पशुओं में जलवायु परिवर्तन के प्रति बड़ा रिजिलिएंस है, रिजिस्टेंस है, जलवायु परिवर्तन को बहुत लंबे समय तक जवाब दे सकती है। जो बाहर से पशु आए हैं या क्रास ब्रीड है वह क्लाइमेंट चेंज को बहुत ज्यादा सहन नहीं कर सकता है। देशी गाय में सुधार की आवश्यकता है लेकिन इसकी उत्पादकता बहुत कम है, दुध का उत्पादन कम है, दुध की उत्पादकता को किस तरह बढ़ाया जाए, इसके साथ ही देशी नस्ल की गायों में उन जिन्स को खोज लिया जाए जिसका उपयोग हम नस्ल सुधार के लिए कर सकते है,

नस्ल सुधार कार्यक्रम जलवायु परिवर्तन के लिए बहुत अच्छा पर्याय साबित होगा उसके ऊपर आईसीआर नजर रखे हुए है और आईसीआर उस दिशा में प्रगति कर रही है। इसी तरह फिशरीज, पोल्ट्री के क्षेत्रों में चाहे मराइन फिशरीज हो या फ्रेश वॉटर फिशरीज हो इन सारे क्षेत्रों में अनुसंधान चल रहे हैं। निगरा नाम की एक योजना है जिसके माध्यम से अनुसंधान किया जाता है और इसको सप्लीमेंट करने के लिए नेशनल मिशन (एनएमएस) के माध्यम से भी इसे डेवलपमेंट काम में लगाया जाता है।'

3.27 While submitting view on need to encourage improvement of indigenous varities of cattles, the representatiove of BAIF has stated as under:-

'....क्रॉस ब्रीडिंग लम्बे समय से चल रहा है। मेरे ख्याल से उस पर ब्रेक लगाने की जरूरत है, उसे साइंटिफिक वे में चलाने की जरूरत है। हमने देखा है कि हर कोई ऐग्ज़ॉटिक ब्रीड को बार-बार करता है जिससे किसान के पास जो जानवर पैदा हुए हैं, उनमें विभिन्न तरह की बीमारियां और इनफर्टिलिटी की प्रॉब्लम आई हुई है। उसे चैक करने के लिए हमने दो तरह की पद्धति अपनाई है। जैसे झारखंड, ओड़िसा और बुंदेलखंड के लिए हमने देसी गाय पर ज्यादा काम किया है। उसमें भी हमने देखा है कि भारतवर्ष में पांच ब्रीड बहुत अच्छी हैं - राठी, गीर, सायवाल, थरपारकर और रैड सिंधीं। ये ऐसी गाय हैं जिनमें बहुत अच्छा दूध देने का पोटैंशियल है। इसमें अभी भी कुछ जानवर मिलते हैं जिनका अगर हम ब्रीडिंग स्टॉक उपयोग करें तो अगले 25-30 सालो में व्यापक तौर पर किसानों के पास ले जा सकते हैं। एरिया स्पैसीफिक ब्रीड्स पर ध्यान देने की बात है। जैसे बुंदेलखंड और डैजर्ट एरिया में बाड़मेर और जैसलमेर एरिया में थरपारकर ब्रीड बहुत अच्छी चल रही है। बायफ एक ऐसी संस्था है जिसने खासकर देसी गायों के लिए अलग से सीमन स्टेशन की स्थापना की है। इस साल हमने 22 लाख डोज़ फ्रीज़ किए हैं और उनमें से 10 लाख के करीब अपने कार्यक्रम में प्रयोग किए हैं जिससे तीन लाख के करीब देसी गाय के बच्चे भी पैदा हुए हैं। दूसरा, जो क्रॉस ब्रीड हो रहे हैं, उसे रिवर्स क्रॉस करना है ताकि जब गर्भाधान करेंगे तो अच्छे सांड से करेंगे। उससे उस क्लाइमेट में ऐडॉप्टेबिलिटी अच्छी होती है। अगर हम 62 प्रतिशत के अंदर ऐग्ज़ॉटिक ब्लड रखते हैं तो वे जानवर फिर भी अच्छे चलते हैं, दूसरे हमें प्रॉब्लम देने लगते हैं। ऐसे कार्यों पर हम साइंटिफिक वे में ब्रीडिंग प्लान तैयार करके इम्प्लींमैंट करते हैं।

3.28 While elaborating further on the above issue, the representatiove of BAIF has stated as under:-

'इसी तरह बुंदेलखंड में थारपरकर ब्रीड अच्छी चल रही है। इसका भी हम वहां प्रचलन कर रहे हैं। हमें अपने ब्रीड को डेवलप करना बहुत जरूरी है जिसके ऊपर रिसर्च के बारे में अपना प्वाइंट बताऊंगा। क्रॉस ब्रीड को वापस ब्रीड करते-करते रिवर्स ब्रीड करते हुए हो सके तो दो-चार परसेंट ही एक्जोटिक रहे बाकी सारा इंडिजिनस हो जाए। ऐसे केस में मिल्क प्रोडक्शन बना रहता है। इसके लिए हमें स्ट्रेटेजी बनाने पड़ेंगे और रिसर्च के काम भी करने पड़ेंगे। एनडीआरआई और आईबीआरई जैसे इंस्टीट्यूट के साथ मिलकर हमें इस पर ध्यान देने की आवश्कता है। हमारे देश में गोट और शिप के ऊपर इंस्टीट्यूशन में इसके ऊपर काम नहीं हुआ है। अगर आप गवर्नमेंट ऑफ इंडिया की स्कीम देखेंगे तो आपको पता चल जाएगा, इधर दो-चार साल से कुछ काम होने लगे हैं लेकिन पहले इसके ऊपर ज्यादा स्कीम्स नहीं थीं। गोट को मिसअंडरस्टूड एनिमल बना दिया गया है, हमने उसे बिना बात के कह दिया है कि यह सारे पेड़ को खराब करती है, फॉरेस्ट वाले तो इसके अंगेंस्ट ही हो गए हैं। इसमें तीन-चार चीजों की आवश्यकता है, इसके लिए एक प्रोपर ब्रीडिंग प्लॉन तैयार होनी चाहिए। सबसे बड़ा किसान को घाटा मोराटिलिटी पर होता है। इसके ऊपर वैक्सीनेशन नहीं हो रहा है। इसका मास स्तर पर वैक्सीनेशन होना चाहिए ताकि मोराटिलिटी रुक सके। ई-वर्मिंग हो सके, जिससे ग्रोथ बढ़ सके। अगर हम तीन-चार चीजें करते हैं तो मेरे ख्याल से इससे किसानों को डबल इनकम हो सकता है। इसको भी निगलेट नहीं करना चाहिए।'

3.29 On the query of the Committee regarding strategy being envisaged by the Government to offset negative impact of climate change on milk production of both cattle and buffaloes due to rise in temperature during 2040-2069 and 2070-2099, the Department have stated as under:-

".....Government will have to play important role in upscaling of these technologies by way of launching different programmes and providing financial support.Through the Technology Demonstrations through KVKs is providing timely adversaries on endemic diseases and their control through mass vaccination, low cost sheltering, fodder production with improved cultivars, supplementation of mineral and vitamin mixtures etc., for improved management of animal health. Proven technologies like supplementation of probiotics, feeding complete feed, protein supplementation etc., are being demonstrated to decrease GHG emissions and improve the digestibility and nutrient use efficiency in livestock...."

Rumen Fermentation as a Source of Greenhouse Gas Emission

3.30 Rumen fermentation is the major source of greenhouse gas emission (60%) in farm sector. Heat stress due to high temperatures also affects milk production and reproduction in livestock. Thus the efforts were made to identify unique traits in indigenous livestock breeds which make them resilient to climate change and utilize this information in selection and promotion of adapted breeds in different agro-climatic regions depending on the projected change in climate. Feed manipulation, supplements and improved shelter can reduced GHG emissions and prevent loss in milk production from large and small ruminants. When asked about achievement of ICAR to devise Feed manipulation, supplements and improved shelter to reduce GHG emissions from large and small ruminants, the Department have stated as under:-

"..Identification of bacteriocin producing strains of lactic acid producing bacteria,microencapsulation of Bacteriocins, release kinetics of encapsulated Bacteriocins,lignocellulosic biomass for improving feed utilization, biogeography of gut microbes, novel approaches for assessing and improving nutrient bio-availability, supplementation of fortified (with varied levels of antioxidants, electrolytes and osmolytes) feed, astaxanthin, melatonin, different forms of complete feed, silage and herbal supplements to reduce etc along with different types of shelters with low cost and locally available material were developed at various institutes like NIANP, NDRI, CIRG, CSWRI under NPCC and NICRA project to reduce GHG emissions from large and small ruminants. Further, the increase of GHG emissions by Indian livestock was less (74% vs 82% over the period of 1961 to 2010) than the developing countries and this was due to creation of awareness, demonstration of field experiments (FLDs), encouragement provided for growing green fodder, silage making, complete feed preparation, regulations in manure management and waste disposal.."

3.31 On the above issue, the representative of Ministry of Environment, Forest and Climate Change have stated as under:-

'दूसरा पक्ष जलवायु और कृषि के बारे में यह है, कृषि से जुड़ा हुआ एक बड़ा समुदाय पशुओं का है, चूँकि जलवायु परिवर्तन का मूल कारण कार्बन कान्सन्ट्रेशन है, जो ग्रीन हाउस गैसों से बढ़ता है, तो उसमें जानने की बात यह है कि ग्रीन हाउस गैसों का एक बड़ा उत्सर्जन पशुओं के माध्यम से होता है। हम विश्व के उन बड़े देशों में आते हैं, जहाँ पर पशुओं की संख्या सबसे ज्यादा है, इसलिए हमारे लाइवस्टाक का जो ग्रीन हाउस गैस उत्सर्जन है, वह भी

काफी ज्यादा है। हमें इस बात की भी चिंता रहती है कि जो हमारा लाइवस्टॉक सेक्टर है, उसमें इस तरह के संरक्षण और संतुलन की व्यवस्था रहे कि आगे हमारे लिए कोई चिंता न बने, चूंकि ग्रीन हाउस गैस कंसंट्रेशन बढ़ने से हमारी उत्पादकता पर असर पड़ सकता है, दूध की उत्पादकता पर, पशुओं के स्वास्थ्य पर उसका असर पड़ सकता है। कृषि विभाग को इसके बारे में पूरी जानकारी है। इसे बारे में कई स्कीमें हैं, जो वे चला रहे हैं।'

3.32 On the query of the Committee regarding identification of unique traits in indigenous livestock breeds which make them resilient to climate change, the Department have stated as under:-

> **"...**Especially the trait like melanin secretion has been identified in some indigenous cattle for resilience. Increase in the expression of Melanogenesis pathway (MC1R, MITF, PMEL & TYRP1) genes and heat shock proteins (Hsp 70.1, Hsp 70.2 &Hsp 70.8) after heat stress has been observed in *Bosindicus* cattle. Further, a decrease in the expression of pro-apoptotic genes (BAX & BID) and increase in expression of anti-apoptotic (BCLxl) gene after heat stress was observed. An increase in the melanin concentration with increase in the expression of heat shock proteins by the melanocytes provides protection to the cell under heat stress. Melanin secreted by melanocytes seems to be acting as antioxidant and providing protection to the skin of *Bosindicus* cattle under heat stress...."

3.33 When asked about steps being undertaken to incorporate these traits in high milk yielding cattle varieties available in the country, the Department have stated as under:-

> "...The studies being conducted were on few selected breeds at segregated locations; hence further in-depth studies on different breeds of animals are required to incorporate these resilient traits in high milk yielding cattle..."

3.34 When asked about success achieved by the ICAR to devise feed manipulation, supplements and improved shelter to reduce GHG emissions from large and small ruminants, the Department have stated as under:-

> "Ration balancing, use of ionophores, probiotics, plant secondary metabolites (Saponins, tannins, terpenoids etc.), organic acids (fumarate, malate), essential oils, defaunation etc. have been found to reduce GHG (methane) emission to the extent of 10-15% in dairy animals. Animals selected based on residual feed intake (RFI) also produce lower methane by 10% and feeding silage is also advantageous to reduce methane by 8-11%.
> ICAR-National Institute of Animal Nutrition and Physiology, Bangalore using latest livestock population, primary data on methane production potential, feeding practices and seasonal variability of feed resources in different agro-ecological regions has already developed the state wise enteric methane emission database for the Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Bihar, Chandigarh, Chattishgarh, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Maharashtra, Delhi, Punjab, Rajasthan, Uttar Pradesh and Uttarakhand states. Development of state wise enteric

methane emission database for the north-east states of the country is in progress and will be accomplished very shortly.

GHG Amelioration:

- Studies conducted in sheep at National Institute of Animal Nutrition and Physiology, Bangalore demonstrated that 20-26 % enteric methane reduction can be achieved by using tanniferous tropical tree leaves of *Ficusbenghalensis* (Banyan), *Artocarpusheterophyllus* (Jack fruit) and *Azadirachtaindica* (Neem) at 10% level of concentrate or 2.5% of the basal diet (patent filed).
- Another study in cattle at the institute established tamarind seed husk (Tamarindusindica) as enteric methane ameliorating agent which reduced the emission by 17% on the inclusion at 5.0% level in straw based diet (patent filed). Silkworm pupae oil, an un-explored source also revealed 15-20% reduction in methane production at selected levels in the in vitro studies carried out at the institute (patent filed). The in vivo evaluation of silkworm pupae oil in cattle and sheep as methane ameliorating agent is in progress.
- The institute has identified the prominent methane producing methanogen archaea in cattle & buffaloes using molecular approaches and exploring the possibilities of developing methane inhibition vaccine using these prominent methanogen as antigens."

3.35 On the query of the Committee regarding unique traits identified in indigenous livestock breeds which make them resilient to climate change, the Department have submitted following details:-

i. "Cattle: An attempt was made to undertake comparative evaluation of Sahiwal cows (*Bos indicus*), Karan Fries cows (Cross-bred), Holstein Friesian cows (Exotic cattle) and Murrah buffaloes (*BubalusBubalis*) towards heat stress tolerance. The serum level of three major chaperons (*HSP70*, *HSP90* and *HSP27*) was relatively higher in Holstein Friesian and Karan Fries cows. Similarly, the transcriptional pattern of *HSP27*, *HSP40*, *HSP60*, *HSP70* and *HSP90* mRNA was relatively high in PBMCs of Holstein Friesian cows during peak summer. On the other hand, HSP transcripts in Sahiwal cows showed minimum change in expression with change in season. The data provides evidence that Sahiwal cows have better cellular tolerance than exotic, crossbred cows to summer stress and warrant further research in this area

Further, comparative genome wide transcriptome analysis of PBMCs showed difference in transcriptome signature of cattle types and buffaloes in response to summer stress. The analysis revealed several heat responsive genes and pathways impacted to summer stress. Such study will be helpful in providing scientific basis that our indigenous cattle breeds have superior tolerance to heat stress and would be better in combating climatic change.Additionally, the genes related to heat stress and adaptations are being characterized in Indian native cattle to find out variations in the coding as well as regulatory region. The data on these genes will serve as *Bosindicus* or bubaline specific

SNPs resource that can be utilized in future for association studies. The observed sequence variations or INDELs in UTRs or CDS of heat responsive genes might have vital role to play in differential heat stress response in cattle and buffaloes.

ii. Goats:Unique traits identified in indigenous goats that makes them resilient to climate change are:

a. Adaptive Trait Markers:

- *Genetic Markers*: Heat Shock Protein 70 (HSP70) and HSP90
- *Physiological Markers*: Respiration rate & Rectal Temperature
- *Endocrine Markers*: HSP70, Cortisol, Tri-iodo-thyronine (T_3), Thyroxine (T_4)
- *Blood Biochemical Markers*: Hemoglobin, Packed Cell Volume, Free fatty Acid (FFA), Non-Esterified Fatty Acid (NEFA), Super Oxide Dismutase (SOD) and Glutathione Peroxidase (GPx)

b. Immunological Trait Markers: Toll-Like-Receptor 3 (TLR3), TLR6 and TLR8

c. Productive Trait Markers: Growth hormone (GH), Growth hormone Receptor (GHR) and Leptin genes"

3.36 On the query of the Committee regardingt steps being undertaken to incorporate these traits in high milk yielding cattle varieties available in the country, the Department have stated as under:-

"Efforts are being made to identify more such variations to correlate them with phenomic data (in relation to thermotolerance traits) in diverse Indian native livestock species."

CHAPTER-IV

ASSESSMENT OF FOOD REQUIREMENT VIS-À-VIS FOOD AVAILABILITY

4.1 Vulnerability of Indian agriculture due to vagaries associated with climate change and low adaptation capacity of majority of Indian farmers poses risk to food security of the country. Therefore, Planned adaptation is essential to increase the resilience of agricultural produc/on to climate change. there is need to assess the enormity of problem and take steps which can put us in a position to face challenges to ensure food security of the Country. On the query of the Committee regarding projection for requirement of food grains, pulses, oil seeds, milk, meat, poultry products etc. keeping in view of future population growth in country, the Department have stated as under:-

> "...The exploding population, expanding urbanization and rising incomes have raised a wide range of important issues linked to national food-security, including dietary preferences (higher demand for livestock products), consumption of more processed foods and crowding out of peri-urban agriculture which plays a significant role in the supply of perishable commodities (FAO, 2012). By 2030, ICAR-National Institute of Agricultural Economics and Policy Research has projected food demand of 345 million tonnes (mt), almost 30% higher than in 2011. Demand is projected to be will be 205 mt, for fruits, 261 mt for vegetables, 261 mt for milk, 39 mt for animal products (meat, eggs and fish), 36 mt sugar, and 28 mt edible-oils. Overall, the demand for these products by 2030 is estimated to be 2-3 times more than that in 2011.
>
> Further, the population of India is projected to be 1.65 billion by 2050 with 50% people residing in the urban areas. It is projected that by 2050, the calorie consumption will reach 3000 kcal/cap and the share of animal-based calories will rise from the current level of 8% to 16%. This will increase the demand for food grains. In many ways, the Indian diets may slowly come closer to the diets in developed countries, necessitating production or import of food commodities (functional and special foods), consumed previously only in Western societies. Further, urban population being more vulnerable to increase in food prices and price spikes, it may adversely affect the food security scenario. Food wastages and losses also constitute an important driver of food demand. The estimates though vary, the wastages and losses of perishable commodities (fruits, vegetables, fish, meat and milk) can be put on average in 15-25 per cent range, while loss of non-perishable commodities may be anywhere between 5-15 per cent and this puts a considerable pressure on natural resources. By 2050, these losses are expected to be reduced significantly due to better use of technology and establishment of value chains.
>
> Food safety is an integral part of food security, because unsafe food has significant economic costs in terms of health problems as well as cross border trade, which is hampered by inconsistent/poor food safety standards. The latent demand for food safety among urban India is set to grow with urbanization and will also increase acceptability in the export market. There are various projections

of increase in demand for food commodities in India. According to one scenario (Kumar, 2015), at 7 per cent growth rate in national GDP, though the demand for food grains will only grow by about 50 per cent, the rise in demands for fruits, vegetables and animal products will be more spectacular, the range being 100-300 per cent (Fig. 1). Achieving such a high productivity will entail increase in total factor productivity (TFP). One-third of TFP must contribute to the agricultural growth. The food production density (kcal/km2 /day) requirement in most parts of India will increase from 50,000-100,000 in 2005 to 100,000-500,000 by 2050, requiring a rise in food grain productivity from 25000/kcal/ha/day to about 46000 kcal/ ha/day (Chaumet et al., 2009).."

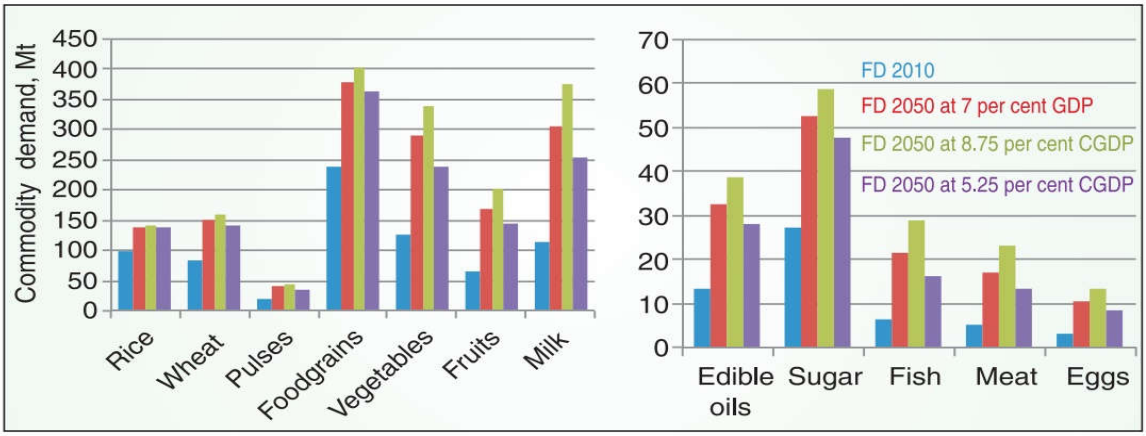


Fig. 1 Demand for various food commodities (FD) in 2010 and projections to 2050 at GDP growth scenarios of 7, 8.75 and 5.25 per cent

4.2 When asked about projection of agriculture and allied sector production in the country while adjusting effect of climatic changes in coming decades, the Department have stated as under:-

"..The regional impact of climate change, adaptation and vulnerability of irrigated wheat (rabi crop), and irrigated and rainfed rice (in Kharif season), maize and sorghum was assessed using the InfoCrop models. Climate change is projected to reduce the timely sown irrigated wheat production by about 6% in 2020 scenario from existing values. When late and very late sown wheat also is taken into consideration, the impacts are projected to be about 18% in 2020, 23% in 2050 and 25% in 2080 scenarios, if no adaptation measures are followed. However adaptation to climate change by sowing improved varieties and employing improved input efficiency technologies coupled with application of additional nitrogen can not only offset the negative impacts, but can also improve the net yields by about 10% in 2020. However, in 2050 scenario, such adaptation measures marginally improve yields while in 2080 scenario the wheat yields are projected to be vulnerable by about 6% in spite of above adaptation strategy, thus making it necessary to develop input use efficiency technologies and 'region specific adverse-climate tolerant varieties'.

On an aggregated scale, the irrigated rice yields are projected to reduce by 4% in 2020, 7% in 2050 and by 10% in 2080 scenarios. On the other hand,

rainfed rice yields in India are likely to be reduced by 6% in 2020 scenario, but in 2050 and 2080 scenarios they are projected to decrease only marginally (<2.5%). Irrigated rice in north-west India, comprising of Haryana and Punjab is projected to lose more (6-8%) than in other parts of the country (<5%) in 2020 scenario. Yield loss will be more in 2050 scenario in north-west India (15-17%) while some parts of central India (Maharashtra and Madhya Pradesh) also are projected to face >5% of yield loss. Adopting improved varieties with improved input efficiency and providing 25% of additional nitrogen can not only offset the climate change impacts but also can improve the production by 6-17% in irrigated conditions and by about 20 to 35% in rainfed condition in future climate scenarios.

Simulation analysis was also carried out on the impact of climate change on sorghum and maize crops in India. Irrigated kharif maize is projected to reduce yields by up to 18% in 2050 and about 23% in 2080 scenarios. Adaptation strategies such as improved and tolerant variety managed under improved input efficiency with additional nitrogen fertilizer can enhance the irrigated maize net production by about 21% in 2020, 10% in 2050 and 4% in 2080 scenarios. Rainfed sorghum yields, on all India scale, are projected to marginally (2.5%) decline in 2020 scenario while it is projected to decline by about 8% in 2050 scenario. Adaptation to climate change can not only offset the negative impacts but also can improve the yields by about 8% in 2020 scenario.

Global climate change may increase production of potato in Punjab, Haryana and western and central UP by 3.46 to 7.11%, but potato production may decline by 4-16% over rest of India particularly West Bengal and southern plateau region. It is primarily the mean minimum temperature during tuber growing period which affects potato yield. The increase in temperature due to climate change may decrease harvest index (HI) in large parts of Maharashtra, parts of Karnataka and Andhra Pradesh. Even though, in the traditional potato growing belt in the Indo Gangetic plains, the HI may remain more or less the same but pockets of high HI likely to diminish. Analysis on the stress degree hours in winter potato growing regions showed that under the baseline scenario, most of the Indo-Gangetic plains region experienced 1000 to 5000 degree hours of stress due to a combination of both maximum and minimum temperatures. However, under climate change scenario (A1F1) the temperature stress increased further and the area with severe stress (9000 to 13000 degree hours) is projected to increase significantly in large parts of Maharashtra, Jharkhand, Odisha and Gujarat. Similarly, pockets with extreme stress (>13000 degree hours) are projected to increase.

The simulation results indicated that on an average, future climate would have a positive impact on productivity of rainfed soybean in the country. Increase in soybean yield in the range of 8-13% under different future climate scenarios (2030 and 2080) is projected. In case of groundnut, except in the climate scenario of A1B 2080, which showed a decline of 5% in yield, rest of the scenarios showed 4-7% increase in rainfed yields as compared to the baseline. The maximum positive impact of future climate was observed on chickpea, which

showed an average increase in productivity ranging from 23 to 54%. However, a large spatial variability for magnitude of change in the productivity is projected. The simulated rainfed yields of soybean and groundnut showed a strong positive association with crop season rainfall while that of chickpea yields were significantly associated with crop season temperature.

Simulation studies using InfoCrop-Coconut model indicated positive effect of climate change on coconut yields in west coast and parts of Tamil Nadu and Karnataka and negative effects on nut yield in east coast of India. However, in the event of reduced availability of irrigation, the beneficial impacts will be less or negative impacts will be more. On all India basis, results indicate that climate change positively impacts coconut production in the range of 4.3% in A1B 2030, 1.9 in A1B 2080, 6.8% in A2 2080 scenarios of PRECIS from existing production levels. The magnitude of impacts (positive or negative) is higher in analysis based on GCM scenarios, than in analysis based on RCM scenarios. Adaptation to climate change can increase the yields by 13-19% in different scenarios thereby increasing the overall production by about 20%.

The field experiments indicated that the short-duration terminal-or early-heat tolerant wheat varieties can significantly reduce the adverse effects of heat stress on wheat. Crop diversification can not only reduces the climatic risks but also improves the farm income. Rice cultivars such as Swarna-sub are suitable for water logging conditions. In north-eastern region, short duration rice varieties like VivekDhan 82 was found suitable for late transplanting up to mid-August. In-situ soil moisture conservation, zero tillage with mulching, crop residue management reduces the risk of crop failure especially during dry season. Field experiments aimed at identifying genetic resources for tolerance to line EC 538828 for possessing high yield potential (3000 kg/ha) and tolerance to multiple abiotic stresses such drought, high temperature and low solar radiation. In onion, planting in raised beds can reduce the damage due to heavy rainfall events. In plantation crops such as coconut, soil moisture conservation methods such as mulching in palm basins, drip irrigation, coir pith burial in basin/trenches are found not only to improve the water use efficiency but also to protect the palms from droughts/prolonged dry spells.."

4.3 On the above issue, the CRIDA has submitted as under:-

"..The projected domestic demand for different crop groups shows that rice and wheat may be surplus whereas other cereals will be in acute shortage. Out of 59 million tonnes shortfall, most of the produce will constitute maize which would go for animal/poultry feed. Also, the deficit would be primarily for oilseeds, fruits, vegetables and pulses. Hence, the challenge would be to enhance productivity levels of these crops by promoting breeding programs and dryland horticulture. Further, as rice and wheat are going to be surplus, we need to follow a two-pronged strategy i.e. to increase their productivity by bridging the yield gaps and thus shifting some of the area under these crops to other cereals and vegetables through integrated farming systems approach which will optimize the use of

natural resources. Currently, there is an imbalance between natural resources endowment and cropping patterns in the country. It is an irony that areas with less rainfall are net exporters of agricultural produce to areas with sufficient rainfall and untapped groundwater potential. A study on water footprint analysis and the trade of agricultural commodities especially for rice and wheat indicates that eastern India is a net importer from North India. The projected changes in crop yields (%) at maximum changes in temperature and rainfall by 2035, 2065 and 2100 are presented as below:-

Projected changes in crop yields (%) at maximum changes in temperature and rainfall by 2035, 2065 and 2100*

Crop	2035	2065	2100
Rainy season			
Rice	-7.1	-11.5	-15.4
Maize	-1.2	-3.7	-4.2
Sorghum	-3.3	-5.3	-7.1
Pigeonpea	-10.1	-17.7	-23.3
Groundnut	-5.6	-8.6	-11.8
Winter season			
Wheat	-8.3	-15.4	-22.0
Barley	-2.5	-4.7	-6.8
Chickpea	-10.0	-18.6	-26.2
Rapeseed-mustard	0.3	0.7	0.5

*Maximum changes in temperature and rainfall are 1.3 %and 7% by 2035, 2.5□and 26% by 2065 and 3.5□and 27% by 2100, respectively (Source: Adapted from Birthal et al., 2014)"

4.4 On the query of the Committee regarding preparedness of the country to meet the future requirement of food in the country, the Department have stated as under:-

"..The fulfilment of future requirement of food in the country can be assessed by examining the gap between projected demand and supply under specified scenarios. The existing literature suggests that under the normal rainfall situation, food supply shall be sufficient to meet the food demand in the next 20 to 30 years. Although few food commodities like pulses and oilseeds may face deficit in next few years due to supply-side constraints. The total food grain demand is estimated to be 291 Mt by 2025 and 377 Mt by 2050, whereas the total production is estimated to be 292 Mt by 2025 and 385 Mt by 2050, which is 2.0% more than the demand. However, production deficits are projected for other

cereals, oilseeds, and pulses. The projected deficit is 33% by 2025 and 43% by 2050 for other cereals, while 3% by 2025 and 7% by 2050 for pulses. The rainfed crop yields are expected to increase to 1.8 t/ha in 2030 and 2.0 t/ha in 2050. The irrigated cereal yields are projected to increase from 3.5 to 4.6 t/ha during the same period. The cereal production in India is thus projected to increase by 0.9% per year between 1999–2001 and 2050, and is expected to exceed the demand by 2050 even if the projected growth is about 0.9% per year.."

4.5 When asked about policy/vision/planning of Government to ensure food security in the country in coming decades, the Department have stated as under:-

"...Food Security is the ability to assure timely, reliable and nutritionally adequate supply of food to total population on a long term basis. And, food availability is a necessary condition for food security. India is more or less self sufficient in cereals but deficit in pulses and oilseeds. Due to changes in consumption patterns, demand for fruits, vegetables, dairy, meat, poultry, and fisheries has been increasing. There is need to increase crop diversification and improve allied activities. However, access to food is still a big challenge for many people in the country. India's poor population amounts to more than 300 million people, with almost 30 percent of India's rural population living in poverty. The access to food can be increased through employment due to growth in labour intensive sectors and/or through social protection programmes. The malnutrition problem is much broader than that of access to food. The South Asian Enigma (levels of malnutrition in Asia are higher than in Africa) is well known. India has malnutrition levels almost the levels double those of many countries in Africa. This problem needs a multi-disciplinary approach covering diet diversification including micronutrients, women's empowerment, education, health, safe drinking water, sanitation, and hygiene. India has government programmes such as TPDS including AAY, nutrition programmes like mid-day meals, and ICDS to improve food and nutrition security. NREGS and self employment programmes can also increase access to food and nutrition.

Therefore, Indian Government has always accorded high priority to ensure food security for its citizens and launched a Food Security Mission during 2007. The mission aims to increase production of rice, wheat and pulses through area expansion and productivity enhancement in sustainable manner in identified districts of the country; restoring soil fertility and productivity at individual farm level; creation of employment opportunities; and enhancing farm level economy (i.e. farm profits) to restore confidence among farmers. Accordingly, new targets of additional production of food grains of 25 million tons food grains comprising 10 million tons rice, 8 million tons wheat, 4 million tons pulses and 3 million tons of coarse cereals was set by the end of 12th Five Year Plan. Further, in coming decades the government aims to ensure food security in the nation through implementing National Food Security Act 2013 by undertaking price support operations through efficient procurement of food crops, strengthening public distributions systems, increasing crop production and productivity, and enhancing resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. To meet

the requirement of food commodities, particularly pulses and oilseeds, trade related measures are also undertaken by the government besides the ongoing efforts to improve the production within the country. All these programmes aim at increasing the production of food grains in the country. The government is supporting the ICAR by funding the NICRA project with the aim of developing technologies that help minimize the adverse impacts of climate change. The government is also adjusting the trade policies and domestic marketing policies keeping in view the food security. All these efforts should continue in future while taking into consideration emerging issues that have a bearing on food security.."

4.6 On the query of the Committee regarding consideration of effect of climatic changes associated with global warming has been taken in to account while planning of Government to ensure food security in the country in coming decades, the Department have stated as under:-

"..Recognising that climate change is a global challenge, government is implementing National Action Plan for Climate Change (NAPCC) to identify measures and steps to advance India's development and climate change related objectives of adoption and mitigation. In addition, for ensuring food security in the country, National Mission for Sustainable Agriculture (NMSA) was initiated with the aims to devise strategies to make Indian agriculture more resilient to climate change. It would identify and develop new varieties of crops and alternative cropping patterns, capable of withstanding extremes of weather, long dry spells, flooding and variable moisture availability. Besides, climate resilient interventions have been embedded and mainstreamed into Missions/Programmes/Schemes of Department of Agriculture & Farmers Welfare (DAC & FW). The emphasis is also being given on integration and convergence of integrate traditional knowledge, information technology, geospatial technologies and biotechnology. New credit and insurance mechanisms are being devised to facilitate adoption of desired practices.."

R&D on Alternative Food Sources for Future

4.7 Climatic fluctuation is considered to affect production of major food crops such as Wheat and paddy which are staple diet for majority of Indian population. Keeping in view of these factors, it is important to take steps to identify and develop some alternative food sources which can withstand climatic variability and hence can be utilized as staple diet of vast population of our country. Coarse grains such Millets, Jackfruit, tuber crops are some of the agriculture produce which are considered to be future crops which being rich in nutritional values and essential minerals can also withstand climatic fluctuation associated with global warming. When asked about policy in place to identify crops of future which can withstand climatic fluctuation associated with global warming and can help to ensure food security in the country, the Department have stated as under:-

".. Presently, rice and wheat are the major staple food for the large masses of the country and are important component of Government's food basket to ensure national food security. However with changing climate, production of rice and wheat is projected to reduce in many parts of the country and may also become unsustainable traditional regions. It may disturb the food security of the nation. Further, the increasing population, depleting agricultural land, deteriorating environment, water shortage and demand for quality food are going to be the vital issues in coming decades, and it is important to timely diversify agricultural activities to meet these challenges. Government is fully aware of the status and thus promoting cultivation and value addition in more efficient, climate resilient, short duration C_4 crops viz. maize, pearl millet, sorghum and finger millets in suitable regions. In addition, ICAR through its network programmes on small millets (AICRP on Small Millets), future crops (AICRN on Potential Crops), legumes (AINP on Arid Legumes) is continuously engaged in conservation of germplasms; breeding short duration, tolerant and climate resilient varieties; developing suitable location specific package of practices for potential future crops; and disseminating production and value addition technologies to the stakeholders.

In addition, secondary agriculture is going to play a pivotal role in changing agricultural scenario for the supply of the health food besides the food security. And mushroom fits very well in this category. Our country can emerge as a major player in mushroom production utilizing available abundant agricultural residues. India produces around 700 million tonnes crop residues, a good proportion of that can profitably be utilized for mushroom cultivation. Currently, we are using only 0.03% of these residues for producing around 1.2 lakh tonnes of mushrooms. Further, mushroom being an indoor crop, utilizes vertical space and requires only 25-30 litre water for production of one kg mushroom, thus offering a solution to shrinking agricultural land and water. The modern technologies like bioinformatics, proteomics, functional genomics, etc., will help us in cataloguing, understanding and exploiting our genetic resources.."

4.8 On the query of the Committee about efforts being made by the ICAR to identified crops or food source which can emerge as wonder crops of future, the Department have stated as under:-

"..ICAR is continuously working on conservation of bio-resources including land races and wild species of potential source of food and nutrition under emerging changes in population, lifestyle, food habits and climate; identifying suitable genotypes for cultivation in different regions; and standardize package of practice. Thus, ICAR is giving priorities to small millet crops viz. foxtail millet, kodo millet, proso millet, little millets, and barnyard millets through All India Coordinated Research Project on Small Millets. These crops have potential to withstand the vagaries of climate and ensure the food and nutritional security in future. Further, the council is also putting efforts on other minor but potential crops through All India Coordinated Research Network on Potential Crops with

objectives to find out new plant resources for food, fodder, fuel, energy and industrial uses; identify superior genotypes for cultivation in different regions; and standardize package of practice. The important crops includes pseudocereals viz. Grain amaranth (*Amaranthus* spp.), Buckwheat (*Fagopyrum* spp.), Chenopodium (*Chenopodium* spp.), Job's tear (*Coix lacryma*-jobi); food legumes/pulses viz. Rice bean (*Vigna umbellata*), Adzuki bean (*Vigna angularis*), Faba bean (*Vicia faba*), winged bean (*Psophocarpus tetragonolobus*); oilseeds viz. Perilla (*Perilla frutescens*), Paradise tree (*Simarouba glauca*); vegetables viz. Kankoda (*Momordica dioica*), winged bean (*Psophocarpus tetragonolobus*); fodder crops viz. Amaranth (*Amaranthus* spp.), Salt bush (*Atriplex* spp.), fodder tree species; and energy and industrial plants viz. Jojoba (*Simmondsia chinensis*), Guayule (*Parthenium argentatum*), Jatropha (*Jatropha curcas*), Tumba (*Citrullus colocynthis*), Paradise Tree (*Siimarouba glauca*) and Perilla (*Perilla frutescens*).

Mushroom cultivation recycles agro-residues, much of which is otherwise burnt in the field. With rapid urbanization and increased production of agro-residues along with increased food production, there will be a need to radically change the way we look at agriculture. High-tech agriculture including mechanized mushroom cultivation under controlled conditions is going to gain importance in coming decades. Mushroom production in the world has increased rapidly in the last few decades and the trend is likely to pickup in our country as well.

From aquaculture perspective, air breathing fishes are useful resource under changing climate. In this direction, NBFGR has undertaken work on bio-prospecting of genes and alleles for abiotic stress tolerance in *Clarias mangur* and air breathing fish.

Furthermore, ICAR is putting sincere efforts for *in situ* and *ex situ* conservation, characterization and evaluation of non-descriptive bovine population of the country as a future source for food and nutritional security of the country besides ongoing breed improvement and management programme."

4.9 On the query of the Committee about participation of ICAR in international project or alliance which is engaged in identifying and popularizing alternative crops of future, the Department have stated as under:-

"..ICAR through its ongoing programmes/projects/schemes at NBPGR New Delhi, NBAGR Hisar, NBFGR Lucknow, NBAIM Mau and other ICAR institutes is continuously participating in international project or alliances of CGAIR, FAO, SAC to share genotypes, breed or species for use in national crop/breed improvement programmes. The shared materials are maintained and preserved at respective national repositories in the country.

Furthermore, in order to provide the best planting materials available in the world to the Indian farmer and to increase productivity, farm incomes and export earnings, New Policy on Seed Development, 1988 has been formulated. Import of seeds and planting materials are governed by New Policy on Seed

Development, 1988. The provisions regarding import of seeds and planting material are:

- import of seeds/tubers/bulbs/cuttings/saplings of vegetables, flowers and fruits is allowed without a licence in accordance with import permit granted under Plant Quarantine Order, 2003 (PQ Order).
- Import of seeds, planting materials and living plants by ICAR, etc. is allowed without a licence in accordance with conditions specified by the Ministry of Agriculture & Farmers Welfare, Government of India;
- Import of seeds/tubers of potato, garlic, fennel, coriander, cumin, etc. is allowed in accordance with import permit granted under PQ Order, 2003 and amendments made their under.
- Import of seeds of rye, barley, oat, maize, millet, jowar, bajra, ragi, other cereals, soybean, groundnut, linseed, palmnut, cotton, castor, sesamum, mustard, safflower, clover, jojoba, etc. is allowed without licence subject to the New Policy on Seed Development, 1988 and in accordance with import permit granted under PQ Order, 2003. A small quantity of seeds sought to be imported would be given to ICAR, or farms accredited by ICAR, for trial and evaluation for one crop season. On receipt of applications for commercial import, DAC would consider the trial/evaluation report on the performance of the seed and their resistance to seed/soil borne diseases. All importers have to make available a small specified quantity of the imported seeds to the ICAR at cost price for testing/accession to the gene bank of NBPGR.
- The Department of Agriculture and Cooperation has revised the New Policy on Seed Development 1988 on 27.6.2011 to allow import of specified quantity of seeds of wheat and paddy initially for trial and evaluation purpose. Based on the results of trial for one crop season, the company may be allowed to import seeds of wheat and paddy for a period not exceeding two years subject to the conditions stipulated in the revised New Policy of Seed Development 1988.."

Farming and Consumption of Coarse Grains

4.10 When asked about policy to encourage farming and consumption of Coarse grains and other underutilized crops in the country , the Department have stated as under:-

"..There exists a vast untapped potential of coarse grains, underutilized crops to meet food, fodder, fibre and fuel requirement of increasing population under changing needs and climate and support the National Food Security Mission in future. The potential available in different agroclimatic zones for the various small millets based cropping systems makes it evident that there is still large potential available in presently recommended technology, and could be bridged through the appropriate development strategies. Technological dissemination and development strategies should focus on specific technology package for different farming situations, and intensive extension education on the package. Rainfed farming production technologies, particularly water

management and usage, greater coverage under improved cultivars, efficient water use, integrated nutrient and pest management and good crop husbandry can result in a rapid progress in small millets productivity, provided appropriate guidelines are formulated and implemented for comprehensive development of these crops in harmony with other components of cropping systems. Therefore, AICRP on Small Millets, AICRN on Potential Crops, AINP on Arid Legumes, AICRP on Farming System are continuously engaged in identification of suitable crop varieties, cropping systems, farming technologies and post harvest management.

In addition, ICAR popularising several ready-to-cook and ready-to-eat health foods based on coarse grains which have been developed under the NAIP project. The technology for manufacturing them has either been passed on to prospective enterprises for commercial production or is available for that purpose. Multi-grain chapattis made of a mixture of sorghum, wheat and soybean flours is one example. A bakery unit has already started producing such chapattis for sale in the market. The flour mixture is also modifiable to include bajra, ragi, maize or barley for greater health benefits.."

Land Resource Inventory

4.11 The knowledge on land recourses is prerequisite to mitigate the effect of climate change on sustainable development basis. knowledge of site specific land resource data within each agro-ecological sub-regions is required to generate situation specific recommendation. ICAR project on land resource inventory on 1: 10000 scale is very helpful to provide site specific information needed for farm/village level planning. The project is currently being undertaken 60 blocks each representing agro-ecological sub-region of the Country. The Department of Agricultural Research and Education in the submission before the Committee has stated that they need collaboration with State Government for funds, manpower and other infrastructure, if they have plan to generate land resource inventory of whole Country. In this regard, the DARE has also signed MoUs with States like Gujarat, Karnataka, Meghalaya and Telangana. When asked about utility of land resource inventory for mitigating the effect of climate change on sustainable development basis in the country, the Department have stated as under:-

"...Land resource inventory (LRI) on 1:10000 scaleinvolves systematic survey of soils and collection of other collateral data needed for scientific land use planning in GIS environment. The detailed database generated at farm level will be the basis of prioritizing, initiating and executing any land-based developmental activities. In LRI, high resolution remote sensing data, digital elevation model (DEM) and digital terrain model (DTM) using Geographic Information System (GIS) provides new dimensions to the soil survey programme. DEM is capable of providing very precise and quantified information on degree, length and curvature of slope which are much needed information for execution of soil conservation programme, irrigation planning and precision agriculture. Data on degree, length and curvature of slope together with contours and drainage lines are very important to quantify the water harvesting potential under rainfed agriculture. The database will help to develop situation specific recommendations consisting of

right land use and best combination of agro-techniques for a well-defined set of soil and site characteristics. The recent study suggests that a well-developed LUP is capable to address the issues related to climate change like arresting land degradation, increasing carbon sequestration, reducing CO_2 emission and finally ensuring food security...."

4.12 When asked about the status of the project on Land Resource Inventory as on date, the Department have submitted following details:-

"As of today, the following LRI blocks have been completed by preparing base and soil maps

Region	Number of blocks completed*
Southern	17
Western	5
Central	3
Eastern	17
Northern	6
North-East	6
Total	**54**

* With the generation of soil and thematic maps"

4.13 On the query of the Committee regarding MoU signed with State Governments for funds, manpower and other infrastructure under the project apart from Gujarat, Karnataka, Meghalaya and Telangana, the Department have stated as under:-

"..Apart from Gujarat, Karnataka, Meghalaya and Telangana states, Govt. of Goa has signed MoU with ICAR-NBSS&LUP and involves in the LRI programme of the state as the funding agency.."

4.14 On the query of the Committee regarding details of financial, infrastructure and manpower support required by the ICAR for successful completion of project, the Department have stated as under:-

"..The details of financial, infrastructure and manpower support required by the ICAR for successful completion of project is given below:

i. <u>Financial requirement:</u>

S.No.	Description of the items	Cost (₹ in lakhs)
1.	Laboratory/ field equipment and lab facilities	3004.50
2.	Geographical Information System	1286.25
3.	Contingencies for Field Work	38000.80
4.	Others	15725.00
5.	Development of Geo-portal on soils	5050.00
	Total – (A)	**49341.55**
	Unforeseen expenses @ 5% of the cost **(B)**	**2467.08**
	Total (A + B)	**51808.63**

ii. <u>Infrastructure requirement</u>:

Laboratory and field equipment, Remote sensing equipment and satellite datasets, GIS software, Computers for soil geoportal development

iii. Manpower:

Category	Requirement
Scientist	25
Technical	33
Administrative	21
Supporting	27

* Besides the above strength, 56 (YP1 + YP2) contractual workers are required to complete the LRI project."

CHAPTER-V

NATURAL RESOURCE MANAGEMENT

5.1 Land is a vital natural resource, both for the survival and prosperity of humanity and maintenance of all terrestrial ecosystems. The limits of land resources are finite whereas human demands on them are ever increasing. Fertile land in rural areas becomes scarcer due to population growth, pollution, erosion and desertification, effects of climate change, urbanization, etc. The increasing demands put pressure on land resources leading to decline in crop production and degradation in land quality. Arresting land degradation, mitigating and adapting to climate change, protecting biodiversity, that aim at ensuring food security are just a few of the many challenges developing countries are currently facing. Land use planning is one of the tools that can help to meet them as it focuses on negotiating future land and resource uses by stakeholders. The sustainable food production is further constrained by ill effects of projected climate change. In 2050, it is estimated that maximum and minimum temperature will go up by 2.40 C and 40 C, respectively. Southern peninsula, northwest India and the southern parts of Punjab, Haryana and Bihar will be the severely affected due to the rise of minimum temperature. Apart from this, large shift in monsoon months, reduction in number of rainy days, increase in rain intensity and high frequency of cyclone would further aggravate the problems of agrarians. Management of soil, water and biodiversity have scope both in adaptation and mitigation. Natural resources management strategy to cope with the climate change includes (i) Building soil carbon and enhancing water holding capacity to enhance resilience of soil towards climate variability, (ii) assessing the potential of resource conservation technologies (RCTs), water harvesting, water saving irrigation methods, flood control, improved drainage, etc. in adaptation and mitigation; and (iii) enhancing carbon sequestration by quantifying and promoting agro forestry on degraded lands.When asked about the views of the Government of India for devising Natural resources management strategy to cope with the climate changes in the country on above-mentioned sectors, the Department have stated as under:-

i. "Under NICRA (National Innovations on Climate Resilient Agriculture) project ICAR-IISWC is carrying out studies to address basin level hydrological and sediment flux using hydrological models. Assessing the effect of climate change on water regime, sediment dynamics, and water quality in some regional sub-basins representing different agro-ecological regions of the country is being done. Subsequently a climate change vulnerability of various sub-basins (operational size watersheds) will be done with adaptation strategies and best management practices (BMPs) pertinent to soil and water conservation technologies in those operational size watersheds to overcome the adverse impact of climate change on runoff, soil loss and to evolve and strengthen design criteria of soil water conservation structures to cope with contingent climatic extremes.
ii. Research project mode to establish erosion productivity relationship to address the dynamics of soil carbon change due to land use change in present and contingent climate change scenario and to evaluate resilience of

various restorative management practices towards offsetting future changing climate.

Soil Health Management

5.2 Water holding capacity of the soil determines the capability of soil to supply water to plants. If the soil water holding capacity is low, the ability of the soil to supply necessary water to plant is limited even in high rainfall areas.When asked about the Impact of global warming on soil heath, the DARE has submitted as under:

> "..Many soil properties such as organic C, N mineralisation, soil respiration, microbial biodiversity and biomass are sensitive to temperature and moisture conditions. Global warming and reduced availability of water is expected to increase the rate of decomposition of soil organic carbon and thereby resulting loss of carbon to atmosphere. Gradually, the loss of soil organic carbon may eventually reduce nutrient and moisture holding capacity of soil, degrade physical and structural stability, hamper water and air movement in soil and ultimately soil quality.."

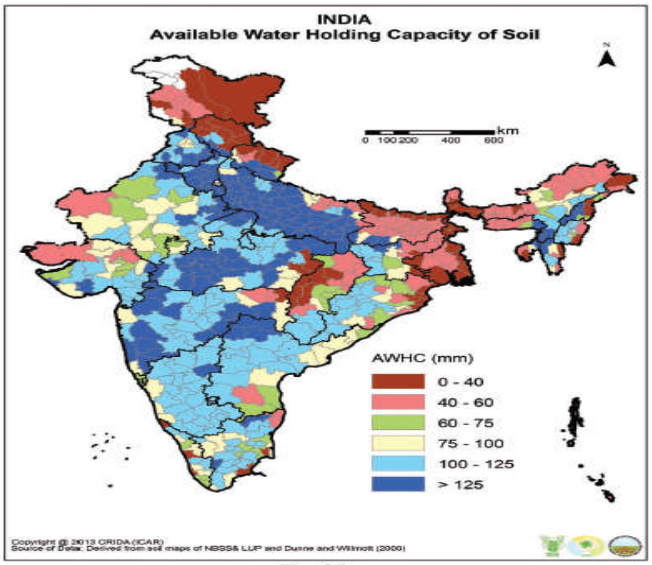
5.3 On the query of the Committee regarding any study by the ICAR to assess impact of increasing temperature on soil health in the country, the DARE has submitted as under:

> "..Studies were conducted at ICAR-IISS Bhopal to assess the impact of environmental parameters (temperature and moisture content) on Methane ($CH_{4)}$ and CO_2 emission. Farm yard manure (FYM) exhibited maximum CH_4 oxidation at 35°C, while CO_2 emission was maximum at 25°C in macro-aggregates, 35°C in micro-aggregates and 45°C in mineral associates. The soil Carbon mineralisation rate was significantly influenced by temperature besides source and type of the substrate applied on the soil. In addition, the modelling studies revealed that the soil carbon sequestration rate is the function of rainfall, temperature, soil carbon content, soil texture, net primary productivity and C: N ratio of residue.."

5.4 On the query of the Committee regarding any study to assess the status of organic carbon content and water holding capacity of soil in different parts of the country, the DARE has submitted as under:

> "..ICAR through its institutes is regularly assessing the status of organic carbon content and water holding capacity of soils in different parts of the country. AICRP on Long Term Fertility Experiments through its network of centres across the country regularly assess the status of organic carbon content and water holding capacity of the soils. In addition, ICAR-NBSS&LUP Nagpur has already generated the soil resource inventory of the country at 1:1 million scale and of different states at 1:250000 scale under its project on Soil Resource Mapping. The soil resource inventory includes soil organic carbon status and water holding capacity for dominant and sub-dominant soils of each mapping unit. The information is well documented in “Soil Resource Mapping Reports of various states for prospective land use planning” by ICAR-NBSS&LUP Nagpur. Further,

NBSS&LUP is presently engaged to survey different parts of the country at 1:10000 scale to generate detailed soil inventories under ongoing project, land Resource Inventory for Agricultural Land use and development of National Portal on Soil.The soil depth adjusted water holding capacity at district level is shown below:-



5.5 When asked the reasons for deterioration of quality of soil in the country and ways for its improvement, the DARE has submitted as under:

"..Soil quality is the function of land physiography, type of parent material, weather conditions, land use and land cover status, anthropogenic agricultural acidities practices in an agro-ecosystem. There is very delicate balance among various attributes of soil quality and any deviation from optimum leads to deterioration in soil quality. For example, adoption of non-sustainable cropping system, imbalance use of fertilizers, and faulty agricultural practices may leads to soil degradation, soil erosion, salinity, water logging etc. However, a systematic technological intervention could leads to improvement of soil quality. Some of the options includes:

- Soil conservation to reduce erosion, maintaining soil organic matter, and enhance water and nutrient bioavailability.
- Cultivation of crop species, genotypes and cropping systems that make optimal use of soil resources for food production while conserving soil fertility.
- Employing conservation agricultural practices i.e. no-tillage, reduced or minimum tillage with residues retained at the surface as surface cover.
- Employing various morphological (e.g. altered root: shoot ratio), physiological (e.g. improved nutrient uptake efficiency of root) and biochemical (e.g.

secretion of nutrient solubilizing and mobilizing rhizo-chemicals) adjustments in crop rhizosphere.

- Integrated application of fertilisers, organic manures and bio-fertilisers to different crops and cropping systems in agriculture.
- Besides being a measure of climate change mitigation, carbon sequestration is also important for improving organic carbon status and hence quality of soil in a long term. Thus it improves soil health.."

5.6 On the query of the Committee regarding efforts being taken by the Government for soil health management to enhance resilience of soil towards climate variability in India, the Department have stated as under:-

"... With a view to conserve top soil and to prevent soil erosion, Government of India, Ministry of Agriculture is implementing various watershed programmes, namely; National Watershed Development Project for Rainfed Areas (NWDPRA), Soil Conservation in the Catchments of River Valley Project and Flood Prone River (RVP&FPR) and Reclamation and Development of Alkali & Acid Soils (RADAS) across the country. Ministry of Rural Development is also implementing Integrated Watershed Management Programme (IWMP) for restoring ecological balance by harnessing, conserving and developing degraded lands in the country. The soil and water conservation works including the construction of check dams are undertaken under various Centrally Sponsored Schemes such as National Afforestation Programme (NAP), Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Integrated Watershed Management Programme (IWMP). IWMP has now been subsumed under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and PMKSY (Watershed Development) aims effective management of runoff water and improved soil & moisture conservation activities such as ridge area treatment, drainage line treatment, rain water harvesting, in-situ moisture conservation and other allied activities on watershed basis. The Government is implementing location specific Bio-engineering technologies including water harvesting as well as increase *in-situ* water storage measures developed by Central Soil and Water Conservation Research and Training Institute, Dehradun through different integrated watershed management programmes run by various agencies. The institute also organized regular training courses for field functionaries and farmers in this regard. With aim to reduce siltation in the reservoirs, various Soil & Water Conservation activities are being implemented under catchment area treatment measures for direct draining areas which is in built programme of irrigation projects.."

5.7 On the issue of soil health, the representative of DARE has stated as under:-

'..आजकल स्वाइल हेल्थ की बहुत चर्चा है। स्वाइल हेल्थ केमिकल हेल्थ नहीं है। इसकी तीन तरह की हेल्थ होती है। एक केमिकल हेल्थ, जो हम स्वाइल फर्टिलिटी बोलते हैं, दूसरा फिजिकल हेल्थ, फिजिकल कोड स्ट्रक्चर, वाटर इटेंशन है और तीसरा जो नेगलेक्टेड है, बायोलाजिकल हेल्थ। यह कंप्लीटली नेगलेक्टेड है। आप देखते हैं कि आजकल केंचुआ नहीं मिलता है। This is an indicator as to how your biological health of the

soil has been degraded. यह बायोलाजिकल हेल्थ तभी सुधरेगी जब आप स्वाइल में आर्गेनिक मैन्योर डालेंगे। धीमे-धीमे आर्गेनिक मैन्योर को डालना तो बहुत नेगलिजिबल हो गया। हम सब लोग केमिकल फर्टिलाइजर ही डालते हैं। इसके ऊपर ध्यान बहुत जरूरी है। The soil should be physically and biologically fit so that उसके ऊपर जो आप फर्टिलाइजर देते हैं, वह फिर ले सकता है। अगर फिजिकली वीक है, तो आपके सामने कितना भी खाना रख दो, आप नहीं ले पाएंगे। अगर बायोलॉजिकल हेल्थ ठीक होगी तो क्लाइमेट चेंज का इंपैक्ट भी इनके ऊपर कम पड़ेगा।..'

5.8 Further elaborating on above issue, the representative of DARE has stated as under:-

'..गंगा-यमुना के मैदानी इलाके, केन्द्रीय भारतवर्ष के इलाके जिसमें एरिड, सेमी-एरिड रीजन्स हैं, हमारा पैनिनसुलर इंडिया जिसमें दक्षिण भारत के राज्य आते हैं, उन सभी भूभागों पर भिन्न-भिन्न तरीके से जलवायु परिवर्तन का प्रभाव पड़ता जा रहा है। इसका पहला प्रभाव मिट्टी के स्वास्थ्य पर दृष्टिगोचर होता है। गंगा-यमुना के मैदानी इलाकों में जहां धान और गेहूं की खेती कई सालों से की जा रही है, तापमान वृद्धि के कारण उत्पादकता पर प्रभाव पड़ रहा है, लेकिन जिस तेजी से ऑर्गैनिक कार्बन का लॉस हो रहा है, वह बहुत चिन्ता का विषय है। मिट्टी में ऑर्गैनिक कार्बन का स्तर काफी नीचे चला गया है। मिट्टी के अंदर आर्गैनिक कार्बन एक ऐसा पदार्थ है जो जलवायु परिवर्तन से मिट्टी का बचाव और इस सारी सिविलाइजेशन का बचाव कर सकता है और करता है। लेकिन समय के चलते हम जो प्रैक्टिसेज इस्तेमाल करते हैं, अधिक खाद का इस्तेमाल करते हैं, अंधाधुंध पानी का इस्तेमाल करते हैं, उसके चलते आर्गैनिक कार्बन का जो क्षरण हो रहा है, उसके कारण मिट्टी के तीनों स्वास्थ्य - रासायनिक, भौतिक और जैविक स्वास्थ्य - पर इसका बुरा प्रभाव पड़ रहा है। उसके लिए आईसीएआर ने कई तकनीकों का विकास किया है जिसमें डायरैक्ट सीडिंग ऑफ राइस, रैसिड्यू रिटैंशन, कन्जर्वेशन एग्रीकल्चर, जिसकी मार्फत मिट्टी में वापिस आर्गैनिक कार्बन को ऐड करने की बात कही जाती है।..'

5.9 When asked to explain problem of soil degradation and efforts being taken by the government for restoring soil health, the representative of DARE has stated as under;-

'..भारतवर्ष में लगभग 141 मिलियन हेक्टेयर जमीन है जिसमें सॉल्ट अफैक्टेड, सैलिनिटी और सोडिसिटी मिलाकर 7 मिलियन हेक्टेयर है। उस 7 मिलियन हेक्टेयर जमीन पर भारत सरकार ने पिछले तीस सालों में जो रीक्लेमेशन के प्रोग्राम चलाए हैं, जिपसम टेक्नोलॉजी से बहुत सारी जमीन, लगभग साढ़े तीन मिलियन हेक्टेयर जमीन और ड्रेनेज का प्रोविजन करके हमने सुधारी है। इस सुधार के दौरान जिपसम मिलाने से सोडियम सल्फेट नाम का जो रसायन तैयार हुआ, वह जमीन के नीचे चला गया। जब उसकी लीचिंग नीचे हुई, लवण नीचे गए तभी ऊपर की जमीन ठीक हुई। ऊपर की जमीन ठीक हो गई, लेकिन समय के चलते हमने कुछ ऐसी पॉलिसिज़ अपनाईं जहां बिजली मुफ्त कर दी तो नीचे से पानी उठाना शुरू कर दिया। वह सोडियम सल्फेट वाला पानी फिर से जमीन के ऊपर आ रहा है। अच्छी जमीन थी, उसमें सोडियम सल्फेट के पानी से इरिगेशन करने से वह फिर से क्षारीय हो जाती है। यह मुद्दा बहुत खुलकर सामने आ रहा है जो जलवायु परिवर्तन के कारण होता है। हम और गहरे जाते हैं और सांदल वाले पानी को ऊपर ले आते हैं। खेती के क्षेत्र में ऐसे पानी और मिट्टी का रीक्लेमेशन महत्वपूर्ण बात है। उसके लिए एनएमएसए के माध्यम से सरकार की योजना है। इसके अलावा हमने अनुसंधान के लिए निकराम की जो योजना चलाई है, उसके मार्फत भी काफी अनुसंधान कर रहे हैं। इसके लिए हमारे संस्थान डैडिकेटेड हैं और काम कर रहे हैं।

हमारे बिहार का कुछ भाग, पश्चिम बंगाल और पूरे ईस्टर्न कोस्ट और थोड़ा-बहुत वैस्टर्न कोस्ट में एसिड सॉयल्स की जमीन हमारे देश में लगभग 20 मिलियन हेक्टेयर है। उस 20 मिलियन हेक्टेयर में जो अम्लीय मृदाएं हैं, उनमें से सामान्य अम्लीय मृदाएं अच्छा उत्पादन देती हैं, लेकिन जहां पीएच साढ़े पांच से नीचे है, साढ़े चार और साढ़े पांच के बीच पीएच की उत्पादकता पर अधिक अम्लीयता के कारण प्रभाव पड़ता है। दुर्भाग्य से उन क्षेत्रों में वर्षा असमायिक होने लगी है। यह तब होती है जब हाइड्रोजन आयन का कनसैंट्रेशन मैक्सिमम होता है और अगर उस समय बरसात हो गई तो वह एसिडिटी को और बढ़ाता है। वहां का कैल्शियम, मैग्निशियम बाहर चला जाता है, आयरन,

ऐल्युमिनियम और हाइड्रोजन इकट्ठा होने के कारण वहां एसिडिटी और बढ़ती है। जहां पूर्वी क्षेत्रों में पुराने समय में हमें धान की लगभग एक से डेढ़ टन प्रोडक्टिविटी मिलती थी, वहां वह घटकर कम हो गई है, हालांकि हमने जो नई वैरायटीज़ बनाई हैं, उनके कारण प्रोडक्टिविटी थोड़ी आगे बढ़ गई है। अगर हम पुरानी वैरायटी लें, तो अभी उनकी उत्पादकता कम हो रही है। यह भी जलवायु परिवर्तन के कारण हो रहा है। कई भाग हैं जहां समुद्र से पानी का रिसाव अच्छे पानी के अंदर हो रहा है। जब क्षारीय जल का रिसाव अच्छे पानी के अंदर होता है तो अच्छा पानी भी क्षारीय हो जाता है। उस पानी की उपयोगिता, उत्पादिकता उतनी नहीं रह पाती जितनी होनी चाहिए। यह भी जलवायु परिवर्तन के कारण हो रहा है।..'

Agro-forestry

5.10 Agro Forestry is considered one of the major methods which can help to mitigate effect of Green House Gases (GHGs) and reduce effect of global warming. When asked to explain Policy of Government on promotion of agroforestry in the country, the Department have stated as under:-

"..Agroforestry is significantly contributing in conservation of natural resources, diversification of landuse and farming systems to meet the demands of fuel, fodder, timber, and thus promoting economic transformation of farmers. Land being a limited resource, farm area cannot be expanded, but efficiency of farm could realistically be improved by integrating tree growing as agroforestry. Moreover, planting trees outside the forest in the form of agroforestry/farm-forestry is only the answer to meet the goal as required by the National Forest Policy of increasing vegetation cover to 33% from the present level of 24.01% (FSI, 2013). Thus, the Government of India pronounced National Agroforestry Policy during 2014 with the following objectives:

- Encourage and expand tree plantation in complementarity and integrated manner with crops and livestock to improve productivity, employment, income and livelihoods of rural households, especially the small holder farmers.
- Protect and stabilize ecosystems and promote resilient cropping and farming systems to minimize the risk during extreme climatic events.
- Meet the raw material requirements of wood based industries and reduce import of wood and wood products to save foreign exchange.
- Supplement the availability of agroforestry products (AFPs) such as the fuel-wood, fodder, non-timber forest produce and small timber of the rural and tribal populations, thereby reducing the pressure on existing forests.
- Complement achieving the target of increasing forest/tree cover to promote ecological stability especially in the vulnerable regions.
- Develop capacity and strengthen research in agroforestry and create a massive people's movement for achieving these objectives and to minimize pressure on existing forests.."

5.11 On the above issue, the representative of Ministry of Environment, Forest and Climate Change have stated as under:-

'..जैसा कि आपने कहा है, कृषि वानिकी अनुसंधान इस देश में लगभग तीस सालों से चल रहा है। इसमें जो निरंतर परिवर्तन हो रहे हैं, उनका भी साक्ष्य लिया जाता है और निरंतर यह प्रयास किया जा रहा है कि देश में कृषि वानिकी को कैसे बढ़ाया जाए? भारत सरकार ने वर्ष 2014 में एक कृषि वानिकी नीति घोषित की थी, जो कि विश्व की पहली कृषि वानिकी नीति है। इसमें यह देखा गया है कि अगर हम कृषि के साथ-साथ पेड़ों का समावेश करें तो जो जलवायु परिवर्तन या वैश्विक तापमान में वृद्धि है, उसका सामना कर सकते हैं। किसान की आय दुगुनी करने का जो लक्ष्य है, उसमें भी अगर हम क्रॉप डायवर्सिफिकेशन के मद्देनज़र कृषि वानिकी अपनाते हैं तो किसान को लाभ होता है। इस विषय में जो भी समस्या आ रही थी, कृषि वानिकी नीति आने के बाद इसका प्रयास किया जा रहा है कि जितनी भी समस्याएं हैं, उन्हें दूर किया जाए। उसके लिए राज्य सरकार के जो वन विभाग है, उसके साथ मिलकर ऐसे वृक्ष लगाए जाएं, जिससे किसानों की आमदनी बढ़ सके और उसकी आमदनी भी बढ़ सके। साथ ही साथ, मिट्टी की उत्पादकता में भी वृद्धि हो। इसके लिए ऐसे पौधे जो भूमि को नत्रजन प्रदान करते हैं, उनका चयन किया गया है। पूरे देश के लिए लगभग 35 ऐसे मॉडल तैयार किए गए हैं जो वहां की जलवायु के अनुरूप हैं और जिनसे किसान अपनी आय भी बढ़ा सकता है और साथ ही साथ अपनी अन्य आवश्यकताओं की भी पूर्ति कर सकता है। इस विषय में निरंतर अनुसंधान चल रहे हैं। एक केन्द्रीय कृषि वानिकी अनुसंधान संस्थान झांसी में कार्यरत है। इसके अलावा, पूरे देश में इसके 37 केन्द्र हैं। चूंकि हर स्थान की कृषि वानिकी अलग-अलग है, इसलिए वहां के अनुरूप अनुसंधान करने के लिए कार्य किया जा रहा है।..'

5.12 Further on the above issue, the representative of Ministry of Environment, Forest and Climate Change have stated as under:-

'यूकलिप्टस के बारे में तरह-तरह के मत हैं। ऐसी बात भी है कि यह वाटर टेबल डिप्लीट करता है, जिसकी वजह से चिंता रहती है। हमारी मिनिस्ट्री हर स्टेट को यह एडवाइजरी देती है कि आप लोकल इंडीजिनस पेड़-पौधों को लगायें। दूसरी बात है कि अगर हम नॉर्दन अमेरिका या वेस्टर्न यूरोप के पेड़ को अपने अंगुलियों पर गिन सकते हैं, लेकिन हमारे यहां एक हजार से ज्यादा स्पेसीज हैं। We have more than over 1000 species of trees; whereas if we see Western Europe or Northern America, you can count. वहां ज्यादा से ज्यादा ओक, पाइन्स and temperate flora होंगे। So, our flora is embarrassingly rich.'

5.13 When asked to furnish details of the programmes being implemented by the Government on agroforestry and assistance being provided to the farmers in the country, the Department have stated as under:-

"..The various programmes implemented by Government on agroforestry are:

- The agroforestry R & D through ICAR- Central Agroforestry Research Institute Jhansi and ICAR- All India Coordinated Research Project on Agroforestry.
- Agroforestry programme of Indian Council of Forestry Research and Education, Dehradun.
- Through various programmes of State Forest Departments
- Assistance provided to the farmers for technical guidance on the subject through capacity building programmes and with the implementation of National Agroforestry Policy and Sub Mission on Agroforestry under National Mission on Sustainable Agriculture through DAC and FW.."

5.14 On the query of the Committee regarding plants which are suitable for different agro-climatic conditions, the Department have stated as under:-

"..ICAR- Central Agroforestry Research Institute Jhansi and ICAR- All India Coordinated Research Project on Agroforestry has identified suitable tree species for different agro-climatic conditions of the country.

(1)Western Himalayan region :*Grewiaoptiva,Ulmuswallichiana*, *Morus alba*, *Salix, Robinapseudoacacia*and Poplar

(2)Eastern Himalayan region *: Acacia auriculiformis, Alnusnepalensis,* Bamboos*,* and*Gmelinaarborea*;

(3)Indo-gangetic region :Populus, Eucalyptus, *Dalbergiasissoo*, Meliaazedrach

(4)Arid and semi aridregions :*Dalbergiasissoo, Acacia nilotica, Ailanthus excelsa, Prosopis cineraria,Leucaenaleucocephala* and *Azadirachtaindica*

(5)Western India : *Acacia nilotica, Prosopis cineraria* and *Zizyphus, Ailanthus* and *Azadirachtaindica*

(6)Southern Region :*Tectonagrandis*, Meiladubia, *Tamarindusindica,* and cashew nuts

(7) Humid and sub humid regions :*Albizia*spp*., Gmelinaarborea, Gliricidia, Acacia auriculiformis, Acacia mangium*

(8) Coastal and islandregion *:Artocarpus*, *Azadirachtaindica*, *Casuarina equisetifolia, Grevillea robusta* and bamboos.

In addition twenty species have been identified at national level for agroforestry programmes. The identified species are Populus spp., Eucalyptus spp., Tectonagrandis, Prosopis spp., Bamboo spp., Acacia spp., Gmelina spp., Grewia spp., Melia spp., Ailanthus spp., Dalbergiasissoo, Casuarina spp., Leucaenaleucocephala, Azadirachtaindica, Jatropha carcus, Anthocephalus spp., Albizia spp., Terminalia spp., Salix spp. and Hardwickia spp.."

5.15 On being asked about assessment of effect of eucalyptus and other exotic plantation on local climate and soil health which was prevalent during early stage of agroforestry drive, the Department have stated as under:-

"..Several studies conducted on water use efficiency of Eucalyptus suggest that eucalyptus is more water efficient than other tree species for the per gram biomass production. Some of the research findings based on studies conducted in different parts of the country are mentioned below:

- Several studies capture some of the concerns of eucalypts that make them more productive and water use efficient. The findings of the research taken up by Calder et al 1997, in Karnataka under dry tropical climate, at one site, the water use of a young E. tereticornis plantation was found to be no different from that of an indigenous dry deciduous forest. At two other sites, the annual water use of the eucalypt plantation and the indigenous forest was found to be equal to the rainfall. At yet another site, with deeper soil, water use of the eucalypt plantation was greater than the rainfall, i.e. 3,400 mm used against 2,100 mm received in the 3 years period of study. During these 3 years, rainfall was less than normal and yet at none of the sites was there any evidence of abstraction from the water table. The source of the extra

water is unknown. One hypothesis is that, if roots penetrate successively deeper layers, water 'mined' would account for it.The efficiency of water use of E. tereticornis as against that of species of other genera including fast growing species such as Albiziafalcataria, Meliaazadarach and Acacia auriculiformis has been proven (Tiwari, D.N.). While the earlier findings were that E. tereticornis used 0.48 mm-0.55 mm of water to produce one gram of dry matter under unrestricted supply of water, in rainfed conditions in Dehra Dun (India) only 0.122 mm of water was used, reconfirming its capacity to cut down water consumption under moisture stress. It has been found that the maximum consumption of water by E. tereticornis, in the Dehra Dun climate is during the rains (60%), followed by winter (26%) with the least during summer (14%), showing that the species adjusts its water use to the availability of water.

- In India, Tiwari and Mathur (1993) reported that experiments were conducted to compare water requirements and biomass production of selected tree species. The species studied included Pongamiapinnata (slow growing), Syzgiumcuminnii (Mzambarau) with moderate growth and Eucalyptus hybrid (fast growing), among others. The results concluded that:
    - Eucalyptus hybrid consumed more water on per litre basis, but produced more biomass per unit volume of water
    - *Pongamiapinnata* consumed the least water but produced least biomass per unit volume of water.
    - Eucalyptus hybrid was the most efficient water user compared to the other species studied.

- In another study in Central India where large-scale plantations of Eucalyptus tereticornis had been established, the level of water in wells declined until the plantations were 6 to 8 years (when trees have their maximum rate of growth) and thereafter, reverted to the earlier level. Similarly, adverse effects on hydrological cycle were not observed in older plantations of E. globulus. Cromer et al. (1993) on comparing the response of E. grandis under irrigation and fertility treatment found that the trees reacted favourably to additional fertility more than water. After three years, fertilizer treatment had significantly and substantially increased growth in mean height and basal area, but there was no response to irrigation and no interaction between fertilizer and irrigation.

- Studies at FRI, Dehradun by Gurumurti and Rawat, hold that the overall use of water by eucalyptus is limited to the total rainfall regime of the area.
- The Overseas Development Administration of the UK supported a study to understand the impact of fast growing species on the environment by comparing water use in plantations of eucalypts, indigenous forest and annual agricultural crop (Calder, 1994). The main findings of the study were:
    - In the dry zone, the water use of young Eucalyptus plantation was no greater than that of indigenous dry deciduous forest;

- The annual water use of Eucalyptus and indigenous forest was equal to annual rainfall;
- The annual water use of either indigenous or plantation forests was higher than that of agricultural crops; and
- There was no evidence of water abstraction from the water table by all species.

The general observations from these studies is that the effect of planted trees on ground water depends on the species, climatic conditions and type of soil.."

5.16 On the above issue, the representative of DARE have stated as under:-

'सभापति महोदय, आपके प्रश्न सामयिक हैं और जो आपने बताया है उस दिशा में पहले से काम हो रहा है। कृषि वानिकी में हमारा मूलतः पहले तो यह है कि उसके लिए कौन से वृक्ष हैं? सभी वृक्ष हम इसमें नहीं लगाते हैं। इसमे ध्यान यह दिया जाता है कि वृक्ष तेजी से बढ़े और उसकी छाया ज्यादा बड़ी न हो और तीसरा उसके अन्य लाभ भी हों। जैसे अगर छाया वाला हो, तो उसकी पत्तियां हम चारे के काम में लाते हैं, इस तरह का अनुसंधान भी किया जा रहा है। कृषि जलवायु के अनुकूलन ही वृक्षों का चयन किया जा रहा है। इसीलिए मैंने कहा था कि 37 केंद्रों में वहां की जलवायु के अनुरूप ही वह अनुसंधान हों, तो ऐसे क्षेत्रों में इस तरह के वृक्षों का चयन किया जा रहा है, जो वहां की परम्परागत कृषि है, उसमें समस्या न हो। वृक्षों के चयन के साथ-साथ यह भी होता है कि उसके साथ कौन सी फसलें शुरू में लाना है। प्रायः दो-तीन साल तक जब तक छत्र नहीं बढ़ता है तो कोई समस्या नहीं होती है। जैसे-जैसे वृक्ष की आयु बढ़ती है, तो उसका छत्र बड़ा होता है तो फसलों का चयन भी हम लोग उसी के अनुरूप परिवर्तन करते हैं। इसके साथ ही अनुसंधान में हम ये सारी चीजें देखते हैं कि उसकी जड़ों का कैसे हम, जैसा आपने स्वयं कहा है कि जिसकी जड़ें कम से कम नीचे तक जाए, जिससे जो न्यूट्रियंट उसका है, वह कंपटीशन न हो। इस विषय में भी अनुसंधान चल रहे हैं। जैसा मैंने बताया है कि जो ये 35 मॉडल की बात की थी, इनमें इन चीजों को रखा जा रहा है। जैसा कि जो हमारे शुष्क वाले क्षेत्र हैं, जैसे खेजरी के विषय में है, आप लोग तो अच्छी तरह से भिज्ञ है, जैसे खेजरी पर पहले से ही काफी अनुसंधान हो रहा है और उसको आगे बढ़ाया जा रहा है। उसी तरह से अन्य जातियों के हैं जो ऐसे क्षेत्रों के लिए उपयुक्त पाए गए हैं।'

5.17 Further elaborating on the above issue, the representative of Ministry of Environment, Forest and Climate Change have further stated as under:-

'वन विकास में या वन संरक्षण में जो प्रोजैक्ट बनाये जाते हैं, जिसमें यूकलिप्टस या किसी भी तरह की प्रजाति का प्रयोग होता है, वह राज्य सरकारें अपने स्तर पर निर्णय करती हैं, हम उनको मदद मुहैया कराते हैं और प्रौजेक्ट के तहत उन्हें सपोर्ट करते हैं, लेकिन वैज्ञानिक रूप से निश्चित है कि इस पर अलग-अलग मत हैं और भौगोलिक कारणों से कौन-सी प्रजाति उपयोगी है या उचित है, इसका निर्णय वहां के लोकल स्तर के अधिकारी करते हैं।'

5.18 Further elaborating on the above issue, the representative of Ministry of Environment, Forest and Climate Change have further stated as under:-

यूकेलिप्टस के बारे में आपने पूछा था। यह हमारा नेटिव नहीं है, यह अस्ट्रेलिया से आया है। अस्ट्रेलिया में इसकी 500 के आस-पास प्रजातियां हैं। 40-50 साल पहले इसे जब लाया गया था, उस समय फायर वुड की कमी थी। उस परिप्रेक्ष्य में इसे लाया गया। 500 प्रजातियों से सिर्फ दो को चुना गया और वे दो प्रजातियां कुछ हद तक वैस्टर्न घाट में सक्सेसफुल रहीं। वे दो प्रजातियां यूकेलिप्टस टैरिटीकार्निस और यूकेलिप्टस कैमलडोलेंसिस थी। अमरकंटक के लिए यूकेलिप्टस नहीं बल्कि साल वृक्ष ही उचित है क्योंकि साल वृक्ष वहां पहले से था। बबूल भी एक नेटिव है लेकिन जो सुबाबुल जो आया, लूसीनालूकोसिव आया, उसे साउथ अमेरिका से लाया गया कि जल्दी से एक साल में ही पूरा वृक्ष बन जाएगा और फायर वुड दे देगा। इसलिए इन वृक्षों को लाया गया लेकिन अब वैज्ञानिकों द्वारा समझा

गया कि ये ठीक नहीं हैं। यूकेलिप्टस अस्ट्रेलिया के लिए ठीक था। मैं उदाहरण देना चाहता हूं कि वहां जो भालू कोलाबैर हैं उन्हें खाने के लिए एक किलो यूकेलिप्टस चाहिए। यह प्लांट एनिमल के लिए था। यूकेलिप्टस नहीं होगा, तो उनका भालू मर जाएगा, लेकिन हमारे यहां ऐसा कुछ नहीं है। नई बैल्ट में यूकेलिप्टस की कोई भी एडवाइजरी मिनिस्ट्री ने इश्यु नहीं की है।

5.19 When attention of the Ministry of Environment, Forest and Climate Change invited to the need of issue of advisory to State Governments for use of locally suitable species in the programme of agro-forestry, the representatives have submitted as under:-

'महोदय, आपकी चिंता जायज है। मुख्य मुद्दा माननीय सदस्यों ने यह उठाया है कि वृक्षों की सही प्रजातियों का प्रयोग राज्यों में होना चाहिए। इस बात को हमने नोट कर लिया है। इस बारे में शोध तो होता है। जैसा इन्होंने बताया कि इंडियन काउंसिल आफ फारेस्ट रिसर्च एजुकेशन जो हमारा सबसे बड़ा संस्थान देहरादून में है, इस बारे में निरंतर शोध करता रहता है और राज्य सरकारों से इसका तालमेल है। वे इस बारे में ट्रेनिंग और स्किल्स देते रहते है। लेकिन इसमें कहीं कोई कमी होगी, तो मंत्रालय की तरफ से इस पर विचार करके तत्काल राज्यों को जो भी निर्देश देना होगा, वह देंगे। यह एक गंभीर विषय है, हम कोशिश करेंगे कि इस पर निर्देश जारी किया जाए और जो भी युक्ति-सम्मत और शोध-सम्मत होगा, वैसा निर्देश राज्यों को दिया जाएगा।

Water Resource Management

5.20 Water being fundamental for development of life on Earth is scare natural resources. India with around 18 % of world population has only 4 % of World's renewable water resouces. As per the latest assessment out of the total precipitation, including snowfall, of around 4000 billion cubic metre in the country, the availability from surface water and replenishable ground water is put at 1869 billion cubic metre. Because of topographical and other constraints, about 60% of this i.e. 690 billion cubic metre from surface water and 432 billion cubic metre from ground water, can be put to beneficial use.There are further limits on utilizable quantities of water owing to uneven distribution over time and space. In addition, there are challenges of frequent floods and droughts in one or the other part of the country. With a growing population and rising needs of a fast developing nation as well as the given indications of the impact of climate change, availability of utilizable water will be under further strain in future with the possibility of deepening water conflicts among different user groups. Against this becground, it becpome imperative the country to analyze preparedness to augment water resources to face the climatic changes associated with global warming.

5.21 Irrigation is a vital component of agricultural production. Our country is at advantageous position in respect of water resources. However, these water resources are not evenly distributed and development of irrigation facility are restricted in relatively small areas. agriculture in our country is mainly dependant on moonsoon rainfall. Increasing global average temparature and resultant climate change will have two consequences for water availability for agriculture sector. Firstly, rainfall may become irratic and secondly, there will be higher loss of water due to evapo-transpiration. Out of the 140 million hectares of net sown area in the country, 65 million ha is irrigated, leaving 75 million ha under rainfed farming. Even after completing all irrigation projects and covering the potentially irrigable area, nearly 50% of the cultivated area will

continue to remain rain dependent. Therefore, improving the productivity of rainfed agriculture is critical to achieving the objectives of growth, equity and sustainability as well as ensuring food security of the country along with stabilizing productivity levels in irrigated agriculture. In India, semi-arid tracts are more extensive covering about 57 m ha. Arid climate is prevalent in about 15 m ha and dry sub-humid regions occupy about 25 m ha in the eastern parts of the country. Thus, dryland agriculture is more predominant in the states of Rajasthan (arid), Maharashtra, Madhya Pradesh, Gujarat, Karnataka and Tamil Nadu (semi-arid). Within the irrigated area, the area irrigated through tube wells is about 29.7 m ha and canal irrigated area is 15.7 m ha and area irrigated through tanks, other wells and other sources is about 19.7 m ha . The area irrigated through other sources, tanks and other than tube wells is more than the canal irrigated area by about 4 m ha and the investments on these sources are made through individual farmers and government sources under various schemes such as IWMP, MGNREGA, etc.

Description	**Area ('000 ha)**
Net sown area	140823
Net Irrigated area	65151
Net rainfed area	75672
Area Irrigated by canals	15761
Area Irrigated by tubewells	29661
Area irrigated by other wells and other sources	19728

5.22 Rainfed agriculture has been high on the agenda of the Government of India considering that a larger part of cultivated area in the country does not have access to irrigation and is dependent on the rainfall for crop and livestock production. Major challenge of rainfed agriculture in the decades to come will be sustaining the livelihoods of the small and marginal farmers who will still depend on agriculture despite increased climate variability and shrinking land holdings. Failure to address this challenge will lead to substantial shift of rural youth to service sector resulting in huge manpower shortage in farming. The growing preference for commercial crops even in less endowed areas will put further pressure on land and water resources and enhances the risk. The challenge therefore lies in balancing the land use and cropping pattern as per the resource capability and shifting markets. Some of the challenges like retaining area under the nutritious cereals can be converted into opportunities with by spreading awareness on the health benefits of these crops. Against this background, it is important that there is well placed plan for managemnet of water resources in the country in order to face challanges associated with climate change. Water is most critical input for Agriculture. Ensuring availability of adequate water in monsoon dependant Indian agriculture is a daunting task which can become a serious problem if climate changes affect intensity and timing of Monsoon rains in India.

5.23 On the issue of impact of Climate changes on water availability in the country, the Department of water resources have stated that relatively very large temporal and spatial variation in rainfall and consequently in the river flow and ground water aquifers is an important feature of the water resources in India. Although the impact of climate

change on water resources has not been accurately quantified, various studies indicate that the likely impact of climate change on water resources could contribute to further intensification of the extreme events. Further, the features of water resources – both the availability and the quality may also be considerably affected by the changes in the land use in the form of urbanization, industrialization and changes in the forest cover. Realizing that the various processes which influence the hydrologic cycle are of dynamic nature, precise quantification of the impact specifically due to climate change may not be a simple task and it would be necessary to make suitable assumption at the initial stages and undertake detailed simulation studies with more and more data as they become available with time. However, the likely impact of climate change on water resources could be in the form of:

i. Decline in the glaciers and the snowfields in the Himalayas;
ii. Increased drought like situations due to overall decrease in the number of rainy days in many parts of the country;
iii. Increased flood events due to overall increase in the rainy day intensity;
iv. Effect on groundwater quality in alluvial aquifers due to increased flood and drought events;
v. Influence on groundwater recharge due to changes in precipitation and evapotranspiration;
vi. Increased saline intrusion of coastal and island aquifers due to rising sea levels.

From the above, it is apparent that in the context of likely impact of climate change on water resources, the most vulnerable areas in India would include (a) drought prone areas, (b) flood prone areas, (c) the coastal regions, (d) the region with deficient rainfall, (e) areas with over-exploited, critical and semi-critical stage of ground water development, (f) water quality affected areas, and (g) snow-fed river basins. For achieving the objectives of the National Water Mission, long-term sustained efforts both in terms of time bound completion of identified activities and ensuring the implementation of identified policies and enactment of necessary legislation through persuasion at different levels with the State Governments have been envisaged.

5.24 When asked about study by the ICAR on water availability for agriculture in future due to impact of Climate changes, the Department have stated as under:-

"...A pilot study was conducted on the impact of climate change on the water availability of different places in the erstwhile Andhra Pradesh. Thornthwaite and Mather (1955) water balance was computed for the climate change scenarios projected for the years 2020 and 2050 at 21 selected places and compared with baseline year 1990. From the output, the water surplus values were considered and the per cent deviation for the years 2020 and 2050 from the baseline year 1990 were tabulated. Following observation have been noticed in pilot study:-

- There is no water surplus available in the stations located in the south Telangana, Rayalaseema and in some coastal stations.

- Stations located in the northern Telangana, Krishna, West and East Godavari districts showed water surplus in the baseline year and subsequently decreased in the projected years.
- The reason for declining in the water surplus after baseline year could be attributed to increase in the demand (PET) during these years due to the increase in temperature and variability in the rainfall.

S.NO	STATION NAME	Water Surplus(mm)	Water Surplus(% Deviation from baseline year1990)	
		1990	2020	2050
1	ANANTHAPUR	0	NO CHANGE	NO CHANGE
2	MAHABUBNAGAR	0	NO CHANGE	NO CHANGE
3	KURNOOL	0	NO CHANGE	NO CHANGE
4	AROGYAVARAM	0	NO CHANGE	NO CHANGE
5	BAPATLA	0	NO CHANGE	NO CHANGE
6	CUDDAPAH	0	NO CHANGE	NO CHANGE
7	TIRUPATHI	0	NO CHANGE	NO CHANGE
8	NANDYAL	0	NO CHANGE	NO CHANGE
9	TIRUPATHI	0	NO CHANGE	NO CHANGE
10	MACHILIPATNAM	0	NO CHANGE	NO CHANGE
11	NALGONDA	0	NO CHANGE	NO CHANGE
12	MEDAK	211.9	-6.3	-14.6
13	KARIMNAGAR	158.2	-6.8	-10.2
14	ADILABAD	217.3	-9.0	-15.4
15	NIZAMABAD	228.4	-5.2	-13.2
16	NARSAPUR	98.6	-13.6	-41.0
17	KALINGAPATNAM	74.1	-14.2	-42.9
18	KHAMMAM	30.3	-41.9	-97.0
19	VISAKHAPATNAM	21.2	-49.1	-100.0
20	VIJAYAWADA	10.4	-100.0	-100.0
21	AMARAVATHI	24.8	-45.6	-100.0

5.25 On the query of the Committee regarding ways by which Climate change will affect monsoon cycle in Indian subcontinent, the Department have stated as under:-

- "The study conducted by IITM suggested a likely strong sensitivity of Indian Subcontinent Monsoon (ISM) to global warming under the projected climate change scenarios.
- It is projected that the rainfall magnitude will increase over core monsoon zone in future climate along with lengthening of the season due to late withdrawal. On inter-annual timescales, the severity and frequency of both strong monsoon (SM) and weak monsoon (WM) might increase in future climate.
- Substantial changes in the daily variability of ISM are also projected which are largely associated with the increase in heavy rainfall events and decrease in number of wet days during future monsoon.
- Both extreme wet and dry episodes are likely to intensify and regionally extend in future climate with enhanced tendency of long dry spells."

5.26 When asked to explain impact of Climate change on Monsoon rainfall in the country, the representative of Ministry of Earth Sciences has stated as under:-

"Regarding post-Monsoon rain, that is, October to December rain as well as winter rain, there has also been a lot of change. In both seasons, we are getting more rainfalls. There are many categories of rainfall like light, moderate and heavy rain. The frequency of light rain is reducing and heavy rain is increasing. This is a big difference which has been observed. But overall rainfall seems to be the same. Some change has been found in respect of onset Monsoon also. In Northern parts of India on-set Monsoon comes a little later. Similarly, the withdrawal is also a bit later. So, there is a small shift in the Monsoon pattern. Monsoon does not come in June as it usually used to.

5.27 When asked to explain Impact of climate change on rainfall days, the Representative of Ministry of Earth Sciences have stated as under:-

'आने वाले 2050 तक यह ट्रेंड पाया गया है, based on simulations of present day model. आईपीसीसी की यह रिपोर्ट 2014 में आई है। अगली रिपोर्ट 2021 में आयेगी। अभी तक के जो बैस्ट साइंस हैं, बैस्ट साइंस के अनुसार अगले पचास साल तक नम्बर ऑफ रेनी डेज कम होंगे। यद्यपि सीजनल क्वांटम घट नहीं रहा है, लेकिन ज्यादा बारिश कम दिनों में हो रही है। उसकी वजह से वाटर मैनेजमैन्ट इश्यूज, वाटर स्टोरेज कैपेसिटी, सर्फेस वाटर मैनेजमैन्ट, लोकल टैंक्स, मीडियम टैंक्स, माइनर टैंक्स, इरिगेशन टैंक्स का वाटर मैनेजमैन्ट सिस्टम में बदलाव लाने के पक्ष में हैं।'

Augmentation of Water Resources in the Country

5.28 When asked about efforts being taken by the Government of India to augment water resources and scientific management of water resources available in the country, the Department have stated as under:-

".... Several steps for augmentation, conservation and efficient management to ensure sustainability of water resources are undertaken by the respective State Governments. In order to supplement the efforts of the State Governments, Government of India provides technical and financial assistance to State Governments to encourage sustainable development and efficient management of water resources through various schemes and programmes such as Accelerated Irrigation Benefits Programme (AIBP); and scheme for Repair, Renovation and Restoration (RRR) of water bodies etc. The Government of India has also launched National Water Mission with main objective as "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management".

5.29 While outlining objectives of National water Mission, the Ministry of Water resources and Ganga rejuvination has stated as under:-

"…Main objective of the National Water Mission (NWM) is "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management". The five identified goals of the Mission are:

(a) Comprehensive water data base in public domain and assessment of impact of climate change on water resource;
(b) Promotion of citizen and state action for water conservation, augmentation and preservation;
(c) Focused attention to vulnerable areas including over-exploited areas;
(d) Increasing water use efficiency by 20%, and
(e) Promotion of basin level integrated water resources management.

5.30 The Department have further stated that various strategies for achieving the goals have been identified which lead to integrated planning for sustainable development and efficient management with active participation of the stakeholders after identifying and evaluating the development scenario and management practices towards better acceptability on the basis of assessment of the impacts of climate change on water resources based on reliable data and information.

5.31 On the issue of availability of water resources in the country and planning of the Government for its effective utilization, the reppresentative of Ministry of Water resources and Ganga rejuvination has stated as under:-

'जो व्यापक तैयारी हुई थी, उस व्यापक तैयारी में जब हम लोगों ने वाटर रिसोर्सेज असैसमैन्ट डिफरेन्ट बेसिनवाइज किया तो यह आया कि चार हजार बिलियन क्यूबिक मीटर प्रसिपिटेशन हमारा पूरा वर्षाकाल और नार्थ-ईस्ट और साउथ-वैस्टर्न मानसून के थ्रू प्राप्त होता है। उसमें से लगभग 50 प्रतिशत 1869 बिलियन क्यूबिक मीटर पानी डिफरेन्ट नदियों से बहकर आता है और हम उसमें से केवल 1120 यूज कर सकते हैं। उसे ध्यान में रखते हुए हमने अल्टीमेट इरिगेशन पोटेंशियल जिसमें हम पूरी सिंचाई सुविधा प्रदान कर सकते हैं, वह 142 मिलियन हैक्टेअर था। 142 मिलियन हैक्टेअर में से बाकी रेनफैड हो गया, 182 मिलियन हैक्टेअर टोटल है, 182 मिलियन हैक्टेअर में से 142 मिलियन हैक्टेअर हम इरिगेशन से कर सकते हैं, 118 कर लिया है तो बचा हुआ जो 24 मिलियन हैक्टेअर और इंटरलिंकिंग से 35 मिलियन हैक्टेअर एक्स्ट्रा और हो जायेगा, उसके हिसाब से एक बार सम्पूर्ण योजना बनाई गई थी।'

5.32 When asked to furnish details of programmes/schemes being undertaken or being envisaged to solve the problem of water crisis in future, the Department have stated as under:-

"...The NMSA has four major programme components e.g. 'Rainfed Area Development', 'Soil Health Management', 'On Farm Water Management' and 'Climate Change and Sustainable Agriculture Modeling and Networking'. Through the OFWM programme, the Government is converging and upscaling efforts to ensure adequate water availability for agriculture in coming decades.

i. On Farm Water Management (OFWM) will primarily focus on enhancing water use efficiency by promoting on-farm water management technologies and equipment. This not only focus on application efficiency but in conjunction with RAD component, also will emphasize on effective harvesting & management of rainwater. Assistance is being extended for adopting water conservation technologies, efficient delivery and distribution systems etc. Emphasis is also being given to manage and equitably distribute the resources of commons by involving the water users

associations, etc. To conserve water on farm itself, farm ponds are being dug using MGNREGA funds and earth moving machinery when manual digging under MGNREGA is not feasible.

Planning & Implementation:

a. OFWM will focus on enhancing water use efficiency by promoting appropriate technological interventions like drip & sprinkler technologies, efficient water application & distribution system, secondary storage and drainage development.
b. The unit cost of drip irrigation system varies with respect to plant spacing and location of the water source. The normative cost has been laid down for 11 various Micro Irrigation systems for the purpose of calculating financial assistance. Twenty-five (25) percent higher cost, over & above the normative cost for all the systems has been fixed for North Eastern & Himalayan states for the purpose of calculating financial assistance.
c. Location and crop specific technologically appropriate irrigation systems will be propagated ensuring least cost burden to the farmers/beneficiaries;
d. It will be ensured that atleast 25% of the micro irrigation fund allocated to the State is used for crop sector.
e. Support to each farm family under OFWM component will be restricted to a farm size of 5 Ha. However, beneficiaries who have already availed the benefit of central support for micro irrigation cannot avail further assistance for the same land for the next 10 years;
f. Support for creating secondary storage at tail end of canal system to store water when available in abundance (rainy season) or from perennial sources like streams for use during dry periods through effective on-farm water management; Support for drainage development through surface/subsurface/bio-drainage system;
g. Training on appropriate water management technologies, judicious use of water and agronomic & land development measures for effective water management;
h. Implementing Agency at the District level should follow uniform procedures and assure transparency in selecting beneficiaries and releasing assistance expeditiously. PRIs need to be consulted in selection of beneficiaries.

i. The water resources developed through watershed development programmes/MGNREGA in the demonstration area should invariably be linked with the activities of OFWM component for its potential use. Project areas under National Food Security Mission (NFSM), National Mission on Oilseed & Oil Palm (NMOOP), Mission for Integrated Development of Horticulture (MIDH), National Livestock Mission (NLM) may also take the advantage of this component for improving water use efficiency, if this component has not been utilized from the parent scheme.

ii. Prime Minister Krishi Sinchayi Yojana PMKSY):-For ensuring adequate water availability Prime Minister Krishi Sinchayi Yojana (PMKSY)has been launched to achieve convergence of investments in irrigation at the field level, expand cultivable area under assured irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance the adoption of precision-irrigation and other water saving technologies (More crop per drop), enhance recharge of aquifers and introduce sustainable water conservation practices by exploring the feasibility of reusing treated municipal waste water for peri-urban agriculture and attract greater private investment in precision irrigation system.

PMKSY has been conceived amalgamating ongoing schemes viz. Accelerated Irrigation Benefit Programme (AIBP) of the Ministry of Water Resources, River Development & Ganga Rejuvenation (MoWR,RD&GR), Integrated Watershed Management Programme (IWMP) of Department of Land Resources (DoLR) and the On Farm Water Management (OFWM) of Department of Agriculture and Cooperation (DAC). The scheme will be implemented by Ministries of Agriculture, Water Resources and Rural Development. Ministry of Rural Development is to mainly undertake rain water conservation, construction of farm pond, water harvesting structures, small check dams and contour bunding etc. The MoWR, RD &GR, is to undertake various measures for creation of assured irrigation source, construction of diversion canals, field channels, water diversion/lift irrigation, including development of water distribution systems. Ministry of Agriculture will promote efficient water conveyance and precision water application devices like drips, sprinklers, pivots, rain-guns in the farm “(Jal Sinchan)”, construction of micro-irrigation structures to supplement source creation activities, extension activities for promotion of scientific moisture conservation and agronomic measures. Programme architecture of PMKSY will be to adopt a ‘decentralized State level planning and projectised execution’ structure that will allow States to draw up their own irrigation development plans based on District Irrigation Plan (DIP) and State Irrigation Plan (SIP). It will be operative as convergence platform for all water sector activities including drinking water & sanitation, MGNREGA, application of science & technology etc. through comprehensive plan. State Level Sanctioning Committee (SLSC) chaired by the Chief Secretary of the State will be vested with the authority to oversee its implementation and sanction projects.

The programme will be supervised and monitored by an Inter-Ministerial National Steering Committee (NSC) will be constituted under the Chairmanship of Prime Minister with Union Ministers

from concerned Ministries. A National Executive Committee (NEC) will be constituted under the Chairmanship of Vice Chairman, NITI Aayog to oversee programme implementation, allocation of resources, inter-ministerial coordination, monitoring & performance assessment, addressing administrative issues etc.

5.33 The DARE has further stated as under:

"Apart from implementation of above scheme, following initiatives have been/proposed to be taken: -

a) Completion of incomplete irrigation projects under Mission Mode: The Ministry has prioritized 99 irrigation projects for completion in mission mode including CADWM works within a period of 3-4 years. The financing of these projects are being arranged through borrowing funds from NABARD.

b) Enhancing irrigation efficiency: A new Incentivization Scheme for Bridging Irrigation Gap (ISBIG) is proposed to be implemented for balance implementation of CADWM works in outstanding projects other than prioritized irrigation projects to improve the irrigation efficiency and covering more area under irrigation. Under this scheme there is also a component for re-use of waste water for enhancing the irrigation area.

c) New Irrigation Projects and Inter Linking of Rivers: Adequate water availability for irrigation can be ensured by taking up new water storage projects, and by taking up inter linking of rivers."

5.34 On the issue of implementation of PMKSY, the representatives of Ministry of water resources and Ganga rejuvination has submitted as under:-

'राष्ट्रीय जल मिशन कृषि से संबंधित कार्य नहीं करता है। इसका एक लक्ष्य है कि जलवायु परिवर्तन के कारण जल संसाधन में जो परिवर्तन हो रहे हैं, उन पर ध्यान दिया जाए। इनमें से एक इंडियन नेशनल कमेटी ऑन क्लाइमेट चेंज है, जिसके अंदर हमारे कुल 20 मेजर रिवर बेसिन हैं। हिमालयन रिवर बेसिन और पेनिनसुलर रिवर बेसिन हैं। इनमें से आठ रिवर बेसिन में हमने एक इनिशिएटिव लिया है, जिनमें जलवायु परिवर्तन की वज़ह से क्या-क्या परिवर्तन होंगे, उसके लिए यू.एन.आई.पी.सी.सी. ने एक ग्लोबल मॉडल जो विकसित किया है। उसे डाउनस्केल करके उसे रिवर बेसिन के परिप्रेक्ष्य में एग्ज़ामिन किया जाएगा तथा उसकी स्टडी की जाएगी। हमारे देश में जितने आई.आई.टीज़ हैं, और साउथ में जो इंडियन इंस्टीच्यूट ऑफ साइंस हैं, वे इसकी स्टडी करेंगे। वे सब इसके एक्सपर्ट्स हैं। इस तरह से आठ रिवर बेसिन का निर्णय हो गया है। इन रिवर बेसिन में जलवायु परिवर्तन के परिप्रेक्ष्य में जो स्टडी की जाएगी, मेरे ख्याल से उसकी जानकारी तीन-चार सालों में उपलब्ध होगी। उस जानकारी से यह भी ज्ञान मिलेगा कि जल संसाधन के परिवर्तन से खेती में किस तरह का परिवर्तन आएगा। इसके अलावा, नयी सरकार बनने के उपरांत तुरंत ही जून में प्रधानमंत्री जी का एक रिव्यू मिला, जिसमें उनका यह उद्देश्य था कि हर एक खेत को सिंचाई का पानी मिलना चाहिए। उसके अंदर पी.एम.के.एस.वाई. प्रोग्राम बनाया गया। जल संसाधन मंत्रालय ने ही इसके लिए जून, 2014 में एक प्रेज़ेंटेशन दिया। फिर वर्ष 2014 में जो बजट बना, उससे पहले तीन बैठकें हुईं और उसके बाद कृषि मंत्रालय, जल संसाधन विकास मंत्रालय और ग्रामीण विकास मंत्रालय के लैंड रिसोर्स विभाग को इसका कार्यभार दिया गया। इन तीन मंत्रालयों को यह जिम्मेदारी दी गयी है। जैसे जल संसाधन मंत्रालय मेजर इर्रीगेशन, मीडियम इर्रीगेशन और कमान एरिया डेवलपमेंट के तहत इसे देखें कि सबको जल मिल रहा है या नहीं। कृषि मंत्रालय माइक्रो इर्रीगेशन और वाटरशेड मैनेजमेंट को देखें और इसी तरह लैंड रिसोर्सेज विभाग को इसका कार्यभार दिया गया है। इन तीनों मंत्रालयों में जल संसाधन मंत्रालय ने अपना कार्यभार बहुत तेजी से संभाला है।'

5.35 Further elaborating on the issue, the representatives of Ministry of water resources and Gangaa reguvination has stated as under:

'महोदय, जल संसाधन विकास मंत्रालय को प्रधानमंत्री कृषि सिंचाई योजना के लिए दो मदों के लिए कार्य करने की अनुमति मिली है। पहला है मेजर मीडियम प्रोजेक्ट्स, जो ए.आई.बी.पी. के अन्तर्गत पहले से चल रहे थे, उन्हें पूरा करने की जिम्मेदारी दी गयी है। दूसरा पीएमकेएसवाई -हर खेत को पानी- है। पीएमकेएसवाई-हर खेत को पानी- के अंतर्गत हमने पांच या छः कम्पोनेंट्स को हम लोगों ने सम्मिलित किया है। पहला है सरफेस माइनर इर्रीगेशन स्कीम। जो सिंचाई योजना 2000 हेक्टेयर से कम की हैं, उनके वित्त पोषण का जो भी प्रतिशत नियम के अनुसार केन्द्र सरकार के अन्तर्गत होगा, वह केन्द्र सरकार करेगी। दूसरा है, रिपेयर, रिनोवेशन एण्ड रेस्टोरेशन ऑफ वाटर बॉडीज़। उसके लिए जिला सिंचाई योजना में समाहित होकर जो योजनाएं आएंगी, उनका वित्त पोषण हम करेंगे। तीसरा है, कमांड एरिया डेवलपमेंट एण्ड वाटर मैनेजमेंट। देश में लगभग इस समय क्रियेटेड इर्रीगेशन पोटेंशिएल और यूटीलाइज्ड इर्रीगेशन पोटेंशिएल में 24 मिलियन हेक्टेयर का गैप है। हमारे पास योजना आयोग की जो फिगर्स हैं, उसमें हमारी 142 मिलियन हेक्टेयर जो अल्टीमेट सिंचित क्षमता है, उसमें 118 मिलियन हेक्टेयर सृजित हो चुका है, जिसमें से मार्च, 2013 के आंकड़ों के हिसाब से केवल 88 मिलियन हेक्टेयर का उपयोग हो पा रहा है। इस तरह यह जो 24 मिलियन हेक्टेयर का गैप है, उसको प्राथमिकता के आधार पर कमांड एरिया डेवलपमेंट वाटर मैनेजमेंट में प्रधानमंत्री कृषि सिंचाई योजना में हर खेत को पानी- के कम्पोनेंट में प्राथमिकता में रखा है। है, रिसाइकल्ड वाटर। सीवेज ट्रीटमेंट प्लांट से जो पानी ट्रीटमेंट के बाद निकलेगा, उसे संभवतः किसी नजदीकी सिंचाई नहर नेटवर्क तक पहुंचा दिया जाए। जिस समय सिंचाई की सुविधा की जरूरत नहीं है, उस समय पर उस पानी को नज़दीकी वाटर बॉडीज़ में डाल दिया जाए। चौथा भूमिगत जल के संबंध में है। हम लोग अब तक भूमिगत जल का वित्त पोषण नहीं करते थे। भूमिगत जल को भी इसमें समाहित कर दिया गया है। इसके अलावा, राज्य सरकारों को भी पूर्ण रूप से यह अधिकार दिया कि अगर उनके विचार से किसी खास किसान को पानी पहुंचाना है या कोई नई पद्धति से काम करना है, तो वह नई पद्धति भी जिला सिंचाई योजना में शामिल कर लें। जब जिला सिंचाई योजना और राज्य सिंचाई योजना अनुमोदित हो कर आ जाएगी तो जल संसाधन मंत्रालय को जो वित्त पोषण करना है, वह उसे उपलब्ध कराएगा। इस तरीके से इसमें हमने जलवायु परिवर्तन का ध्यान रखते हुए इसमें जो भी तरीके हो सकती थीं और जिस तरीके से भी सिंचाई की सुविधा उत्पन्न की जा सकती है, उसे करने के लिए हमने पूरा अनुपात बना दिया है और उसमें राज्य सरकारों को भी पूर्ण स्वायत्तता दे दी है।'

5.36 Further elaborating on the PMKSY scheme, the representative of Ministry of Water resources and Ganga Rejuvination has stated as under:-

'माइनर इरिगेशन दो हजार हैक्टेअर से कम की हैं। यह बहुत पापुलर स्कीम है और इससे तुरंत किसानों को फायदा होता है, क्योंकि मेजर और मीडियम इरिगेशन प्रोजैक्ट्स में दस से बारह साल लगते हैं और ये परियोजनाएं तीन साल में पूरी हो जाती हैं तो इनका किसानों को बहुत अच्छा लाभ मिल रहा है।

दूसरी बात यह है कि ग्राउंड वाटर के लिए हमारे पास अब तक कोई स्कीम नहीं थी। ग्राउंट वाटर के लिए हमने स्टेट्स को कर दिया है।तीसरा रिपेयर, रिनोवेशन, रिस्टोरेशन ऑफ वाटर बाडीज में जो आप लोगों की चिंता थी, हम लोगों ने जल मंथन किया, उसमें राज्यों के प्रतिनिधि आए, उन्होंने बताया और जो आपने कहा कि छोटी-छोटी नदियां सूख गई हैं, छोटी वाटर बाडीज सूख गई हैं तो हमने पूरी स्कीम रीवैम्प कर दी है। यह माननीय मंत्री जी के पास अप्रूवल के लिए रखी हुई है। जो भी क्लस्टर ऑफ स्कीम मिलकर दो हजार हैक्टेअर तक इरिगेशन प्रोवाइड कर देंगी, उन सब स्कीम्स को हम इसमे शामिल कर लेंगे, चाहे वे इर्रिस्पैक्टिव वाटर बाडीज हों, चैक डैम्स हो, नदियां हों या नाले हों, उन सबको इस स्कीम के लिए लागू कर दिया है।'

5.37 While explaining availability of funds for implementation of PMKSY, the representative of Ministry of Water resources and Ganga Rejuvination has stated as under:-

'वर्तमान में हमें पीएमकेएसवाय में टोटल 50,000 करोड़ रुपये आवंटित किए गए हैं, जिनमें से 20,000 करोड़ रुपये अगले पांच वर्षों के लिए जल संसाधन मंत्रालय को दिए गए हैं। जल संसाधन मंत्रालय की कमिटेड लायबिल्टी लगभग 92,000 करोड़ रुपये थी, जो आन-गोइंग प्रोजेक्ट्स को कंप्लीट करने के लिए थी। हमारे पास 297 मेजर और मीडियम प्रोजेक्ट्स थे, जिनमें से हमें 143 प्रोजेक्ट्स राज्य सरकार की मदद से पूरे कर दिए थे। इन बृहद और मध्यम श्रेणी की परियोजनाओं को पूरा करने हमारी भूमिका ऐसी थी कि राज्य सरकारों ने बहुत सारी परियोजनाएं एक साथ चालू कर दी थीं, लेकिन उनको पूरा नहीं कर पा रही थीं। वे परियोजनाएं एडवांस्ड स्टेज ऑफ कंस्ट्रक्शन में पहुंच गयी थीं, लेकिन धन के अभाव में पूरी नहीं हो पा रही थीं। इसलिए वर्ष 1996-97 में एक्सेलरेटेड इरिगेशन बेनिफिट स्कीम शुरू की गयी जिससे राज्यों को पहले लोन दिया गया और बाद में वर्ष 2004 में उसे अनुदान में कन्वर्ट कर दिया गया, इसलिए हम अनुदान देकर उन परियोजनाओं को पूरा कर सके। यह गर्व की बात है कि 143 परियोजनाएं सभी समस्याओं के बावजूद पूरा हो सकीं। बाकी 146 ऑन-गोइंग परियोजनाएं हैं।'

5.38 The representative of Ministry of Water resources and Ganga Rejuvination has also stated about flexibility provided to the State Governments in the scheme as under:-

'स्वविवेक से राज्य सरकार किसी भी खेत को पानी पहुंचाने के लिए योजना बनायेगी, हम फंड करेंगे, उसके तहत वह कवर हो जायेगी। कहीं पर किसी भी स्कीम में कितने भी छोटे खेत को पानी देने का प्रयास होगा, वह इस योजना में शामिल हो जायेगा। एक क्लाज जो हमने रखी कि राज्य सरकार स्वविवेक से जो भी परियोजना बनाना चाहती है।'

Support to Farmers for Adoption of Improved Irrigation Methods

5.39 On the query of the Committee regarding support being given to the farmers in India for adopting precision irrigation such as drip/ sprinkler irrigation method etc., the Department have stated as under:-

"...The rain-fed agro-ecologies cover about 55 per cent of the net cultivated area of India and is widely distributed in the country. Rain-fed agriculture is always vulnerable due to vagaries of monsoon. Change in weather pattern, long dry spells, deficit rainfall, change in onset and withdrawal of monsoon has always affected adversely the agriculture production and put the farmers who are mainly small and marginal category into risk in farming. Provision of water as live saving irrigation and adoption of integrated farming systems including agro-forestry are among the most effective adaptability measure to minimise this risk. With the objective to provide water security to agriculture sector, Pradhan Mantri Krishi Sinchayee Yojana has been launched with the motto of 'Har Khet Ko Paani'.

PMKSY aims at providing end-to end solutions in irrigation supply chain, viz. water sources, distribution network and farm level applications. PMKSY not only focuses on creating sources for assured irrigation, but also creating protective irrigation by harnessing rain water at micro level through 'Jal Sanchay' and 'Jal Sinchan'. It also focuses on water conservation and ground water recharge. Micro irrigation will be popularised to ensure 'Per drop-More crop'. Programme architecture of PMKSY adopts a 'decentralized State level planning and projectised execution' structure that will allow States to draw up their own irrigation development plans based on District Irrigation Plans and State Irrigation Plans prioritising the immediate needs of the state. Ministry of Water Resources, River Development & Ganga Renuvenation, Deptt. of Land

Resources and Deptt. of Agriculture Cooperation & Farmers Welfare are jointly implementing the programme with the responsibility to implement specific components of the programme.

Dept. of Agriculture, Cooperation & Farmers Welfare has been assigned as implementing department for the component of 'Per Drop More Crop' of the programme which is mostly to address water use efficiency at farm level. During 2015-16, Rs.1000.28 crore were released to the States for installation of micro irrigation systems in the farmers' fields and as per information made available by them, about 5.72 lakh hectare has been covered under drip and sprinkler systems. Besides promoting precision irrigation and better on-farm water management practices to optimise the use of available water resources, this component also supports gap filling interventions like micro level water storage or water conservation/management activities as 'Other Interventions' to complement and supplement the works undertaken through various national/state level programmes for drought proofing.

It has also been observed that 219 districts in the country have been frequently affected by drought in the recent past. These areas are witnessing regular agrarian crisis and the farmers are in the state of distressed condition, requiring special attention and support for a durable & sustainable solution. These areas have been considered for special treatment under this sub component to improve the condition of underground water, to improve soil moisture regime and to create micro water storages for protective irrigation during longer dry spells. In the notified blocks, funds have been given to the states for supplementing material component of selected MGNREGS projects on water harvesting/ conservation. Department of Agriculture and Cooperation released Rs. 433.9 crores for these activities. As per available reports about 17000 water harvesting structures have been created with nearly 25000 hectare of irrigation potential (life saving irrigation). From 2016-17 any supplementary interventions for drought proofing and water conservation works beyond the permissible limit are being supported under this intervention, based on district/state irrigation plan.

For the year 2016-17, Rs.1500 crores for micro irrigation and Rs.840 crores for other interventions respectively have been allocated under Per Drop More Crop component of PMKSY. Considering the drought situation in the 13 states, Rs.849 crores was released as first instalment for micro irrigation and Rs.398.90 crores for other interventions in advance during May, 2016 to tackle the drought situation…"

Interlinking of Rivers

5.40 Interlinking of rivers envisages transfer water from surplus to water deficit areas in the country. Inter-Linking River Program will help saving the people living in drought-prone zones from hunger and people living in flood-prone areas from the destruction

caused by floods. The idea of linking rivers had been proposed by Sir Arthur Cotton more than a century ago. Dr. K. L. Rao, the Minister of Power and Irrigation in the Cabinet of Smt. Indira Gandhi, revived this proposal in 1972. The then-Ministry of Irrigation (nowthe Ministry of Water Resources) conceived a plan for National Perspectives for Water Development in August 1980. This paved the way for the establishment of National Water Development Agency (NWDA) in 1982 to work out basinwise surpluses and deficits and explore possibilities of storage, links and transfers. It has identified 30 river links, which would connect every major river in the Indian mainland. NWDA has also prepared a feasibility report on six of these. The Supreme Court has also asked the Government of India to complete all planning required to launch the project by 2006 and these projects of inter-basin transfers be completed in the next 10 years or so. However, the Government is yet to start work on projects for interlinking of rivers. On the query of the Committee regarding policy/ views of Government of India for interlinking of rivers in the country, the Department have stated as under:-

> **"...**Interlinking of River (ILR) Programme has been taken up on high priority. The Government is pursuing the Interlinking of River program in a consultative manner. Its implementation is dependent upon the consensus and co-operation of the concerned States and upon obtaining various mandatory clearances from Ministry/ Departments of Central and State Governments including statutory clearances. The policy of Government of India for interlinking of rivers is to pursue the projects with consensus and cooperation of the States. In Himalayan Component, the proposed storages and the initial reaches of some of the water transfer links are falling in neighbouring countries of Nepal and Bhutan. To carry out surveys & investigations, their permission is essential. National Water Development Authority could not conduct the studies and investigations in the territory of Nepal and Bhutan to establish the feasibility of the links involving international dimensions..."

5.41 When asked about ways by which interlinking of rivers in the country will be able to solve availability of water for agriculture purpose, the DARE have stated as under:-

> **"..**Interlinking of Rivers schemes envisages construction of as many optimal storages as possible on these streams and interlinking them to make available appreciable quantum of water to solve availability of water for agriculture purpose as well as water supply to the needed areas. As per the National Perspective Plan, the implementation of interlinking would give benefits of 25 million ha of irrigation from surface water, 10 million ha by increased use of ground water, raising the ultimate irrigation potential from 140 million ha to 175 million ha and generation of 34 million KW of power apart from other benefits.

5.42 On the above issue, the representative of Ministry of Water Resources and Ganga Rejuvination has stated as under:-

'नदियां एक स्टैंड-एलोन सिस्टम नहीं हैं, वह एक पूरा रिवर बेसिन होता है। जल संसाधन मंत्रालय ने खोज की है कि जितने रिवर बेसिन्स हैं, उनमें इंटीग्रेटेड वाटर रिसोर्स डेवलपमेंट किया जाए। हमारे जो 20 मेजर रिवर बेसिन्स हैं, उनमें नदियों को जल, वाटर बॉडीज का जल, अंडरग्राउण्ड वाटर एवं एक्वीफर्स आदि सभी के रिसोर्सेस को एक साथ इंटीग्रेटेड वे में किया जाएगा। इसलिए ऐसी बात नहीं है कि अगर नदियों के जल को इंटरलिंकिंग के माध्यम से दूसरी नदियों में डायवर्ट किया जाए तो उससे ओवरआल इनवायरनमेंट्स डिसटर्बेंस होगा। जब पानी उनकी कैरिइंग कैपेसिटी से बढ़ता है तभी वह नदियों से डिसचार्ज होता है।'

5.43 Further elaborating on the above issue, the representative of Ministry of Water Resources and Ganga Rejuvination has stated as under:-

'हमारे देश में मॉनसून के समय में ही थोड़ी अच्छी बारिश होती है। नार्मली इसके लिए एक इंटरलिंकिंग ऑफ रिवर प्लान बना था। यह प्लान वर्ष 1982 से ही है। वर्ष 2003-04 में श्री वाजपेयी जी की सरकार में एक इंटरलिंकिंग ऑफ रिवर्स का प्लान बना था। वह एक बहुत ही बड़े मुद्दे के साथ बना था। उसमें 16 हिमालयन रिवर्स और 14 पेनिनसुला रिवर्स को लिंक करने का प्लान था। यह बहुत ही अच्छा प्लान था। लेकिन उस प्लान को पूरी तरह से डि-रेल करने की कोशिश की गयी। उनमें अधिकांशतः एनजीओज इंवोल्व्ड थे। सुप्रीम कोर्ट ने भी उसमें पहल की थी कि सरकार को यह करना जरूरी है। लेकिन उसके बावजूद न भारत सरकार कर पायी और न ही कुछ हुआ। उसका मेन रीजन यही था कि जल संसाधन का जो कंस्टीट्यूशनल प्रोवीजन है, उसके अंदर भारत सरकार को पावर नहीं है क्योंकि भी लिंक्स लिये गये उसमें कंसर्न स्टेट्स से भी काफी ऑब्जेक्शंस हुए। एक तरह से उसे अभी फिर रिवाइव किया गया है। अभी दो प्रोजेक्टस शुरू किये गये हैं- उनमें से एक पंचेश्वर प्रोजेक्ट है, जिसकी जानकारी श्री प्रदीप कुमार जी देंगे। उसमें नेपाल के साथ अंडरस्टैंडिंग आया है, दूसरा केन-बेतवा प्रोजेक्ट है, जिसमें यू.पी. और एम.पी. गवर्नमेंट के साथ यह बात काफी आगे बढ़ गयी है। इन दोनों प्रोजैक्ट्स में काम हो रहा है। इसके अलावा जरूरी है कि ईस्टर्न रिवर्स, जैसे ब्रह्मपुत्र में 600 बिलियन क्युबिक पानी है। देश में टोटल उपलब्ध पानी 1800 बिलियन क्युबिक है। उसमें एक तिहाई पानी केवल ब्रह्मपुत्र नदी में है। इंटरलिंकिंग ऑफ रिवर्स से अगर ब्रह्मपुत्र नदी के पानी को वेस्ट और साऊथ में डायवर्ट कर पाएं, जो कि बहुत हद तक पॉसिबल है, तो देश में जल की समस्या को बहुत हद तक कंट्रोल किया जा सकता है। इसमें भी न केवल भारत सरकार को इम्पावर करने की जरूरत है, क्योंकि इसका पावर बहुत कम है, क्योंकि इसमें राज्य सरकारों के को-ऑपरेशन की भी जरूरत है। यदि ऐसा नहीं हो पाया, तो हम लोग ऐसे ही चर्चा करते रहेंगे और यह समस्या बनी रहेगी। इसका निदान नहीं हो पाएगा। ये बहुत ही महत्वपूर्ण पहलू हैं। वाटर पॉलुशन एक बहुत ही महत्वपूर्ण मुद्दा है क्योंकि हमारे जल के बहुत ही लिमिटेड रिसोर्स हैं। अभी हम केवल 700 बिलियन क्युबिक मीटर पानी का ही संचयन कर पाये हैं। अलग-अलग जलाशयों, रिजरवायर्स और बाकी स्त्रोतों से 1300 बिलियन क्युबिक मीटर पानी समुद्र में जा रहा है। यदि इसे हम बचाना चाहते हैं, तो इसका उपाय इंटरलिंकिंग ऑफ रिवर्स है और दूसरा उपाय है वाटर रिसोर्सेज मैनेजमेंट।

5.44 When asked about environmental consequences of Interlinking of rivers in the country, the Department have stated as under:-

"...The Interlinking of Rivers (ILR) projects are environmental friendly. The adequate provision of water for environmental and ecological needs in the downstream of the proposed diversion structure is being kept while estimating the quantum of water for diversion. The environmental and ecological aspects of the project are duly examined and addressed in the Detailed Project Report (DPR) of each link. The ILR projects are green projects and are like any other water resources projects."

5.45 On the query of the Committee regarding arrangements of finance for projects on interlinking of rivers in the Country, the Department have stated as under:-

"...From the trends available about the availability of funds in the financial sector and the future projection of GDP and the savings rate it would clearly appear that sufficient domestic resources can be available for funding the programme. However, since these savings are entirely in terms of household savings and in the private sector, appropriate instruments have to be designed to channelize these funds into the programme. This can be through a combination of private participation, appropriate public-private partnership and pure public funding as was done for funding the roads programme..."

5.46 While explaining problems in implentation of interlinking of rivers due to constitutional provisons regarding water, the representatives of Ministry of water resources and Ganga rejuvination has stated as under:-

'महोदय, समिति की तरफ से बहुत बहुमूल्य सुझाव आए हैं और हमें खुशी है कि माननीय सदस्य पानी से संबंधित समस्या पर बहुत जागरुक हैं। माननीय सदस्यों को हमारे देश में पानी के कांस्टीट्यूशनल प्रोविजन की जानकारी होना बहुत जरूरी है क्योंकि बहुत से इश्यु इस संबंध में उठते हैं। जल राज्य का विषय है। इसका मतलब है कि जल के बारे में कोई भी प्लानिंग मैनेजमेंट राज्य सरकार द्वारा की जाएगी। राज्य सरकार की पहली जिम्मेदारी है कि पानी से संबंधित विषयों में प्लानिंग करे। लेकिन भारत सरकार उस प्लानिंग में मदद करने को जागरूक रहती है। कांस्टीट्यूशनल प्रोविजन्स के मुताबिक ही भारत सरकार कुछ कर सकती है। एक दूसरा पहलू कांस्टीट्यूशन में इंटर स्टेट डिस्प्यूट को लेकर है। इंटर स्टेट वाटर डिस्प्यूट में सुप्रीम कोर्ट को डिबार किया गया है। एडहॉक ट्रिब्यूनल्स ही इस डिस्प्यूट को रिजाल्व कर सकते हैं। अभी तक शुरू से आठ ट्रिब्यूनल्स काम कर रहे हैं, जिसमें तीन ट्रिब्यूनल्स ने अपने निर्देश दिए हैं जिनका पालन हो रहा है लेकिन ऐसा भी दस-बारह साल के बाद हुआ है। इंटर स्टेट डिस्प्यूट का इश्यू रिजाल्व करना बहुत ही मुश्किल है और इस वजह से कृष्णा, कावेरी, गोदावरी आदि नदियों के संबंध में दिक्कत आती है। इससे उन नदियों के मैनेजमेंट में भी दिक्कत आती है। इसलिए माननीय सदस्यगण इस पहलू पर गंभीरता से सोचें कि जल का अभी जो कांस्टीट्यूशनल स्टेटस है, क्योंकि पावर सैक्टर है, जिसमें इलेक्ट्रीसिटी कांक्रेंट सब्जेक्ट है, उसमें ब्यूरो आफ एनर्जी एफिशिएंसी बनकर पावर सैक्टर में काफी सुधार आया है। उस तरह का सुझाव अगर भारत सरकार चाहे कि वाटर रिसोर्सेस सैक्टर में हो ।'

5.47 When asked to furnish constitutional provisions regarding water, the Ministry of Water Resources, River Development and Ganga Rejuvination have stated as under:-

"The constitutional provisions in respect of allocation of responsibilities between the State and Centre fall into three categories: The Union List (List-I), the State List (List-II) and the Concurrent List (List-III). Article 246 of the Constitution deals with subject matter of laws to be made by the Parliament and by Legislature of the States. As most of the rivers in the country are inter-State, the regulation and development of waters of these rivers, is a source of inter-State differences and disputes. In the Constitution, water is a matter included in Entry 17 of List-II i.e. State List provides that "Water that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of Entry 56 of List - I". Whereas, Entry 56 of Union List provides for regulation and development of inter-State rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest."

The Department have also stated that Article 262 of the Constitution deals with adjudication of water disputes. The provisions in this regard are:

Article 262 (1)

Parliament may, by law, provide for the adjudication of any dispute or complaint withrespect to the use, distribution or control of the waters of, or in, any inter-State river or river valley.

Article 262 (2)

Notwithstanding anything in this Constitution, Parliament may, by law, provide that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in clause (1).

5.48 On the issue of interlinking of rivers in the country, Shri K. Nithianandan in his written memoranda submitted before the Committee has stated as under:-

"Rivers is our great sub-continent should be linked on a war footing so that more cultivable area will come under irrigation. Aim should be to eliminate completely dry land farming. It is sad to see enorinous rain and flood water rainy season goes waste and flows into sea. At the same time there is sever drought in other parts of the country. People struggle even to get drinking water."

Rejuvenation of Traditional Water Storage System

5.49 When asked about steps being taken to survey and improvement of traditional Water storage system such as tanks, ponds, Baories etc. in the Country, the Department have stated as under:-

"..GOI is implementing the Scheme for Repair, Renovation and Restoration (RRR) of water bodies which has multiple objectives like Comprehensive improvement and restoration of water bodies thereby increasing tank storage capacity, Ground Water Recharge, Increased availability of drinking water, Improvement in agriculture/horticulture productivity, Improvement of catchment areas of tank commands, Environmental benefits through improved water use efficiency; Promotion of conjunctive use of surface and ground water, Community participation and self-supporting system for sustainable management for each water body, Capacity Building of communities in better water management, Development of tourism, cultural activities etc. This is a continuing scheme since X Plan and is presently being implemented during XII Plan also.Steps taken by Ministry of Water Resources, River Development and Ganga Rejuvenation for Restoration, Renovation and Rehabilitation (RRR) of Water Bodies are as follows:

i. Pilot scheme on RRR of water bodies: During X Five Year Plan, a pilot scheme for repair, renovation and restoration of water bodies as a State Sector Scheme was launched by the Government of India. The pilot scheme envisaged a Plan Outlay of Rs. 300 crores to be shared by Centre and State in the ratio of 3:1. The objective of the pilot scheme on water bodies was to restore and

augment storage capacities of water bodies and to recover and extend their lost irrigation potential. The central share of Rs. 197.30 crore was released up to March, 2008 under the pilot scheme for taking up 1098 water bodies in 26 districts of 15 states. The work was completed in 1085 water bodies.

ii. Scheme of RRR of water bodies with domestic support during XI Plan: The Government of India approved the scheme of Repair, Renovation & Restoration (RRR) of water bodies with domestic support during the year 2009 at a Central outlay of Rs. 1250 crore for implementation as a State Sector Scheme during XI Plan period. The scheme provided for the comprehensive improvement of water bodies, catchment area treatment, command area development and capacity building of stakeholders. Central assistance of 90% of the cost of the project of Special Category States, KBK (undivided) districts of Odisha and projects located in drought-prone, tribal and naxal affected areas and Projects benefiting other areas of Non- Special Category States are eligible for 25% Central Assistance. 3341 water bodies costing Rs. 1309.16 crore with an aim to restore 1,83,102 ha of irrigable area have been taken up during this plan and the works of 2501 water bodies have been completed and a Central Assistance (CA) of Rs 917.259 crore has been released so far. An irrigation potential of 1,45,468 ha has so far been restored. The works of remaining 800 water bodies are under progress.

iii. Scheme of RRR of water bodies with external assistance during XI Plan: The Government of India (GoI) during the year 2008 approved a scheme on Repair, Renovation and Restoration of water bodies with external assistance. Under the scheme, GoI took 25% of the World Bank loan and passed it to the State Government as Central Assistance and 75% of the loan was transferred to the State Government on back to back basis to meet the State share. The Appraisal and implementation process were coordinated by Department of Economic Affairs, Ministry of Finance and World Bank. 10887 water bodies in four states namely Odisha, Karnataka, Andhra Pradesh and Tamil Nadu at an estimated cost of Rs 3672.42 crore were proposed to be covered. As per the latest progress, the works of 8054 water bodies have been completed. There is a potential restoration of around 8.48 lakh ha.

iv. Scheme for Repair, Renovation and Restoration of Water Bodies during XII Plan: The Scheme for Repair, Renovation and Restoration (RRR) of Water Bodies during the XII Plan has been approved by Cabinet Committee on Economics Affairs in its meeting held on 20.09.2013 and the new Guidelines were circulated to all the State Governments. Under the scheme, about 10,000 water bodies having a Culturable Command Area (CCA) of 6.235 lakh hectare at a cost of Rs. 10,000 crore would be covered. Out of 10,000 water bodies, 9,000 water bodies will be in rural areas and balance 1,000 water bodies will be in urban areas. Out of Rs. 10,000 crore, Central Share is Rs. 6235 crore.The Central Assistance(CA) will be in the form of grant which will be 90% of project cost in case of Special Category States (North-Eastern States including Sikkim,

Himachal Pradesh, Jammu & Kashmir, Uttarakhand and undivided Koraput, Bolangir and Kalahandi (KBK districts of Odisha) as well as projects lying in desert development programme(DDP),drought prone area/tribal area/Naxal affected area and Central Assistance of 25% of project cost in case of Non-Special Category States/areas.During 2014-15, a total of 1057 water bodies costing Rs 830.666 crore from 8 States (Odisha 760, Uttar Pradesh 8, Meghalaya 9, Uttarakhand 5, Madhya Pradesh 134, Tamil Nadu 105, Rajasthan 32 and Manipur 4) were included and a CA of Rs 103.48 crore was released. An amount of Rs 27.00 crore was also released during 2014-15 for water bodies of Odisha State which were approved during XI Plan.Similarly, during 2015-16, a total of 297 water bodies costing Rs. 195.21 crore from 3 States (Uttar Pradesh 66, Tamil Nadu 49, Telangana 182) were included under the Scheme. A Central Assistance (CA) of Rs. 103.48 crore was released for the water bodies of Odisha, Madhya Pradesh, Meghalaya & Manipur which were approved /included during 2014-15. Further, a Central Assistance (CA) of Rs. 161.19 crore was released for the water bodies of Odisha, Uttar Pradesh, Rajasthan, Tamil Nadu and Telengana which were approved /included during 2015-16."

Ground Water Resources Management

5.50 Over the years, due to enhanced availability of energy sources such as electricity and petroleum, groundwater has emerged as a secure source of supply for irrigation and become one of backbone of green revolution in the country. However, due to indiscriminate use has led to environmental consequences such as groundwater depletion, pollution and water quality deterioration. It has raised concerns to agrarian economies as millions of rural livelihoods now depend upon groundwater irrigation. Central Ground Water Board (CGWB) has identified 1071 blocks/ talukas under over exploited category, which need immediate special attention for water conservation and ground water recharge. They have also notified about 150 blocks/talukas as most vulnerable areas suggesting regulated and cautious use of ground water. These blocks witness serious scarcity of water and are vulnerable even to sustain drinking water requirement unless addressed for ground water recharge and its regulated use. When asked about the status of groundwater availability in the country, the Department have submitted following details:

Sl. No.	State	Annual replenishable groundwater resource (bcm)	Net annual groundwater availability (bcm)	Annual groundwater draft (bcm)	Stage of groundwater development (%)
1	Andhra Pradesh	35.89	32.57	14.51	45
2	Arunachal pradesh	4.51	4.06	0.003	0.08
3	Assam	28.52	25.79	3.49	14
4	Bihar	29.34	26.86	11.95	44
5	Chhatisgarh	12.42	11.63	4.05	35
6	Delhi	0.31	0.29	0.39	137
7	Goa	0.24	0.145	0.04	28
8	Gujarat	18.57	17.59	11.86	67
9	Haryana	10.78	9.79	13.05	133

10	Himachal Pradesh	0.56	0.53	0.38	71
11	Jammu & Kashmir	4.25	3.83	0.81	21
12	Jharkhand	6.31	5.76	1.86	32
13	Karnataka	17.03	14.81	9.41	64
14	Kerala	6.69	6.07	2.84	47
15	Madhya Pradesh	9.41	64	18.83	57
16	Maharashtra	2.84	47	17.18	53
17	Manipur	0.44	0.40	0.004	1.02
18	Meghalaya	1.78	1.60	0.0017	0.08
19	Mizoram	0.03	0.027	0.001	3.52
20	Nagaland	0.62	0.55	0.03	6.13
21	Odisha	18.83	57	4.73	28
22	Punjab	17.18	53	34.88	172
23	Rajasthan	4.73	28	14.84	137
24	Sikkim	--	0.044	0.011	26
25	Tamil Nadu	34.88	172	14.93	77
26	Tripura	2.587	2.358	0.163	7
27	Uttar Pradesh	77.19	71.66	52.78	74
28	Uttarakhand	2.04	2.00	1.13	57
29	West Bengal	29.25	26.58	10.69	40
	Total	432.11	397.60	244.85	62

(Source: CGWB, 2011)

5.51 On the query of the Committee regardig ICAR study on effect of excess groundwater exploitation on Indian agriculture sector and environmental health, the Department have submitted as under:

> "A study at Ludhiana AICRP centre on groundwater utilization under ICAR-IIWM showed that the groundwater level is decreasing over the years in state of Punjab. With declining water table, farmers are deepening existing bore wells and shifting from cheaper surface mounted centrifugal pumps to expensive submersible pumps. This is increasing the cost of pumping in the agriculture sector. It is found that the quality of groundwater deteriorates with excess groundwater exploitation due to accelerated diffusion of contaminants from industrial and urban effluents to the groundwater. A study at Junagarh AICRP center showed that due to overexploitation of groundwater, there is seawater intrusion in South Saurashtra coast of Gujarat state."

5.52 When asked to explain ways for augmentation of groundwater level in the country, the Department have submitted as under:

> **"**The groundwater level in the country can be maintained in the following ways.
>
> (a) Proper implementation of watershed management programmes.
>
> (b) Rainwater harvesting by creating farm ponds, percolation tanks and check dams.

(c) Regulation of groundwater withdrawal so that it does not exceed the natural groundwater recharge.

(d) Pricing of groundwater and abolition of free energy.

(e) Artificial recharge of groundwater.

(f) Rooftop rainwater harvesting in urban areas.

(g) Conjunctive use of surface water and groundwater."

5.53 When asked about the policy of Government regarding exploitation of groundwater, the Department have submitted as under:

"..The National water policy enunciates the following guidelines for groundwater

(a) There should be periodic assessment of the groundwater potential taking into consideration quality of the water available and economic viability.
(b) Exploitation of groundwater resources should be so regulated as not to exceed the recharge possibilities, as also to ensure social equity. Groundwater recharge projects should be developed and implemented for augmenting the available supplies.
(c) Integrated and coordinated development of surface water and groundwater and their conjunctive use should be envisaged right from the project planning stage.
(d) Overexploitation of groundwater should be avoided near the coast to prevent ingress of seawater into fresh water supplies.."

5.54 When asked to furnish details of programmes for augmentation of groundwater level in the Country, the Department have submitted as under:

"..The programmes for promoting enhancement of groundwater level in the Country are as follows.
(a) Integrated Watershed Management Programmes (IWMP).

(b) Demonstrative artificial recharge project under central sector scheme.

(c) Rooftop rainwater harvesting scheme.."

5.55 When the Committee enquired about efforts by the Government for encouraging rainwater harvesting capacity in the country, the Department have stated as under:-

"..The Department of Land Resources, Ministry of Rural Development had been implementing an area development programme i.e. Integrated Watershed Management Programme (IWMP) w.e.f. 26.02.2009, for development of rain-fed / degraded areas. The major activities taken up under IWMP inter-alia include ridge area treatment, drainage line treatment, soil and moisture conservation, rain water harvesting, nursery raising, afforestation, horticulture, pasture development, livelihoods for asset less persons. In 2015-16, the IWMP has been

amalgamated as the Watershed Development Component of the “Pradhan Mantri Krishi Sinchayee Yojana (WDC-PMKSY).."

As on 30.09.2016, a total of 8214 watershed projects have been sanctioned covering an area of 39.07 million ha and an amount of Rs.13403.08 crore released as Central assistance for all the States of the country except Goa under aforesaid scheme. The funding pattern under WDC-PMKSY is 60:40 between Centre and State Government except in the States of North Eastern Region and Hill States where the funding pattern between Centre and State Government is 90:10. As per the Common Guidelines for Watershed Development Projects-2008 (Revised Edition-2011), the period for completing WDC-PMKSY projects is between 4-7 years. These projects are at various stages of implementation.

During 12th Plan as per the directions of Ministry/NITI Ayog, CGWB has prepared and submitted an EFC proposal for Artificial Recharge in Six Over Exploited ground water blocks (OE Blocks) in Six States namely Andhra Pradesh, Madhya Pradesh, Punjab, Tamil Nadu, Telangana & Uttar Pradesh amounting to Rs 82.26 Crores on 28.04.2016 which has been revised and re-submitted on 29.09.2016 for amounting Rs.94.0 Cr. CGWB has also prepared Artificial Recharge Plans for 442 OE Blocks out of 500 Over exploited blocks in the states of Andhra Pradesh, Haryana, Karnataka, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Telangana and Uttar Pradesh in the country. Based on these AR plans, following Artificial Recharge proposals have been submitted to the Ministry on 24.06.2016. CGWB has prepared a conceptual document “Master plan for artificial recharge to ground water in India, 2013’ which provides State/UT wise information about area specific artificial recharge techniques to augment the ground water resources based on the availability of source water and capability of subsurface formations to accommodate it. Copies of the Master Plan have been circulated to all Hon’ble MPs along with DO letter from Hon’ble Minister for WR, RD & GR for its implementation in their respective constituencies. Copies were also given to respective state government for its implementation. This Master Plan has been placed on the website of Central Ground Water Board.."

5.56 When asked to spell policy of Government of India for controlling exploitation of ground water resources by the water bottling companies and other industries, the Department have stated as under:-

"..Central Ground Water Authority which is responsible for regulation and control of GW development and management in the country and it has undertaken following steps:

i. Notification of the blocks/ talukas/ mandals/areas for regulation of ground water development and management

- CGWA has notified 162 blocks/ talukas/ mandals/ areas in the country for regulation of abstraction of ground water in the country.

- In notified areas abstraction of ground water is not permissible for any purpose other than drinking-water.
- The District Administrative Head(s)/ Municipal Head(s) have been appointed as “Authorized Officer(s)” under Section 4 of the Environment (Protection) Act, 1986 to oversee “all issues pertaining to granting of NOC’s for ground water withdrawal, checking violations, sealing of ground water abstraction structure, launching of prosecution against offenders, attending of complaints are to be addressed by the Authorized Officers”.

ii. Regulation of ground water in non-notified areas - Issuance of No Objection Certificate (NOC) for ground water withdrawal

CGWA has framed “Guidelines / Criteria for Evaluation of Proposals / Requests for Ground Water Abstraction” to accord NOC for industries / infrastructure / mining projects which are existing, new or under expansion in non-notified areas.

iii. Directions/Advisory by CGWA

CGWA has issued suitable directions to all the Chief Secretaries of States/ Administrators of Union Territories and various organizations for regulation and management of ground water resources.

iv. Adoption of Model Bill

Ministry of Water Resources, River Development and Ganga Rejuvenation has been pursuing the matter regarding enactment of law on ground water with all States/UTs.The Model Bill was initially circulated in 1970 which has been re-circulated in 1992,1996 and 2005 to the States/Union Territories to enable them to enact suitable legislation for regulation and control of ground water development on the lines of Model Bill. So far, 15 States/UTs have already enacted and implemented the legislation in this regard. 16 other States/UTs are in the process of enactment of legislation.

v. Criteria for Recharge to Ground Water by the Industries using Ground Water as Raw Material and other Water Intensive Industries

Industries using ground water as raw material/water intensive industries like packaged drinking water, mineral water industries, distilleries, breweries, soft drink manufacturing industries, textiles, paper & pulp, etc. shall not be granted NOC for ground water withdrawal from Over-Exploited areas. In Safe, Semi-Critical & Critical areas NOC is mandatory for ground water withdrawal by these industries. However, ground water withdrawal will be limited as follows:

Category	**Ground Water Withdrawal Limit**
Safe	Withdrawal limited to 200% of ground water recharge.
Semi- Critical	Withdrawal limited to 100% of ground water recharge.
Critical	Withdrawal limited to 50% of ground water recharge.
Over- Exploited	No permission for ground water withdrawal by Industries.

vi. Criteria for Recharge to Ground Water by the Industries/ Infrastructure/ Mining Projects

Category*	**Mandatory Recycle/Reuse (for various purposes except recharge to ground water)**	**Withdrawal permitted (% of proposed recharge)**
Safe	Major and Medium Industries to recycle and reuse at least 40% of the waste water	NOC is required for ground water withdrawal subject to adoption of artificial recharge to ground water.
Semi- critical	Major and Medium Industries to recycle and reuse at least 50% of the waste water	Withdrawal may be permitted subject to undertaking of ground water recharge** measures. The withdrawal should not exceed 200% of the recharged quantity.
Critical	Major and Medium industries should fully recycle and reuse the waste water	Withdrawal may be permitted subject to undertaking of ground water recharge** measures. The withdrawal should not exceed 100% of the recharged quantity.
Over- exploited	All Industries to fully recycle and reuse the waste water	Withdrawal may be permitted subject to undertaking of ground water recharge** measures. The withdrawal should not exceed 50% of the recharged quantity.

*The guidelines will follow the category of blocks as on Ground Water Resource Estimation (GWRE) 2011 till further revision.
**The recharge should be implemented within the premises and/ or same watershed/ assessment unit. Detail project proposal shall be submitted along with the application for NOC."

5.57 On the issue of augmentation of underground water resources in the country, the Sri Sidhartha Welfare Trust has submitted as under:-

- "The underground water is depleting fast in dry zones due many factors which is causing the dehydration of the soils and death and disappearance of many lower order species of flora and fauna in addition to stress on farming being aggravated by GW & CC, The efforts of the govts through watershed models of cultivation and treatments are not yielding the required results. It has to be made compulsory at least in the holdings more that 2 ha in raid fed areas including in forest areas. An extent of 5% of the holding should be reserved for trees planting and a farm pond to a capacity of at least 250 to 500 mts to impound the runoff and recharge the underground water with tree planting around it without fail; and it is not difficult to do it by using machineries. The Government can finance for it as it helps in many ways the state.

- The bore wells are dug indiscriminately and failed bore wells are left to nature without making use for recharging the underground water table by the farmers. There should be authority to monitor bore wells; to permit digging of bore wells and take the failed bore wells to the account of the govt; and use it for recharging the underground water table- The failed bore wells, failed open wells and abandoned Kalyanis- stepped open wells of the South Inda are left to nature except Tamil Nadu which has a programme to use them for recharging under ground water. The government should have a scheme to create a channel intercepting the waste runoff water from the field-farm land to the failed well and allow it to pass through a chute fitted with a mess suitable to locality to filter the floating wastes carried by the runoff to make it suitable for infiltration in to the ground during rains. Tamil Nadu model needs to be followed."

5.58 On the above issue, S . Krishnamoorthi in his representation to the Committee submitted as under:

- "Lakes and Ponds are to be deepened so that more water can be stored Thereby excess Rain Water reaching the ocean can be averted and the underground water level will increase. It will enable us to utilized the reserved water during waterless summer season for irrigation and drinking purpose.
- All areas of River, Lakes, Ponds and Water Canals in the nation may be re-surveyed and recorded so that future encroachment by the unsocial elements can be averted."

CHAPTER-VI

APPROACH FOR MAKING INDIAN AGRICULTURE CLIMATE RESILIENT.

6.1 The need for a climate resilient approach to agriculture is critical for India where more than 80 percent agriculturists are small-holder farmers. the department of agricultural Education and research have informed that Climate change impacts on agriculture are being witnessed all overthe world, but countries like India are more vulnerable in view of the huge population dependent on agriculture, excessive pressure on natural resources and poor coping mechanisms. The warming trend in India over the past 100 years has indicated on increase of 0.60°C. The projected impacts are likely to further aggravate field fluctuations of many crops thus impacting food security.

6.2 There are already evidences of negative impacts on yield of wheat and paddy in parts of India due to increased temperature, water stress and reduction in number of rainy days. Significant negative impacts have been projected with medium-term (2010-2039) climate change, eg. yield reduction by 4.5 to 9%, depending on the magnitude and distribution of warming. Since agriculture makes up roughly 15% of India's GDP, a 4.5 to 9.0% negative impact on production implies cost of climate change to be roughly at 1.5% of GDP per year. Enhancing agricultural productivity, therefore, is critical for ensuring food and nutri/onal security for all, particularly the resource poor small and marginal farmers who would be affected most. In the absence of planned adaptation, the consequences of long- term climate change could be severe on the livelihood security of the poor. On the query of the Committee regarding strategy of the Government to make strategy to make Indian Agriculture climate resilient, the Department have stated as under:-

> "..Based on the scientific data and information obtained from several national and international agencies, it has now been understood that climate change is imminent. The ill effects of climate change are likely be seen in terms of frequent droughts, floods, hailstorms, cold and hot waves associated with extreme events imposing new challenges for successful husbandry of crops, horticulture, livestock, poultry, fisheries etc. Thus, ICAR initiated a National Network Project on Climate Change (2004-13) to assess the vulnerability of Indian agriculture to climate change over medium term (2010-2039) and identify possible adaptation options towards climate resilient agriculture. As a result, the council brought new paradigm of multidimensional approach to agricultural research with emphasis on environment, health, nutrition, and livelihood security besides productivity. Accordingly, a network of ICAR research institute are actively engaged in harnessing the power of science and innovations for food security, food safety, farmers prosperity and enhance natural resource base; disseminating the innovations through network of KVKs; and technical backstopping to developmental agencies under changing climate scenario.
>
> Further, the Government through ICAR has also initiated network project, National Innovations on Climate Resilient Agriculture (NICRA) during 2010-11. It encompasses multi-pronged strategic research, technology development,

capacity building of stakeholders and technology demonstrations at farmer's fields. The strategic research aims mainly to evolve crop varieties tolerant to climatic stresses like floods, droughts, frost, inundation due to cyclones and heat waves. Technology Demonstration Component (TDC) under NICRA aims at demonstration of location specific practices and technologies to enable farmers cope with current climatic variability. Demonstration of available location-specific technologies related to natural resource management, crop production, livestock and fisheries is being taken up in the climatically vulnerable districts for enhancing the adaptive capacity and resilience against climatic variability. TDC is being implemented in a farmer participatory mode in 151 vulnerable districts of the country..."

6.3 When asked about any assessment by ICAR regarding advantages/disadvantages of Indian Agriculture sector vis-à-vis global climate changes, the Department have stated as under:-

"..In recent years climate change and its variability are emerging as major challenges to Indian Agriculture. The projections of global climate change include altered average temperatures, rainfall, and increased extreme events (e.g. heat and cold waves, flooding), enhanced atmospheric carbon dioxide and ground-level ozone concentrations and rise in sea level leading to inundation of coastal areas etc. in recent past it is more evident, as one or the other part in the country is affected by droughts, excessive rains, floods, cyclones, frost, heat wave and other climatic events. The IPCC reports clearly outlined the global and regional impacts of projected climate change on agriculture, water resources, natural ecosystems and food security. Although, climate change impacts are being witnessed world over, the countries in which larger population is dependent on agriculture, such as India, are more vulnerable. The risks are likely to be experienced more by small and marginal farmers of rainfed and other risk prone regions with poor coping mechanisms.

The Department have further stated that climate change studies pertaining to India show enough evidence of rising mean temperature during post-1970 period. Greater warming of 0.21ºC per 10 years during post-1970 period as compared to 0.51ºC per 100 years during past century has been reported. Besides, country experienced 15 deficit and 6 excess monsoon years in post-1960 period in comparison to only 27 deficit and 20 excess monsoon years during 1871-2014. These climate change pattern has already begun affecting Indian agriculture sector adversely by enhanced abiotic and biotic stresses to crops and livestock. The studies under NICRA estimated around 81.3 million ha area in arid, semi-arid and dry sub-humid regions vulnerable to extreme weather events.

Various studies indicated overall reduction in productivity by 4-6% in rice, 6% in wheat, 18% in maize, 2.5% in sorghum, 2% in mustard and 2.5% in potato besides significant regional variability (Naresh Kumar *etal.,* 2012). The crop yields are projected to be more vulnerable in Central and East India for wheat;

Punjab, Haryana and Rajasthan for irrigated rice; Maharashtra, Odisha, Chhattisgarh and Assam for rainfed rice; Central India for mustard; and Punjab, Bihar, Jharkhand, Uttar Pradesh and West Bengal for potato. In total, agriculture makes up roughly 16% of India's GDP, an averaged 4.5-9.0% negative impacts on production implies a cost of climate change to be up to 1.5% of annual GDP. However, the study demonstrated that appropriate climate resilient interventions could greatly negate the impact of climate change.

Further, the analysis of recent weather data in Himachal Pradesh indicated that the maximum temperature is showing an increasing trend during November to April. Increase in the temperature limited the fulfilment of chilling requirement for apple production. The chill units hours showed decreasing trends upto 2400 meter above mean sea level (m amsl) (Kullu and Kinnaur districts). On the other hand increasing trends of chill units at 2700 mamsl suggested that area is becoming suitable for apple cultivation in higher altitude. This is partially attributed for shift of apple belt upwards from 1250 m amsl to 2500 m amsl and increasing area of apple in higher elevations. The new areas of apple cultivation have appeared in Lahaul and Spitti and upper reaches of Kinnaur district of Himachal Pradesh. While the apple productivity in lower elevations was impacted by increase in temperature, it also created opportunity for cultivation of other crops. Increase in temperature in higher elevations created opportunity for cultivation of apple and other fruits and vegetable crops. Increase in temperature did not show any significant impact on the productivity of other temperature fruits like peach, plum and pear. The tea crop in mid-hill regions also showed a decrease in yield with increase in temperature and decreasing trends of rainfall. Crop phenology revealed hastening of crop maturity in mid hill regions due to increase in temperature during crop seasons.."

National Innovations on Climate Resilient Agriculture (NICRA)

6.4 National Mission on Sustainable Agriculture (NMSA) has been formulated to make Indian agriculture more productive, sustainable, and remunerative and climate resilient. Enhancing the resilience of Indian Agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies; demonstrating site specific technology packages on farmers' fields for adapting to current climate risks; and capacity building of scientists and other stakeholders in climate resilient agricultural research and its application are the major objectives. The strategic research is being conducted at 40 ICAR Institutes in a network mode covering crops, horticulture, livestock, natural resource management and fisheries sectors. Activities like promotion of integrated farming system, integrated nutrient management, integrated pest management, water use efficiencies, management of rice cultivation practices like system of rice intensification (SRI), directed seeded rice (DSR) etc., conservation agriculture, livestock management, climate resilient varietal improvement, crop diversification etc. are taken up as sustainable agricultural practices.When asked to furnish objectives as enshrined in National Mission on Sustainable Agriculture (NMSA), the Department have stated as under:-

"...The NMSA drives its mandate from Sustainable Agriculture Mission which was one of the eight Missions outlined under National Action Plan on Climate Change (NAPCC). The Mission document was approved in principle by the Prime Minister's Council on Climate Change (PMCCC) on 23.09.2010 to promote sustainable agriculture through improved soil and water conservation, efficient water use, better soil health management and developing rainfed areas. The Mission have following objectives for the XII Plan:

- To make agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific Integrated/Composite Farming Systems;
- To conserve natural resources through appropriate soil and moisture conservation measures;
- To adopt comprehensive soil health management practices based on soil fertility maps, soil test based application of macro & micro nutrients, judicious use of fertilizers etc.;
- To optimize utilization of water resources through efficient water management to expand coverage for achieving 'more crop per drop';
- To develop capacity of farmers & stakeholders in conjunction with other ongoing Missions e.g National Mission on Agriculture Extension & Technology, National Food Security Mission, National Initiative for Climate Resilient Agriculture (NICRA) etc., in the domain of climate change adaptation and mitigation measures;
- To pilot models in select blocks for improving productivity of rainfed farming by mainstreaming rainfed technologies refined through NICRA and by leveraging resources from other schemes/Missions like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Integrated Watershed Management Programme (IWMP), RKVY etc.; and
- To establish an effective, inter and intra Departmental/Ministerial co-ordination for accomplishing key deliverables of National Mission for Sustainable Agriculture under the aegis of NAPCC.."

6.5 When asked about steps being taken by the Government of India to achieve the objectives of NMSA, the Department have stated as under:-

"....The NMSA has set following multi-pronged strategy to achieve the objectives as under:

- Promoting integrated farming system covering crops, livestock & fishery, plantation and pasture based composite farming for enhancing livelihood opportunities, ensuring food security and minimizing risks from crop failure through supplementary/ residual production systems;
- Popularizing resource conservation technologies (both on-farm and off-farm) and introducing practices that will support mitigation efforts in times of extreme climatic events or disasters like prolonged dry spells, floods etc.

- Promoting effective management of available water resources and enhancing water use efficiency through application of technologies coupled with demand and supply side management solutions;
- Encouraging improved agronomic practices for higher farm productivity, improved soil treatment, increased water holding capacity, judicious use of chemicals/ energy and enhanced soil carbon storage;
- Creating database on soil resources through land use survey, soil profile study and soil analysis on GIS platform to facilitate adoption of location and soilspecific crop management practices& optimize fertilizer use;
- Promoting location and crop specific integrated nutrient management practices for improving soil health, enhancing crop productivity and maintaining quality of land and water resources;
- Involving knowledge institutions and professionals in developing climate change adaptation and mitigation strategies for specific agro climatic situations and promoting them through appropriate farming systems;
- Pragmatic interventions as per land capability and conducive to climatic parameters in select blocks as pilots for ensuring integrated development through dissemination and adoption of rainfed technologies with greater reach in disadvantaged areas & location specific planning by way of coordination, convergence and leveraging investments from other Schemes/Missions like MGNREGS, IWMP, RKVY, National Food Security Mission (NFSM), Mission for Integrated Development of Horticulture (MIDH), National Mission for Agricultural Extension & Technology (NMAE&T) etc. A consortium approach may be evolved with various stake holders including knowledge partners like State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Indian Council of Agricultural Research (ICAR) Centres, professional organisations etc. by the State Government to provide single window service/ knowledge provider system for the benefit of farming community;
- State Government may engage reputed NGOs for implementation of cluster/village development plan in case of limited govt. infrastructure is available in that area through a transparent system of selection and defined process of supervision and monitoring through a line department.
- Strong technical monitoring and feedback systems on climate change mitigation and adaptation issues to the National Advisory Council for regular updates on technical feasibility of various components and their effectiveness in bringing about the climate resilience. The experts of central institutes and state agricultural universities would be part of such technical monitoring/feedback. The capacity building of the implementing agencies would be steered by MANAGE.."

6.6 When asked to furnish number of research projects undertaken in various research institutes under NICRA project since its inception, the Department have stated as under:-

"...About 40 Research Institutes of ICAR are conducting research under Strategic Research Component covering various research theme areas viz., development of multiple stress Tolerant Crop Genotypes, Natural Resource Management,

Green House Gas Emissions, Climate Resilient Horticulture, Marine, Brackish and inland Fisheries, Heat tolerant Livestock, Small Ruminants and Poultry. The institutes continue their research efforts till March 31st, 2017. About 12 Research projects were funded and concluded under Sponsored Research Component of NICRA and about 6 Research projects are continuing till March 31st 2017. Similarly, about 20 research projects were funded and concluded under Competitive Grant Component and about 14 research projects continue till March 31st, 2017.."

6.7 On the query of the Committee regarding policy of Government to involve State Agricultural Universities/research Institutes in private sectors under NICRA projects, the Department have stated as under:-

"..The nation-wide NICRA network programme has included 11-State Agricultural Universities from different states of the country and 2- Research Institutes in private sectors as a partner of the programme..."

6.8 When asked to furnish details of financial allocations and expenditure under the NICRA projects since its inception, the Department have stated as under:-

"..The year-wise details of financial allocations and expenditure under NICRA project is given here under:-

Year	Rs. In Lakhs	
	Sanctioned	Expenditure
2010-11	**19997.80**	5860.864
2011-12	11505.59	17226.1
2012-13	7500.00	6638.446
2013-14	7000.00	6360.282
2014-15	6500.00	5315.22
2015-16	9500.00	6344.554
2016-17	11000.00	**
Total	73003.39	47745.466*

**An amount of Rs. 5500.00 lakh received from Council and released to centres and expenditure details will be known by 31-Mar-2017.

Infrastructure and Research Facilities Creation under NICRA

6.9 In order to support strategic research on crops, livestock, fisheries and modelling, facilities/equipments like high through-put phenotyping platforms, free air temperature elevation (FATE), carbon dioxide and temperature gradient tunnels (CTGC), high performance computers, automatic weather stations, growth chambers, large glass

houses, animal calorimeter, shipping vessel, flux towers and satellite receiving station were commissioned at different Institutions.When asked to furnish Institute-wise details of infrastructure and research facilities created under NICRA project since its inception, the Department have stated as under:-

"...The list of Institute-wise details of infrastructure and research facilities created under NICRA project since its inception is as under:

ICAR Institute	Major Equipment / Facility established
CIAE, Bhopal	TOC Analyzer, Precision vegetable seeder
CIBA, Chennai	Aquaculture laboratory, Greenhouse gases measuring unit Agilent&78908, Multi parameter water quality analyser, CHN analyser
CMFRI, Kochi	Fishery Biology laboratory
IARI, New Delhi	Plant Phenomic Facility,Eddy Covariance Sensor Flux Tower, Photo Synthesis Chlorophyll Fluorescence System, Refrigerated Centrifuge, Gas Chromatography with all accessories, FATE along with CO_2 Rings, PCR Tetrad with accessories, Pressure Chamber Equipment, Plant Canopy Analyser, Time Domain Reflectometer (TDR), Infrared Thermal Imaging System, Protein Separation System, Satellite Data Reception System,
IIHR, Bangalore	Plant Phenomics Facility, Free Air Temperature Enrichment (FATE) facility, CO_2& Temperature Gradient Chamber (CTGC) facility, Environment controlled chamber facility, Photosynthesis system with chlorophyll florescence Portable Gas Exchange Florescence System, Root image scanning system, Line Quantum, Sensor with accessories, UV visible Spectrophotometer
NDRI, Karnal	Livestock Waste Disposal System, Custom Designed and Fabricated Animal Shed in cattle yard, Heating Air Conditioning Ventilation and cooling system in Psychometric Chamber, Gel Documentation System, Multi gas Analyzer System, Physiological Function Monitor, Real Time PCR Machine
CAZRI, Jodhpur	Rainout shelter, CHNS Analyzer, Gas Chromatograph, Leaf area meter, Stereo zoom microscope, IRGA.
CIRG, Makhdoom	2D Electrophoresis, Micro. Litre –spectrophotometer,
CPRI, Shimla	Microsoft/ relational database SQL SvrEnt co mng. system
CSWRI, Avikanagar	Automatic weather station
IISS, Bhopal	Soil Penetrometer, Gas Chromatography
DOGR, Pune	Automated Rainout Shelter facility
IIWBR, Karnal	Automated Rain out shelter facility
CRIDA, Hyderabad	ST-100Na/K/Cl Electrolyte Analyzer, Automatic Biochemistry Analyzer-ichem-168, Micros 60 Automatic Haematology Analyzer, In vitro Gas Production system with wireless RF sensors, In vitro digestion DAISY Incubator, CO2 growth chamber, CO2 and temperature gradient chambers (CTGC), Plant Phenomics Facility,Free Air Temperature Enrichment (FATE) facility, Free Air Co2 Enrichment (FACE)Facility, Root image scanning system, Gas chromatograph(GC),N Distillation set, SCADA,Automatic weather station, Video conferencing system, Net Radiometer, Infrared thermometer

NIASM, Baramati	Plant Phenomics facility, Green house facility
NRCPB, New Delhi	Nano drop, Real time PCR, 80°C Deep Freezer, Photosynthesis System, Environmental shaker
IIWM, Bhubaneswar	Bowen Ratio Tower (Open path eddy covariance based carbon dioxide measuring system), Automatic Weather Station
CRRI, Cuttack	Eddy covariance system
NEH Region, Barapani	Free air temperature enrichment facility (FATE), CO_2 and temperature Gradient Chamber (CTGC), Walk in plant growth chamber (small), Environment Controlled Chamber facility (6), Network of automatic Weather Stations with modem, Rain Out shelter facility, Biochar-1000 with automatic temperature, O_2 and pressure controlled Biochar making system, Protein separation system and characterization facility, Controlled environment laboratory shakers, Photosynthesis system with chlorophyll fluorescence, Time domain reflectrometry, TOC analyzer, Lysimeter with electronic sensors, GC and accessories/ Methane and CO_2analyzer, Soil respiration unit, Root image scanning system, Psychrometer, Cold rooms, Atomic absorption spectrophotometer with graphite furnace, Ultra low deep freezers, Radio telemetry with physiological data recording, Ultra sound with colour Dapple & Cardiac probe, Phase Contrast microscopes with stereo zoom and fluorescence attachment
DPR, Hyderabad	Environment control house,UV spectrophotometer, Growth chamber
CICR, Nagpur	Open top chamber

6.10 On the query of the Committee regarding assessment of research facilities, infrastructure, manpower requirement that required to promote research under NICRA project, the Department have stated as under:-

> "..The major infrastructure required for climate change research have been made in some of the core ICAR institutes representing different sectors viz., Crop Sciences, Horticultural Sciences, Fisheries, Livestock, Poultry and Natural Resource Management. However, some of the facilities require maintenance and servicing by the authorized service providers. Additionally, substantial amount of contingency is required for maintenance and up-keeping of these facilities and equipment. Additional contractual help in the form of Research Associates, Senior Research Fellows and Skilled helpers have been provided during the past five years to carry out the mandated research under NICRA at 40 ICAR research institutes (220 RAs + 515 SRFs)and 121 KVKs (260 SRFs) across the country. In order to carry out the research activities which were initiated during XII Plan period need to be supported by such manpower for few more years. The proposal for expanding the Technology Demonstration Component (TDC) to few more villages require additional manpower (1 SRF for each KVK, 2 SRF for each ATARI) and contingency grants (Rs.10.00 Lakhs per year) and NRC (Rs. 8.00 Lakhs per year) for establishing custom hiring centres at each KVK..."

6.11 When asked about assessment of funds that will be required to fund research projects under NICRA Projects, the Department have stated as under:-

"...The project was initiated during 2011 with 21 research institutes and expanded to 40 institutes, 121 KVKs, 23 AICRPDA and 25 AICRPAM villages. Majority of the infrastructure required to carry out research has been established in these institutes and demonstration of climate resilient technologies in 160 villages representing the most vulnerable districts is under progress. It is important to continue the research activities in some of the institutes after assessing the performance through a third party evaluation. And also it is proposed to expand the technology demonstration to several other vulnerable districts. The capacity building on climate change technologies and research also need to be continued. The Department has submitted following details regarding assessment of fund for NICRA projects for next three fiscal:-

2017-2018	2018-2019	2019-2020
1300.00	1500.00	1730.00

Technology Demonstration Component (TDC)

6.12 The Department in their background note have stated that the technologies with a potential to cope with climate variability are being demonstrated under Technology Demonstration Component (TDC) in 121 most vulnerable districts selected across the country through Krishi Vigyan Kendras (KVK). When asked to furnish module-wise details of demonstrations under TDC under NICRA projects since its inception, the Department have stated as under:-

"..In TDC, the interventions being taken up can be broadly divided in to four groups

a). Natural resource Management (NRM)

NRM interventions consist of site specific rainwater harvesting structures in drought affected areas; recycling of harvested water through supplemental irrigation to alleviate moisture stress during midseason dry spells; improved drainage in flood-prone areas; conservation tillage; artificial groundwater recharge and water saving micro-irrigation methods etc.

b). Crop production

Under the crop production, demonstrations consist of practices and technologies aimed at ensuring stability and resilience to crop production as a strategy for addressing climatic variability. Demonstrations included drought and flood tolerant varieties, community nurseries for delayed monsoon, water saving paddy cultivation methods (SRI, aerobic, direct seeding), green manuring, nitrogen management, advancement of planting dates of rabi crops in areas with terminal heat stress, frost management in horticulture through fumigation, popularization of location-specific & risk-reducing intercropping systems with high sustainable yield index. In-situ moisture conservation practices through ridge and furrow and raised bed planting in soybean, cotton, maize, pigeonpea, short duration pulses,

vegetables, wheat, mustard, sugarcane, potato and vegetables were also taken up.

c). Livestock and fisheries

Under the livestock & fishery module, demonstration of fodder production especially under drought/flood situations, improved shelter for reducing heat stress in livestock, siloge making methods for storage of green fodder and feeding during the dry season, breed selection and stocking ratios for fish production in farm ponds and monitoring of water quality in aquaculture and Integrated farming system models in diverse agro ecosystems.

d). Institutional interventions

Under the institutional interventions, enabling support system in the village comprising of strengthening of existing institutions or initiating new ones (Village Level Climate Risk Management Committees (VCRMC)), establishment and management of Custom Hiring Centers (CHCs) for farm implements, seed bank, fodder bank, creation of commodity groups, water sharing groups, community nursery, initiating collective marketing by tapping value chains are some of the interventions taken up in NICRA villages."

6.13 When asked about criteria for selection of Districts for under Technology Demonstration Component (TDC) under the project, the Department have stated as under:-

"Project sites for the climatic vulnerabilities have been selected using the following criteria:

1. Drought proneness based on 30 years' rainfall data (Source: IMD)
2. Cyclone proneness based on frequency as recorded by IMD/State Disaster Management agencies.
3. Flood proneness based on IMD data and NDMA maps.
4. Vulnerability to heat wave and cold wave based on IMD grid data on temperatures.
5. Actual incidence of floods and droughts as recorded by ICAR-CRIDA-AICRPAM centers

Based on the above criteria, 121 districts involving 28 states and 1 union territory across the country have been selected. The vulnerability assessment for all the districts of the country was also considered in finalizing the districts for the technology demonstrations. As ICAR-KVKs are in direct contact with the farmers at the district level and has the technical expertise, they were involved for demonstrating the resilient technologies to climate change. Further, selection of vulnerable districts and KVKs have been made considering their strengths i.e. the availability of subject matter specialists, better understanding about the crop weather situations in the surrounding villages and better network with the line departments within the selected districts. Villages were selected in consultation with research organizations located in the selected district and the line departments.."

6.14 On the query of the Committee regarding impact assessment by the ICAR on agricultural productivity in Districts selected for Technology Demonstration Component (TDC) to assess its impact, the Department have stated as under:-

> "..The impact of the climate resilient interventions is being taken up as part of the TDC of NICRA and is continuously monitored with the developed questionnaires designed for the same purpose..."

6.15 When asked about targets set for target and achievement of training of farmers under NICRA projects since its inception the Department have stated as under:-

> "..Trainings were organized on various aspects aiming at enhancing the adaptive capacity of the communities and skill up gradation. The number of trainings organized were 816, 1157, 927, 1016 and 1042. The number of participants was18873, 25493, 24153, 31979 and 32219 during 2011, 2012, 2013, 2014 and 2015, respectively in 100 KVKs. About 526 programmes were conducted involving 7581 participants by the new 21 KVKs. Various aspects related to natural resource management, efficient cultivars and cropping systems, livestock and fisheries, nutrient management, resource conservation technology, farm implements and machineries, livestock, feed and fodder management, nursery raising, vermicompost and kitchen gardening for enhancing nutritional security, etc. were covered as part of the training for farmers in NICRA villages..."

6.16 On the query of the Committee regarding policy of the Government to involve progressive farmers in research projects being undertaken under NICRA projects, the Department have stated as under:-

> "..The progressive farmers are being involved in the technology demonstration component of NICRA. As part of the TDC, demonstrations are being conducted in 121 climatically vulnerable districts of the country on various aspects.."

Institutional Intervention under NICRA Project

6.17 The Department in their background note have further stated that as part of institutional interventions under NICRA project, 100 custom hiring centers (CHCs) for farm machinery were setup with about 30 different types of farm implements to improve the timeliness of operations during the limited window periods of moisture availability in rainfed areas and to promote small farm mechanization for adoption of climate resilient practices. A novel Village Climate Risk Management Committee (VCRMC) comprising of villagers was constituted in each of the 100 villages to manage the custom hiring of implements as a paid service operated through a bank account. About 20 such CHCs were studied in detail for their functioning by a joint committee of experts. Over 700 demonstrations with farm implements were carried out to demonstrate appropriate climate resilient practices such as drum seeding of rice, planting on broad bed furrow/furrow irrigated raised bed, crop residue recycling and zero tillage in wheat and

summer pulses. The revenue generated from these centres can serve the needs of capacity building of farmers on using the farm machinery and undertake repair when needed. This fund can act as sustainability fund. These participatory demonstrations are quite successful and have attracted the attention of development departments in several States and triggered the horizontal up-scaling. Other institutional interventions include establishment of seed bank, fodder bank, commodity groups and introduction of climate literacy through setting up of village level automatic weather station. Further, in the XII Plan, a module on use of ICT for knowledge empowerment of the communities in terms of climate risk management will be taken up in select KVKs which have good tele-connectivity with generation of locally relevant content and its dissemination in text and voice enabled formats. A module on studying the impact of climate variability on women is also proposed to be taken up.When asked to furnish criteria for setting Custom Hiring Centres for farm machinery under NICRA project during XI and XII Plan, the Department have stated as under:-

> "..Custom Hiring Centres (CHCs) for farm implements were established in all the 100 NICRA villages during XI plan. During XII plan 21 new KVKs were added and custom hiring centres were established in all the new KVKs also. Criteria for setting of CHCs followed to implement TD component of NICRA involved identifying climatically most vulnerable districts of the country and one representative village for each of the 121 vulnerable districts based on long term data of climate for implementing appropriate adaptation and mitigation strategies and for enhancing the adaptive capacity of the communities against the climatic vulnerabilities. The focus of the programme was not only to demonstrate the climate resilient agriculture technologies but also to institutionalize mechanisms at the village level for continued adoption of such practices in sustainable manner in the years to come. One representative village or a cluster of villages from each of the 121 identified vulnerable districts was selected for this purpose by respective Krishi Vigyan Kendra (KVK) in the district. A Village Climate Risk Management Committee was constituted to manage the custom hiring centre at the village. The rates for hiring the machines/ implements were decided by the committee itself depending upon the socio-economic condition and cropping intensity of the village. Every farmer in the village can hire the machines from these centres. The modalities have been decided by the committee members and amended from time to time as per the local situation and needs. This committee also uses the revenue generated for repair and maintenance of the implements and remaining amount goes into revolving fund.."

6.18 When asked to furnish details of institutional intervention such as seed bank, fodder bank, commodity groups which were envisaged under NICRA projects, the Department have stated as under:-

> "..Participatory village level seed production of short duration, drought and flood tolerant varieties was demonstrated in all the NICRA villages with the support of KVKs in rice, soybean, groundnut, greengram, finger millet, foxtail millet, pigeonpea, etc and seedbank involving these varieties were established in the KVKs. Availability of suitable varieties of fodder seed for various contingency

situations is a serious constraint for implementation of contingency plans in districts experiencing deficit rainfall. Breeder seed / foundation seed was sourced from research farms for multiplication in farmer's fields and the quality seed so produced was mostly used in the village and nearby villages. Farmer to farmer sale as truthful seed was the means of spread. During 2014-15 total 18,964 q seeds of paddy, soybean, foxtail millet, cluster bean, wheat, chickpea, and rapeseed& mustard were produced at farmer level in the village. Fodder based interventions were takenup in all the NICRA villages and fodder bank was established. Short and medium duration fodder varieties were demonstrated in 276 ha covering 762 farmers during the year 2014-15. Effective linkages were developed with state animal husbandry department and state veterinary universities for implementation of successful seed production plan well in advance.."

6.19 When asked to furnish State-wise details of CHCs, seed bank, fodder bank, commodity groups established so far under the Project, the Department have stated that Village level seed and fodder banks were established in 121 NICRA villages. The Department have also furnished following State wise details of CHCs, seed bank and fodder bank established under NICRA**:-**

S.No.	State	No. of KVKs	KVK
	Zone I		
1.	Haryana	2	Sirsa, Yamunanagar
2.	Himachal Pradesh	4	Chamba, Hamirpur, Kullu, Kinnaur
3.	Jammu & Kashmir	3	Kathua, Pulwama, Bandipora
4.	Punjab	5	Bathinda, Fatehgarh Sahib, Faridkot, Ropar
	Zone II		
5.	A & N Island	1	Port Blair
6.	Bihar	7	Aurangabad, Buxar,Jehanabad, Nawadah, Saran, Supaul, Banka
7.	Jharkhand	6	Chatra, East Singhbhum, Gumla, Koderma, Palamau, Godda
8.	West Bengal	3	Coochbehar, Malda, South 24 Paragana
	Zone III		
9.	Arunachal Pradesh	3	Tirap, West Kameng, West Siang
10.	Assam	5	Cachar, Dibrugarh, Dhubri, Sonitpur, Karbi-Anglong
11.	Manipur	3	Imphal East, Senapati, Ukhrul
12.	Meghalaya	3	Umaim, West Garo Hills, Jaintia Hills
13.	Mizoram	2	Lunglei, Serchhip
14.	Nagaland	4	Dimapur,Mokokchung, Phek, Mon
15.	Sikkim	1	East Sikkim
16.	Tripura	2	West Tripura, Dhalai
	Zone IV		

17	Uttar Pradesh	13	Bahraich, Bhagpat, Chitrakoot, Gorakhpur, Gonda, Hamirpur, Jhansi, Kushinagar, Maharajganj, Muzaffarnagar, Sonbhadra, Kaushambi, Pratapgarh
18	Uttarakhand	2	TehriGharwal, Uttarkashi
	Zone V		
19.	Andhra Pradesh	5	Ananatapur,Kurnool, Srikakulam, West Godavari, Chittoor
20.	Maharashtra	8	Amravati, Aurangabad, Ahmednagar, Baramati, Buldana, Nandurbar, Ratnagiri, Jalna
21.	Telangana	2	Khammam, Nalgonda
	Zone VI		
22.	Gujarat	5	Valsad, Rajkot, Kutch, Banaskantha, Amreli
23.	Rajasthan	5	Jhunjhunu, Bharatpur, Jodhpur, Kota, Barmer
	Zone VII		
24.	Chhattisgarh	3	Raipur, Bilaspur, Dantewada
25.	Madhya Pradesh	9	Satna, Guna, Morena, Datia, Tikamgarh, Chhatarpur, Balaghat, Ratlam, Jhabua
26.	Odisha	5	Kendrapara, Jharsuguda, Sonepur, Ganjam, Kalahandi
	Zone VIII		
27.	Karnataka	6	Tumkur, Kolar, Davangere, Belgaum, Gadag, Kalburgi (Gulbarga)
28.	Kerala		Alleppey
29.	Tamilnadu	4	Namakkal, Thiruvarur, Ramanatha-puram, Villupuram

6.20 On the query of the Committee regarding financial assistance being provided to the Farmers for setting of CHCs under NICRA project, the Department have stated as under:-

> "..During the XIthplan, Rs.6.25 lakhs per unit was funded to the 100 NICRA KVKs and andRs. 7.0 lakhs wereprovided to new 21 KVKs for establishment of custom hiring centre during XIIth plan. In addition to the above, Rs. 4.50 lakhs per KVK were provided during 2015-16 for further strengthening of the CHCs..."

6.21 When asked about plan of Government for establishment of CHCs at Block/Panchayat level in entire country, the Department have stated as under:-

> "...There is no such plan pending with the Government to establish CHC at Block/Panchyat level in entire country..."

6.22 When asked to furnish a summary on plan for introduction of climate literacy through setting up of village level automatic weather station, the Department have stated as under:-

> "...Through the NICRA project, ICAR has identified 100 most vulnerable districts to climate change in the country. All India Coordinated Research Project on Agro meteorology has taken the lead role in establishing automatic weather stations

(AWS) in the above mentioned highly vulnerable districts for collecting the half-hourly real time observations, quality checking and analyzing these data for monitoring droughts, floods, cold and heat waves. AWS data is one of the major inputs in preparing the agro-met advisory services (AAS) and the same is disseminated to farmers of AICRPAM-NICRA adopted villages at each center twice in a week..."

District Agricultural Contingency Plan

6.23 ICAR-CRIDA has developed Agricultural Contingency Plans for 614 districts recommending location specific climate resilient crops and varieties for use by the farmers. These agricultural contingency plans cover Delay in monsoon onset, breaks in monsoon leading to early, mid and late-season droughts, delayed or limited release of water for irrigation, floods, unseasonal rains and extreme weather events such as heat wave, cold wave, frost, hailstorm, cyclone etc. On the query of the Committee regarding use of Agricultural Contingency Plan by the States , the Department have submitted as under:-

"..States of Andhra Pradesh, Telangana, Karnataka, Maharashtra, Madhya Pradesh, Gujarat, Rajasthan, Jharkhand, Assam, Meghalaya, West Bengal, etc., are making use of contingency plans as it is evident from the discussions during the Interface meetings held by ICAR-CRIDA with Dept of Agriculture of various states before the commencement of kharif season every year..."

6.24 When asked about assistance being provided by the ICAR to State Governments for implementation of District Contingency Plan, the Department have submitted as under:-

"....ICAR through its network of research institutes and ATARIs (erstwhile Zonal Project Directorates) and state agriculture universities conduct pre-season interface meetings in different states (mostly at state capitals or university/ICAR institutes located in the state) with participation of relevant stakeholders covering higher officials of Dept of Agriculture and district level functionaries, state seed corporations and higher officials from other sectors. During these meetings forecast made by IMD and international agencies are provided for that particular state and crop planning for ensuing *kharif* season is discussed and steps to be implemented in case of weather aberrations is discussed. Further based on the *kharif* season information and water availability in reservoirs, plan for rabi is made and sent out to various stakeholders informing about the crop(s) to be recommended for cultivation in *rabi* season. The ICAR institutes also participate in mid-season review meetings of state governments and provide advisories on steps to be taken up in case of deficit monsoon scenarios, non-availability/supply of water in reservoirs. In addition the ICAR officials also attend the meetings organised by MoA& FW and provided the necessary information sought by the ministry. ICAR- CRIDA is making efforts to monitor dry spells and wet spells based on sub district daily rainfall in selected states and provided the information to state governments with advisories..."

6.25 On the query of the Committee regarding revision of contingency plan on the basis of feedback obtained from its implementation in different States, the Department have submitted as under:-

> "..The process of revision/ updation of available contingency plans is under progress. The MoA& FW has sponsored a project to update the available contingency plans in the next three years.."

6.26 On the query of the Committee about ways by which individual farmers can utilize Contingency plan, the Department have submitted as under:-

> "..The contingency plans provide information on technological interventions to be made during weather aberrations such as alternate crops/ varieties, management practices etc. which could be followed by farmers. These plans are made available on the web sites of MoA& FW, ICAR and CRIDA and could be downloaded by all stakeholders. Further, the state governments, state agriculture universities make them available on their websites and are providing a summary of interventions for specific situations through pamphlets, leaflets in local languages.."

6.27 On the query of the Committee regarding coordination of CRIDA with agricultural universities and Krishi Vigyan Kendra (KVKs) and Agricultural Technology and Marketting Agency (ATMA) for implementation of Agricultural Contingency Plan, the representative of CRIDA has stated as under:-

> 'क्रीडा की तरफ से हम लोग अच्छी कोशिश कर रहे हैं, आने वाली 25 तारीख को हम लोग तेलंगाना के पूरे 10 जिलों में और अगले दिन हम आन्ध्र प्रदेश में पूरे 10 जिलों से आफिशियल्स आ रहे हैं और प्रिंसीपल सैक्रेटरी, एग्रीकल्चर भी आ रहे हैं, प्रोडक्शन कमिश्नर, एग्रीकल्चर यूनिवर्सिटी वाइस चांसलर आकर अगर सूखा नोर्मल स्टेज में है तो क्या है, अगर सूखा है तो क्या करना चाहिए, 26 तारीख हम लोगों ने फाइनलाइज़ किया है, पूरा दिन हम लोग चर्चा करेंगे, एक्शन प्लान तैयार करेंगे, उसके अनुसार वे स्टेट लेवल पर सेंसीटाइजेशन हो रहा है, बीज किस तरफ से देंगे, अगर इस जिले में बीज नहीं है तो विदिन दि स्टेट इस जिले से इस जिले तक बीज कैसे ले जायें। अगर सोयाबीन नोर्दर्न तेलंगाना में बीज कम है, अगर मध्य प्रदेश से कहां तक बीज लेकर आ सकते हैं। उस तरह की योजना को कार्यरूप में ले जाने के लिए 26 तारीख को हमने तेलंगाना में मीटिंग रखी है। इस तरह की अगर नैक्स्ट मंथ सात तारीख को आन्ध्र प्रदेश में, महाराष्ट्र में 13 को रखी है, महाराष्ट्र में भी पिछले साल पूरे जिलों का हम लोगों ने एक्शन प्लान बनाया तो क्रीडा के लिए काफी ग्राउण्ड लेवल है, 150 जिलों में हम लोग साथ-साथ मिलकर यह काम कर रहे हैं। मेरे ख्याल से और भी थोड़ा स्कोप है तो उसे हम स्ट्रेंदन करेंगे। '

District Vulnerability Atlas

6.28 CRIDA has prepared an atlas on Vulnerability of Indian Agriculture to Climate Change. When asked to furnish a brief of atlas on Vulnerability of Indian Agriculture to Climate Change, the Department have submitted as under:-

> "..Assessing vulnerability to climate change and variability is an important first step in evolving appropriate adaptation strategies to changing climate. Such an analysis also helps in targeting adaptation investments to regions that are more vulnerable. According to IPCC, vulnerability is "the degree to which a

system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity". This definition is adopted for this study.

Vulnerability is assessed using the indicator method. Based on review of literature and causal relationship with the three components of vulnerability, a number of relevant indicator variables were chosen, and a database for 572 districts (having rural area) in India was developed. To represent sensitivity, the variables included are net sown area, cyclone proneness, drought intensity, flood proneness, ground water exploitation, population density etc. which determines the level of sensitivity of the district to changing climate. In order to capture the degree of change in climate in terms of change in drought occurrence, incidence of dry spells, change in annual rainfall, heat wave, cold wave, etc. to which a district is exposed, climate projections of the PRECIS model for A1B scenario for the period 2021-2050 were considered. The changes in different climatic parameters were computed relative to the baseline 1961-1990 of the same model. Variables considered to represent adaptive capacity include rural poverty, literacy, work force engaged in agriculture, consumption of fertilizer nutrients, net irrigated area, ground water availability, etc. which determine the adaptation behaviour of the districts with respect to climate change. Districts with higher adaptive capacity are assumed to adapt better to changing climate. The data on these indicators were normalized based on the nature of relationship. They were then combined into three indices for sensitivity, exposure and adaptive capacity and later averaged with weights given by the experts to obtain the relative vulnerability index. Based on the index, all the districts were divided into five categories. It can be observed that districts with higher levels of vulnerability are located in the western and peninsular India. It is also observed that the highly fertile Indo-Gangetic plains are relatively more sensitive, but less vulnerable because of higher adaptive capacity and lower exposure.."

6.29 On being asked about basis of classification of Districts in to different categories on vulnerability index of Indian agriculture, the Department have submitted as under:-

"..A vulnerability index was computed using the data on 38 indicators grouped into sensitivity, exposure and adaptive capacity. The districts were ranked based on the index. These rankings were used to classify the districts in to different categories of vulnerability.."

6.30 On the query of the Committee regarding categories in which Districts are classified on the basis of vulnerability index of Indian agriculture, the Department have submitted as under:-

"..Using the rankings based on the vulnerability index, all the districts were divided in to five categories– very high, high, medium, low and very low – of vulnerability with equal number of districts in each category.."

Agriculture Extension Services

6.31 Existence of robust system of agriculture extension services is very much necessary for dissemination of knowledge and information to the farmers. Timely availability of advice for solving problems faced by the farmers, provision of improved varieties of seeds and agriculture implements by agriculture extension centres are prerequisite for enhancing crop productivity and income of majority of Indian farmers.On the query of the Committee regarding details of schemes for agricultural extension services being implemented by the Government of India and respective State Governments in the Country, the Department have stated as under:-

"..The main extension system for providing agricultural extension services to farmers is operated by State Governments through State extension agencies.The government of India is implementing following schemes to facilitate the efforts of State Governments:-

i. KrishiVigyan Kendra Scheme:The Indian Council of Agricultural Research (ICAR) has established a network of 665 KrishiVigyanKendras (KVKs) in the country aiming at technology assessment and demonstration for its application and capacity development.The activities undertaken by the KVKs for the benefit of farmers include On-farm testing to identify the location specificity of technology under various farming systems; Frontline demonstration to establish the production potential of improved agricultural technologies on the farmers fields; Capacity development of farmers and extension personnel to update their knowledge and skills; Providing farm advisories on varied subjects of interest to farmers. The KVKs also create awareness on improved agricultural technology among the farmers through a number of extension activities. Besides, the seeds, planting materials and other technology inputs produced by the KVKs are also made available to the farmers.

ii. Agricultural Technology Management Agency: Agricultural Technology Management Agency (ATMA) Scheme being implemented by Department of Agriculture, Cooperation and Farmers Welfare aims at making extension system farmer driven and farmer accountable by way of new institutional arrangements for technology dissemination at district level. ATMA has provision for active participation of farmers/farmer-groups, NGOs,KVKs, Panchayati Raj Institutions and other stakeholders operating at district level and below. At present, the Scheme is under implementation in 652 districts in 29 States and 3 UTs in the country.

iii. Mass Media Support to Agriculture Extension: Since Tenth plan a Central Sector Scheme on 'Mass Media Support to Agriculture Extension' is being implemented to strengthen the reach of farm information to farming community by using electronic media i.e the wide network of Doordarshan and All India Radio. Besides the government has also launched the DD Kisan channel on Doordarshan for speedy dissemination of technologies to the farmers.

iv. Agri-Clinic and Agri-Business Centres by Agriculture Graduates: The Agri-Clinic and Agri-Business Centres by Agriculture Graduates (ACABC) scheme is under implementation for creating gainful self-employment opportunities to unemployed agricultural graduates, agricultural diploma holders and intermediate passed students and science graduates with post-graduation in agriculture related courses supporting agriculture development and supplementing the efforts of public extension services for the farmers in the country.."

6.32 When asked to furnish numbers and details of infrastructure and manpower available in each KVK Krishi Vigyan Kendras (KVK) are operating in the country, the Department have stated as under:-

"...In total, 665 KVKs are operating in India. Each KVK is provided with modest infrastructural facilities and required manpower for the purpose. There is a sanctioned strength of 16 staff in each KVK including Head and six Subject Matter Specialists (SMS). In addition to these facilities, farmers are being provided with additional facilities like farmers Hostel in 513 KVKs, demonstration units in 493 KVKs, soil & water testing labs in 389 KVKs and soil testing kits in 400 KVKs..."

6.33 On the query of the Committee regarding steps being taken by the Government to provide adequate manpower to the KVKs, the Department have stated as under:-

"..The Government has approved for increasing the staff strength of a KVK from 16 to 22 during XII plan including 4 posts of SMSs and 2 posts of farm technicians.."

6.34 When asked to furnish details of services/facilities/training provided to the farmers in the country through KVKs during the last five years, , the Department have stated as under:-

"...During the last five years, the KVKs have undertaken 1.51 lakh on farm trials with the participation of farmers to identify the location specificity of agricultural technologies and best practices in their farming systems; conducted 5.89 lakh Frontline demonstrations (FLDs) on various crops to establish the production potential of improved agricultural technologies on the farmers fields; imparted trainings to 61.03 lakh farmers for improving their knowledge and skills on various aspects of farming; In addition, the KVKs created awareness on

improved agricultural technology among the farmers through a large number of extension activities benefitting more than 6.47 crore participants. As much as 1.17 lakh quintals seeds of improved varieties of different cropsand 9.99 crore quality good planting materials of various crops and plant species and 5.23 crore livestock strains and finger lings produced by the KVKs have been made available to the farmers. During the last five years, the KVKs have 16.18 lakh lakh samples of soil, water, plant and manures and provided advisories to the farmers to solve their problems. Besides, the KVKs provided Mobile agro-advisories on different aspects of agriculture including advisories on plant protection, weather conditions and market information etc. to 281.07 lakh farmers..."

6.35 When asked about the views of the Government to strengthen the agriculture extension services in country so that they are able to provide adequate support to the farmers in view of emerging and future challenges associated with climate change, the Department have stated as under:-

".. With an aim at enhancing resilience of Indian agriculture to climate change and climate vulnerability, the ICAR is already implementing a network project namely National Innovation in Climate Resilient Agriculture (NICRA). The technology demonstration component of the NICRA project is being implemented in 121 climatically vulnerable districts through KVKs. During the current year, about 1.0 lakh farmers are being covered for demonstrating proven technologies under four modules namely Natural Resource Management; Crop Production; Livestock and fisheries; and Institutional Innovation. The farmers of selected cluster of villages in each of 121 districts are also being provided different farm machineries and implements on custom hiring basis for timely sowing, intercultural operations and harvesting of different crops by setting up of Custom Hiring Centres. Besides, the farmers are also provided advisories on contingent crop planning as per prevailing weather conditions during the crop seasons.."

6.36 The Department have also submitted about following new initiatives by KVKs:-

i. "..Celebration of Soil health Day: In order to create awareness on the importance of soil in sustaining agricultural production as many as 609KVKs contributed significantly in collecting and analysing soil samples and distribution of 2.09 lakhs soil health cards to farmers on the occasion of World Soil Day on 5th December, 2015. For strengthening soil testing facilities at KVKs, soil testing kits have been provided to 400 KVKs.

ii. Kharif and Rabi Kisan Sammelan: Pre-Kharif kisan sammelan were organized by 373 KVKs with the participation of Hon'ble Members of Parliament and local public representatives. KVKs organized film shows, provided extension literature related to agricultural technologies, displayed exhibits, posters, photographs, digital prints, display boards, sample trays, etc. for dissemination of information developed by ICAR Institutes/SAUs and refined and tested by the KVKs to the farmers and other stakeholders. During the

Pre-Kharif kisan sammelan 1.55 lakh farmers participated. Similarly, Pre-Rabi Campaign was conducted as 374 KVKs."

6.37 While stressing the need for public -private partnership in the field of agriculture extension services, representative of BAIF Research Foundation has stated as under:-

'हमारे खेती करने के तरीके और पशुपालन करने के तरीके में भी काफी बदलाव आ गए हैं, जो हमारा एग्रीकल्चर और वैटरिनरी का एक्सटेंशन सिस्टम है, वह बहुत पुराने तरीके से चल रहा है। इसे रिव्यू करने की आवश्यकता है। अगर मैं एनीमल हस्बेंडरी सैक्टर की बात करूं, जिसमें मेरा ज्यादा एक्सपीरिएंस है, तो आप देखेंगे कि जो भी वैटरिनरी डिस्पेंसरी या पोस्टेड डॉक्टर्स हैं, वे सभी डिस्ट्रिक्ट, रीजनल हैडक्वार्टर्स या मैक्सीमम ब्लॉक लैवल पर रहते हैं। कोई भी इंटीरियर में जाने को तैयार नहीं है।'

6.38 On the above issue, representative of Ministry of Earth Sciences has stated as under:

'हम ग्रामीण कृषि मौसम सेवा के नाम पर चला रहे हैं। वह चार दिन की जो इंफार्मेशन देते थे, रेनफैड एग्रीकल्चर और इरिगेटिड एग्रीकल्चर डिस्टिंक्शन नहीं लाते थे, 60 परसैन्ट एग्रीकल्चर इरिगेटिड एग्रीकल्चर पल्सेज, ऑय़लसीड्स और सीरियल्स का होता है। इसलिए उन लोगों का वैदर इंफार्मेशन चेंज ऑफ सोइंग पैटर्न एंड डिले इन मानसून अराइवल, उसकी वजह से डिस्टिंक्शन लाने की प्रक्रिया हमने शुरू कर दी है। अगले मानसून तक हर जिले में एग्रीकल्चर सर्विस के लिए जो वैदर इंफार्मेशन देंगे, उसमें डिस्टिंक्शन लायेंगे, रेनफैड एग्रीकल्चर रिलेटिड इंफार्मेशन, सोइंग के बाद किसान दस दिन में अगली बारिश एक्सपैक्ट करता है और हर क्राप 15 दिन के बाद अगली बारिश एक्सपैक्ट करता है। क्राप कैलेंडर के अनुसार उस डेज के दौरान बारिश होने की संभावना है या नहीं, अगर होगी तो हम बता देंगे और अगर नहीं होगी तो सप्लीमैन्टरी इरिगेशन, माइक्रो इरिगेशन के लिए अरेंजमैन्ट्स करने के लिए हम एडवाइस देंगे। Wherever State Governments can organise supplementary irrigation or micro irrigation, they can take one irrigation like that so that नैक्स्ट टाइम तक बारिश आ जायेगी और क्रॉप सर्वाइव कर जायेगी। राज्य सरकारों में कुछ कंटीजेन्सी एक्शंस डिस्ट्रिक्ट लैवल में आर्गेनाइज करने के लिए उसका इनेबलिंग मैकेनिज्म हम वैदर एंड क्लाइमेट सर्विस के थ्रू प्रोवाइड करने की चेष्टा कर रहे हैं। यह हम चार-पांच दिन का आगे के लिए बता रहे हैं। हमारी जो क्लाइमेट सर्विस है, हमने बताया कि क्लाइमेट मॉडल पुणे का हमारा इंस्टीट्यूट चला रहा है। वह एक महीने पहले के हिसाब से बताता है, एक महीना पहले जून में कहां बारिश होगी, कितनी बारिश होगी और जुलाई में कितनी बारिश होगीय़ हम रीजन्स नहीं बता पायेंगे, कंट्री एज ए होल मानसून से जितनी बारिश आने की संभावना है, वह बारिश किस रिवर बेसिन्स में होने वाली है, उससे कितना पानी उपलब्ध होगा, चाहे एग्रीकल्चर आपरेशन के लिए हो, वाटर रिसोर्स मैनेजमैन्ट के लिए हो, हैल्थ इम्पैक्ट जैसे हीट वेव और कोल्ड वेव के लिए अप्रैल वाला आउटपुट हम यूज करेंगे। विंटर वाला हम कोल्ड वेव और स्नो स्पैल्स के बारे में नार्थ इंडिया में देने के लिए यूज करेंगे। हम इस तरह की कस्टमाइज इंफार्मेशन एग्रीकल्चर के लिए जनरेट करने की चेष्टा कर रहे हैं। यह सर्विस आईसीएआर के थ्रू बिल्ड की हुई है। हर एक कृषि विज्ञान केन्द्र में हमारी यूनिट खुलेगी। 2019 तक हर कृषि विज्ञान केन्द्र में हमारे मौसम विभाग की फंडेड यूनिट होगी। वहां के बाकी एक्सपर्ट्स के साथ बैठकर उस डिस्ट्रिक्ट की जो वैदर बेस्ड एग्रो एडवाइजरी है, क्राप स्पेसिफिक का जो बनना है, वह बनेगा। इतनी नई चीज हमने प्लान की हैं, आईसीएआर के साथ आने वाले दिनो में उनका इंस्टीट्यूट क्रेडा सैंट्रल रिसर्च इंस्टीट्यूट फॉर ड्राई एंड एग्रीकल्चर लैंड, हैदराबाद में है, उन लोगों ने डिस्ट्रिक्ट लैवल के कंटीजेन्सी प्लान्स बनाये हुए हैं, डिस्ट्रिक्ट लैवल पर क्राप कैलेन्डर सिस्टम है, हमारी सर्विस उनके क्राप कैलेन्डर और कंटीजेन्सी एक्शंस को लिंक करेंगी, लिंक करके आलरेडी एमओयू साइन हो गया। ऑल डिस्ट्रिक्ट सैंटर्स में कृषि विज्ञान केन्द्र में हमारे यूनिट्स भी सैट अप होंगे।'

Mechanisation of Agriculture

6.39 Due to diversification of economy and higher prospect of earning in other sectors, there is problem of shortage of labour in agriculture sector. Apart from this, it is said that climatic fluctuation due to global warming will require shorter duration crops and hence there will be need of enhanced mechanization in agriculture sector to offset problem of shortage of labour. Further, we will also need to reduce post harvest losses significantly in order to ensure food security in country to face challenges associated with climate change.When asked to furnish level of mechanization in agriculture sector in the country, the Department stated as under:

> "Availability of adequate farm power is very crucial for timely farm operations to increase production and productivity besides minimizing losses. With the increase in intensity of cropping the turnaround time is drastically reduced and it is not possible to harvest and thresh the standing crop, on one hand, and prepare seed bed and do timely sowing operations of subsequent crop, on the other hand, in the limited time available, unless adequate farm power is available. DAC&FW funded study indicated increase in total farm power availability from 0.25 kW/ha in 1951 (animate power contributing 97.4%, mechanical sources 2.1% and electrical 0.5%) to 1.35 kW/ha in 2001 (animate sources 18%, mechanical sources 55% and electrical sources 27%) and 1.50 kW/ha in 2010. Further, the availability of draught animals is gradually reducing, thus shortfalls will have to be met mostly through electro-mechanical power sources.
>
> Presently, the overall level of mechanization in country's agriculture sector is about 40-45 %. The important agriculture operations mechanised include seed-bed preparation (40%), seeding/ planting (29%), plant protection (34%), irrigation (37%), harvesting and threshing (60-70% for wheat & rice and <5% for other crops). State-wise level of mechanization is not available at present. However, one research project has been recently initiated by ICAR-CIAE, Bhopal in collaboration with AICRPs on Farm Implements and Machinery and Utilization of Animal Energy to generate such database.

6.40 When asked about policy of the Government to enhance level of mechanization in agriculture in country, the Department stated as under:-

> "The Govt. of India has launched a Sub-Mission on Agricultural Mechanization to extend the benefit of mechanization to small and marginal farmers through establishment of custom hiring centres. This mission also intends to create high tech hubs for high value farm equipment and creating awareness amongst the stakeholders through demonstration and capacity building activities. For establishment of these centres, the government is providing subsidy. The level of subsidy ranges from 25 to 50%. Moreover, 10% additional subsidy is provided to ST, ST and women/small-marginal farmers of NEH state beneficiaries.
>
> CIAE Bhopal has been working on research and development of new agricultural machines & technologies for mechanization of agriculture. In order to provide

quality equipment to farmers, the equipment manufactured by different manufacturers are being tested at various testing centres located at ICAR institutes and State Agricultural Universities. The AICRP on Farm Implements & Machinery is putting a lot of emphasis on Research & Development, prototype feasibility testing and frontline demonstration of improved farm equipment and machinery to bridge mechanization gaps in different parts of the country through 25 centres of the project. No direct financial support is provided to farmers in the project"

6.41 When asked to furnish details of research & development in the sector and programmes and financial support being provided to the farmers in the country to enhance level of mechanization in agriculture sector, the Department stated as under:-

"CIAE Bhopal is engaged in conducting basic and applied research for development of new machines and technologies including harvesting machines in the country. The developed machines are evaluated at different locations throughout the country under multi-location trials to judge its efficacy under different agro-climatic conditions. Suggestions and modifications suggested by the evaluating institutes are further incorporated in the machine to make it more effective before final release of the machines for manufacturing by the manufacturers. Further, the AICRP on Farm Implements & Machinery is working on development of cost effective harvesters and other farm equipments in association with private manufacturers. Some of the equipments developed under the project are Multi-purpose Self Propelled Hydraulic Platform, Tractor Mounted Fodder Harvester, Root Crop Harvester, Tractor Operated Groundnut Digger Shaker, Tractor Operated Coconut Harvester etc."

6.42 When asked to furnish steps being taken by the Government to reduce post harvest crop losses in farm sector, the Department stated as under:-

" In the post production system, the agricultural commodities undergo series of post-harvest unit operations such as: collection, cleaning, sorting/ grading, decortications/shelling, drying, milling, packing, transportation, storage and value addition before reaching the consumer. At all these stages incremental losses occur to the produce. The total post-harvest losses to agricultural commodities are estimated to be from 6 to 18% (Nanda et al., 2012). Protecting the agricultural commodities from losses in the post-harvest system will result in an additional availability of 6 to 18% foods for consumption.To reduce post-harvest losses in farm sector, the institutes of the division have not only conducted scientific estimates of post-harvest losses of selected commodities but also developed technology for low-cost safe storage of pulses especially in rural areas. Besides this storage structures like coal tar drum bins, Hapur bins, metallic bins, etc. and bio fumigants have been propagated. Institutes have also worked on portable evaporative cooling structures and handling devices for fruits and to prevent thermal as well as mechanical shocks leading to losses. Technologies on disinfestation of pulses using chemical free techniques as well

as prototypes based on the thermal disinfestation technology have been developed. Packaging/ storage of high moisture content commodities under modified atmosphere (MA) is known to reduce losses. Technology for MA packaging has been developed for selected fruits and vegetables (guava, mango, tomato & capsicum). The technology for large scale handling of perishables under MA is being pursued. Adoption/ evaluation of sensor flexible hermetic storage system of grains to reduce post-harvest losses at storage level is also being pursued."

6.43 On the issue of need of mechanization of Farming in the Country, Sri Sidhartha Welfare Trust in written submission before the Committee have submitted as under:-

- "Modern cultivation should be initiated with full encouragement for mechanization by pooling of lands through farming societies or family groups or corporate bodies to take up mechanized and modern farming in blocks of 25,50,75 and 100 hectares as one unit for prospecting farming. Rotational farming should be made attractive by educating the farmers with loan facilities from Banks/ Co-operative banks. Each pooled block should be taught to take up-farming of food grains, sugar cane, fruits, dairying, sheep/goatery, pisiculture, piggery, poultry and tree corps with all facilities of roads, fencing, wells, farm house etc and machineries.-depending on market trends with sharing of burdens and profits on company basis with registered contracts.

- The Agricultural Department needs to gear up for modernization of agriculture. It should employ more field staff with field training and basic qualification of Xth or XIIth Standard with certificate course or a Diploma in Agriculture, who can stay in Village Panchayath Hqs and will have the survey number details of all farmers of each village attached to a Panchayath and prepare annual plan for each year for each village for the corps to be grown depending on the fertility condition of the soils- as per laboratory tests, rainfall or irrigation facility and advise the farmer on the crops to be grown and methods of cultivation, pest control and writing of records on crop grown in each holding etc. The present system of keeping a Agri-Doctor in each Hobli Hqrs is not serving the purpose. There is no actual guidance for the farmers in the field level. Eg: Karnataka State."

6.44 On the above issue, Shri K. Nithianandan in his written memoranda submitted before the Committee has stated as under:-

"Post-Harvest Technolgoy: Our Indian farmers in the midst of many constraints to produce enough food grains for our entire population. Not only we are self-sufficient in the food front but also we have a marinal export surplus of wheat, rice (Basmati), sugar, mangoes, spices, fruit and vegetables, Nearly 30% of the agricultural produces harvested is lost due to inadequate storage facilities. So enough godowns and warehouse facilites should be made available in the proximity of villages."

CHAPTER-VII

INTERNATIONAL ACCORD ON CLIMATE CHANGE

7.1 The Paris Agreement is an agreement within the United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gases emissions mitigation, adaptation and finance starting in the year 2020. The language of the agreement was negotiated by representatives of 195 countries at the 21st Conference of the Parties of the UNFCCC in Paris and adopted by consensus on 12 December 2015. It was opened for signature on 22 April 2016 (Earth Day) at a ceremony in New York. As of November 2016, 193 UNFCCC members have signed the treaty, 113 of which have ratified it. After the European Union ratified the agreement in October 2016, there were enough countries that had ratified the agreement that produce enough of the world's greenhouse gases for the agreement to enter into force. The agreement went into effect on 4 November 2016. The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework.

Paris Agreement on Climate Change

7.2 The Ministry of Environment, Forest and Climate Change has stated that Paris Agreement on climate change was adopted on 12 December 2015. It is a legally binding agreement that covers all countries, developed and developing, with the aim to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty.The salient features of the Paris Agreement are us under:

(a) The Paris Agreement acknowledges the development imperatives of developing countries. The Agreement recognizes the developing countries' right to development and their efforts to harmonize development with environment, while protecting the interests of the most vulnerable.

(b) The Paris Agreement recognizes the importance of sustainable lifestyles and sustainable patterns of consumption with developed countries taking the lead, and notes the importance of 'climate justice' in its preamble.

(c) The Agreement seeks to enhance the ' implementation of the Convention' whilst reflecting the principles of equity and common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

(d) The objective of the Agreement further ensures that it is not mitigation-centric and includes other important elements such as adaptation, loss and damage, finance, technology, capacity building and transparency of action and support.

(e) Parties' contributions under the Paris Agreement are defined as 'Nationally Determined Contributions' (NDCs), and a top-down approach of undertaking mitigation ambition has been avoided. The NDCs are country driven and comprehensive.

(f) Agreement maintains differentiation in mitigation actions of developed and developing countries.

(g) The Agreement recognizes that the timeframe for peaking will be longer for developing countries.

(h) The Agreement mandates developed countries to provide financial resources to developing countries. Other parties may also contribute, but on a purely voluntary basis.

(i) The accompanying decision to the Paris Agreement also lays down that US Dollars 100 billion mobilization of funds per year by developed countries will be scaled up after 2020 and before 2025 talking into account the needs and priorities of developing countries.

(j) The Agreement has evolved a new technology framework. This framework notes the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions. The framework also strives to support collaborative approaches to research and development, and facilitating access to technology, in particular for early stages of the technology cycle, to developing country Parties.

(k) A global goal has been established to increase the adaptive capacity, strengthening resilience and reducing vulnerability to climate change, Adaptation has also been accorded equal importance as 'mitigation' as demanded by developing countries.

(l) In addition to adaptation, the Paris Agreement includes the concept of 'Loss & Damage' and recognizes the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change and extreme weather events, and identifies various areas of cooperation and support.

(m) A global stock take, covering all elements, will take place every five years to assess the progress in addressing climate change.

(n) Implementation of REDD+ (Reducing Emissions from Deforestation and Forest Degradation) mechanism has been anchored in the Paris Agreement.

(o) A new market mechanism to provide opportunities for voluntary cooperation in the implementation of the NDCs has been agreed.

(p) An enhances system for transparency has been agreed to. This will cover not only mitigation and adaptation actions, but also the support provided by developed countries.

(q) A separate Capacity Building Initiative for transparency to help developing countries has been agreed to in order to build institutional and technical capacity.

(r) Anew institutional arrangement viz. Paris Committee on Capacity Building is a part of the Agreement. It is established for enhancing capacity building activities in developing countries under the Agreement, Developed countries are to provide financial support for capacity building to developing countries.

(s) Pre 2020 actions are also part of the decisions. The developed country parties are urged to scale up their level of financial support with a complete road map to achieve the goal of jointly providing US $ 100 Billion by 2020 for mitigation and adaptation by significantly increasing adaptation finance from current levels and to further provide appropriate technology and capacity building support in pursuant to paragraph 3 and 4 of the Warsaw decisions.

7.3 While Explaining the role of the Ministry of Environment, forest and climate change for promoting research and development on climate changes, the representativ has stated as under:-

'महोदय, मैं इसके बारे में बताना चाहूंगा कि जो टेम्प्रेचर राइज हो रहा है, उसे मिटिगेट करने के लिए, कम करने के लिए या मैनेज करने के लिए हमारा राष्ट्रीय स्तर पर जो प्रयास हो सकता है, उसके बारे में हम मंत्रालयों को सलाह देते हैं। हमारे मंत्रालय का काम सिर्फ सलाह देना ही है। चूंकि अभी कोई कानूनी व्यवस्था नहीं है, तो जैसे वन विभाग का मुख्य मुद्दा वनों का संरक्षण ही है, वही हमारे मंत्रालय का काम है। इसलिए इस बात पर हमने तवज्जुज दिया है कि जलवायु परिवर्तन में काफी बड़ा रोल वनों का है। उसके बारे में हमारी नीति है। कृषि के बारे में जो नीतियां हैं, हमने उसके बारे में उनको सलाह दी है। उसके अनुरूप नीतियों में जो बदलाव होना चाहिए, उसके लिए कृषि मंत्रालय को नीतियां बनानी हैं और प्रोग्राम्स इम्पलीमेंट करने हैं।

जो साइन्टिफिक रिसर्च हम क्लाइमेट चेंज के बारे में करते हैं, अर्थव्यवस्था और समाज के विभिन्न पक्षों पर उसका जो असर पड़ता है, उसका हम अध्ययन करते हैं और उस अध्ययन के आलोक में जो नीतियाँ अपनानी चाहिए, अलग-अलग विभागों को उनके बारे में हम सलाह देते हैं। हमारा प्रयास यह रहा है कि हमारा शोध इस तरह से हो कि बाकी मंत्रालयों के जितने साइन्टिफिक इंस्टीट्यूशंस हैं, जैसे साइंस एंड टेक्नोलॉजी डिपार्टमेंट है, एग्रीकल्चर है, सीएसआईआर की लेबोरेटरीज हैं और जो अन्य अकादमिक संस्थाएँ हैं, उनके साथ मिलकर हम यह रिसर्च करें और एक प्रारूप प्रस्तुत करें। मैं सबसे पहले आपको यह जानकारी देना चाहूँगा कि कृषि सम्बन्धित जलवायु परिवर्तन के बारे में हमारे विभाग का रिसर्च काफी दिनों से चल रहा है और हम इसकी जानकारी भारतवर्ष में, भारत सरकार को और वैश्विक समाज को भी अपने एक डॉक्यूमेंट के रूप में प्रस्तुत करते हैं। उसे हम नेशनल कम्यूनिकेशन कहते हैं। यह नेशनल कम्यूनिकेशन पहली बार हमने वर्ष 2004 में दिया था। उसमें हम अर्थव्यवस्था के सभी पक्षों का आँकलन करते हैं और कृषि उसका एक मुख्य मुद्दा है। उसमें कृषि, उद्योग, औद्योगिक प्रोसेस, वेस्ट, वन आदि इस तरह के कई अन्य क्षेत्र हैं, जिनमें जलवायु परिवर्तन से जो प्रभाव हो रहे हैं, उसका आँकलन किया जाता है। इस आँकलन का जो मूल असेस्मेंट है, यह उस डॉक्यूमेंट में हम प्रस्तुत करते हैं। वर्ष 2004 के आधार पर हमने जो नेशनल कम्यूनिकेशन प्रस्तुत किया था, उसमें कृषि पर प्रभावों की भी हमने चर्चा की है। दूसरी बार वर्ष 2012 में हमने दूसरा

नेशनल कम्यूनिकेशन प्रस्तुत किया है, जिसमें समाज के सभी अंगों का, जिसमें कृषि भी शामिल है, उसका विवरण हमने दिया है। इसके बीच में हमने एक और डॉक्यूमेंट प्रस्तुत किया था, जो फोर बाई फोर असेस्मेंट के नाम से जाना जाता है मतलब चार सेक्टर्स का चार रीजन्स में अध्ययन हमने किया था और कृषि उसका एक प्रमुख अंग है। यह अध्ययन हम कर रहे हैं, हम करते रहे हैं और आगे भी यह सिलसिला चलता रहेगा। जहाँ तक कृषि के वैज्ञानिक पक्ष की बात है और जलवायु के सम्बन्ध के रूप में उसका विभिन्न विषयों पर जो प्रभाव है, मैं बाद में अपने साथी जे.आर.भट्ट साहब से अनुरोध करूँगा कि वे इसके बारे में समिति को अवगत करायें। यह माना जाता है कि जलवायु परिवर्तन के कृषि पर मूल रूप से दो-तीन तरह के असर पड़ते हैं। पहला तो यह है कि जल स्रोत पर उसका प्रभाव होता है। जो ड्राउट अफेक्टिड एरियाज हैं, अगर क्लाइमेट चेंज की इन्टेन्सिटी बढ़ती है तो ड्राउट अफेक्टिड एरियाज में कृषि की उत्पादकता घटती है। अगर कंडीशंस नॉर्मल रहें, पानी की व्यवस्था सही हो, किसान के पास सारे संसाधन उपलब्ध हों, वैसी अवस्था में अगर क्लाइमेट चेंज होता है, क्लाइमेट चेंज क्योंकि ग्रीन हाउस गैसों के कान्सन्ट्रेशन से बढ़ता है तो उस हालत में उसके असर में बदलाव आ सकता है। कोई जरूरी नहीं है कि यह बदलाव नकारात्मक ही हो, यह बदलाव सकारात्मक भी हो सकता है। हमारे देश में चूँकि तापक्रम ज्यादा होता है और देश के ज्यादा हिस्से जल की कमी से प्रभावित हैं, जैसे करीब 450 जिलों में, देश के करीब 60 परसेंट जिले ऐसे हैं जहाँ पर जल की जितनी आवश्यकता है, उससे कम जल वहाँ उपलब्ध है। वैसे जिलों में यह निश्चित है कि जलवायु परिवर्तन से उनकी उत्पादकता घटेगी। उत्पादकता घटने के बारे में कई प्रकार की कृषि की जो पौध है या कृषि के जो रूप हैं, अलग-अलग क्रॉप्स पर उसका अलग-अलग असर है। गेहूँ है, चावल है, सेब की फसल है, फलों, सब्जियों की फसल है, तापमान बढ़ने से उनकी उत्पादकता घटती तो अवश्य है, लेकिन उसका रेंज घटता-बढ़ता रहता है, जो वहाँ की लोकल कंडीशंस हैं, उनके आधार पर। अभी तक का अनुमान यह है कि हमारी कृषि की जो उत्पादकता है, उस पर अभी ओवरऑल कोई असर नकारात्मक रूप से नहीं पड़ा है। चिन्ता का विषय यह है कि जहाँ-जहाँ जल स्रोत कम हैं, वहाँ पर अगर हम सकारात्मक कदम नहीं उठायेंगे तो इस उत्पादकता में निश्चित रूप से बाधा पड़ेगी और आगे संकट पैदा होने की सम्भावना है।

जब हम कृषि और जलवायु के संबंध के बारे में बात करते हैं तो संतुलन का मुद्दा हमारे लिए सबसे बड़ा होता है, क्योंकि हम कुछ भी नहीं करना चाहते हैं। शोध के जो परिणाम हमारे सामने आ रहे हैं, उसके आलोक में हम जो भी नीतियां बनाएं वह ऐसी बनें कि न उससे हमारे किसान पर कोई चोट पड़े और न ही हमारे समाज की उत्पादकता और फूड सिक्योरिटी पर कोई प्रतिकूल असर पड़े। हमने इस बात को ध्यान में रखते हुए अपनी जो जलवायु परिवर्तन के संबंध में नीतियां बनाई हैं, उसमें इस बात का ध्यान रखा है कि कृषि के बारे में हम कोई ऐसा स्पेसिफिक कमिटमेंट इंटरनेशनल कम्युनिटी के साथ न कर दें कि हमें अपने ग्रीन हाउस गैस उत्सर्जन को घटाना पड़ जाए।'

India's Commitment for Greenhouse Gases (GHGs) Emission Reduction

7.4 When asked to submit details of India's commitment for GHGs emission under Paris accord, the Ministry of Environment, Forest and Climate Change has stated that India has submitted its Intended Nationally Determined Contribution (INDC) on the day of Gandhi Jayanti, i.e. 2nd October, in the year 2015. Its approach has been anchored in the vision of equity inspired by Mahatma Gandhi's famous exhortation; "Earth has enough resources to meet people's needs, but will never have enough to satisfy people's greed" and formulated under the leadership and guidance of our Hon'ble Prime Minister Shri Narendra Modi. The INDC is fair and ambitious, considering the fact that it will make efforts to work towards a low carbon emission pathway, while simultaneously endeavoring to meet all the developmental challenges that the country faces today. Government of India is implementing the National Action Plan on Climate Change (NAPCC) which enshrines eight national missions representing multipronged, long term and integrated strategies for achieving key goals in the context of climate change. It

includes specific areas of Solar Energy, Enhanced Energy Efficiency, and Sustainable Habitat, Water Sustaining the Himalayan Ecosystem, Green India, Sustainable Agriculture and Strategic knowledge for Climate Change anchored by various Ministries. India has adopted several ambitious measures like thrust on renewable energy, promotion of clean energy, enhancing energy efficiency, developing climate resilient urban centers and sustainable green transportation network are some of the measures for achieving this goal. In order to address the growing problem of Climate Change, India declared a voluntary goal of reducing its emissions intensity of its DGP by 20-25%, over 2005 levels, by 2020, despite having no binding mitigation obligations as per the Convention. A slew of policy measures to promote low carbon strategies and Renewable Energy has resulted in the decline of emission intensity of our GDP by 12% between 2005 and 2010. The United Nations Environment Programme (UNEP) in its Emission Gap Report 2014 has recognized India as one of the Countries on course to achieving its voluntary goal.

7.5 The Ministry of Environment, Forest and Climate Change has also staed that besides targeted plans under NAPCC, a range of actions has also been introduced to address adaptation, including plans at the sub national level, India has also implemented a series of schemes which strengthen adaptive capacities of the vulnerable communities Expenditure on human capabilities and livelihoods viz. poverty alleviation, health improvement and disease control and risk management, constitutes more that 80% of the total expenditure on adaptation in India. On the Side-lines of COP-21, India launched the International Solar Alliance jointly with Government of France. This is an alliance of 121 solar resource rich countries lying fully or partially between the tropic of Cancer and tropic of Capricorn. It provides a common platform where global community including bilateral and multilateral organizations, corporates industry, and stakeholders can make a positive contribution to the common goals of increasing utilizing of solar energy in meeting energy needs of ISA member countries in a safe, convenient, affordable, equitable and sustainable manner.

7.6 The 8 goals put forth by India in its INDC are as under:

1) To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2) To adopt a climate friendly and cleaner path that the one followed hitherto by others at corresponding level of economic development.
3) To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
4) To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
5) To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.
6) To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture,

water resources, Himalayan region, coastal regions, health and disaster management.

7) To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resources gap.

8) To build capacities. create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

7.7 When asked about efforts being made by the Government to address the challenges associated with climate change, the Ministry of Environment, Forest and Climate Change has stated that India has taken a number of initiatives as a step to address the climate change issue, which includes:

i) Increase in Coal Cess : The National Clean Energy Fund (NCEF) was created in 2010 for the purpose of financing and promoting clean energy initiatives and funding research in the area of clean energy in the country. The corpus of the fund is built by levying a cess of INR 50 (Subsequently increased to INR 400 in 2016) per tonne of coal produced domestically or imported. NCEF is financing innovative schemes like Jawaharlal Nehru National Solar Mission (JNNSM)'s installation of solar photovoltaic (SPV) Lights and small capacity lights, installation of SPV water pumping as well as other mission projects under the National Action Plan on climate change (NAPCC) and projects relating to R&D to replace existing technologies with more environment friendly ones under National Mission on Strategic Knowledge for Climate Change (NMSKCC). The scope of NCEF has also been enlarged to cover other eligible projects of the Ministry of New and Renewable Energy (MNRE), which are being implemented under the flagship programmes of "Grid Interactive and Distributive renewable power" and " Research Design, Development in Renewable Energy".

ii) Launch of National Adaptation Fund for Climate Change (NAFCC) **:** The NAFCC was created in 2015 with the objective to provide financial and technical support for concrete adaptation activities to be implemented under State Action Plan on Climate Change (SAPCC), funds for adaptation activities in agriculture, water, health, infrastructure, forests, bio-diversity and coastal systems etc, to reduce the vulnerability and associated risks.

iii) National Adaptation Fund on Climate Change(NAFCC) has been established with a budget provision of Rs.350 crores for the year 2015-16 and 2016-17, with an estimated requirement of Rs.181.5 crores for financial year 2017-18. The objective of the fund is to assist States and Union Territories to undertake projects and actions for adaptation to climate change.

iv) Up scaling of our ambitions for installation of Solar power capacity from 20,000 megawatt to 1,00,000 mega watt by 2022.

v) Allocation of Rs.100 crores to set up a National Mission on Himalayan Studies with the objective of enhancing natural and human capital in the Himalayan region The Scheme will also serve to complement and supplement the National Mission on Sustaining Himalayan Ecosystem (NMSHE) anchored by the Department of Science & Technology under National Action Plan on Climate change (NAPCC).

VI) Development of "one hundred Smart Cities" with integrated appropriate and mitigation measures to reduce basic service deficits and significantly reduce vulnerability and exposure to the impacts of climate change in urban areas.

vii) Launch of National Air quality Index on 17th October 2014.

7.8 While explaining about fund allocation for addressing issues related with climate change, the representative of Ministry of Environment, Forest and Climate Change has stated as under:-

> 'पिछले दो सालों से हमने राष्ट्रीय स्तर पर एक फंड क्रिएट किया है, जिसका नाम नेशनल एडॉप्टेशन फंड है। इस फंड के माध्यम से हम राज्य सरकारों को मदद प्रदान करते हैं, ताकि विभिन्न क्षेत्रों में जलवायु परिवर्तन से होने वाले जो प्रतिकूल असर हैं, उनसे निपटने के लिए राज्य सरकारें अलग-अलग क्षेत्रों में कार्य कर सकें। करीब अभी तक इसमें 230 करोड़ का प्रावधान हमारे बजट में हो चुका है और इस पर करीब 180 करोड़ खर्च कर चुके हैं। राज्य सरकारों ने इस नेशनल एडॉप्टेशन का फायदा उठाया है और कृषि के साथ-साथ अन्य क्षेत्रों में भी इस फंड का उपयोग करके अच्छा काम कर रहे हैं। आगे भी हम इस फंड को बढ़ाने की पूरी चेष्टा करेंगे। हमें वित्त मंत्रालय ने आश्वासन दिया है कि अगर आश्यकता हो तो इस वित्तीय आबंटन में और भी बढ़ोत्तरी की जा सकती है। सरकार के पास एक नेशनल क्लीन एनर्जी फंड है, जो कोल सेस से बना हुआ है। कोल पर जो सेस लगाया जाता है, उससे करीब तीन-चार हजार करोड़ रूपए की आमदनी सरकार को होती है और उसमें जो फंड जमा है, वह कुछ तो क्लीन एनर्जी सेक्टर में इस्तेमाल होता है और हमें यह भी आश्वासन है कि उसके कुछ फंड का इस्तेमाल हम एडॉप्टेशन यानी कृषि संबंधित कार्यक्रमों के लिए भी इस्तेमाल कर सकते हैं।

7.9 When asked about use of funds available under National Adaptation Fund for R & D of agriculture sector, the representative of Ministry of Environment, Forest and Climate Change has stated as under:-

> 'महोदय, कृषि पर जितना खर्च है, चाहे वह जलवायु से संबंधित हो या अन्य किसी कारण के लिए हो, उसे कृषि मंत्रालय अपने बजट से करती है। उनकी जो कई स्कीम्स एवं प्रोग्राम्स चल रहे हैं जो किसानों की मदद करते हैं। हमारे मंत्रालय में जो प्रोग्राम है, वह एडाप्टेशन फण्ड के रूप में है। इस फण्ड को हम राज्य सरकारों को मुहैया कराते हैं ताकि वे अपने राज्य में ऐसे क्षेत्रों का चयन करें या ऐसे प्रोग्राम्स का चयन करें जिनके माध्यम से किसानों या अन्य किसी वर्ग को लाभ पहुंचा कसें और जलवायु परिवर्तन से बचाव हो सके। इसमें सिर्फ किसान ही नहीं हैं, अन्य वर्ग भी आ सकते हैं, कोई शहरी विकास की समस्या भी इसमें हो सकती है, वेट लैण्ड्स के प्रिजर्वेशन का मुद्दा हो सकता है, कोई रिसर्च प्रोजेक्ट भी हो सकता है। इस तरह के कई रिसर्च प्रोजेक्ट्स हमें एडाप्टेशन फण्ड में हम लोगों ने सपोर्ट किए हैं।

7.10 While explaning benefits of India's emission reduction commitment on economy and agriculture sector, the Ministry of Environment, Forest and Climate Change has stated that:

"..Over the year, the carbon intensity of the Indian economy has decreased, in large part, due to the adoption of new and innovative technologies which address climate mitigation and climate adaptation. The development, adoption and dissemination of these technologies have been an ongoing process which has led to, inter-alia, increased energy efficiency and an increasing share of renewable in the electricity grid. This has been facilitated by several bilateral and multilateral collaborative efforts both in the public and private sector.

At the same time, climate friendly technologies, adapted and deployed in India are also being utilized in other countries, particularly in developing countries, through bilateral cooperation. This development and transfer of technologies, both into the Indian market and from India into other markets, will continue to sustain future decreases in the carbon intercity of the Indian economy and increases in the share of renewable in the electricity-mix.

India declared its INDC keeping in view its development agenda, particularly the eradication of poverty coupled with its commitment to following the low carbon path to progress and being sanguine about the unencumbered availability of clean technologies and financial resource from around the world. India's goal is to reduce overall emission intensity and improve energy efficiency of its economy over time and at the same time protecting the vulnerable sectors of economy and segments of our society. India's INDC takes into account its commitment to conservation of nature as well as the imperatives of meeting the competing demand of resources for addressing the challenges of poverty eradication, food security and nutrition, universal access to education and health, gender equality and women empowerment, water and sanitation, energy, employment sustainable urbanization and new human settlements and the means of implementation for enhanced action for achieving among others, the sustainable development goals for its 1.2 billion people. India has clarified that its INDCs do not bind it to any sector specific mitigation obligation or action, including in agriculture sector.."

7.11 On the above issue, the representative of the Ministry of Environment, Forest and climate change has submitted as under:-

'माननीय चेयरमैन महोदय और कमेटी के माननीय सदस्यगण, अभी जो हमारा पेरिस समझौता हुआ है, उसमें विकासशील देशों के हितों की पूरी रक्षा की गई है और यह समझौता हमें वर्ष 2020 के बाद कार्यान्वित करना है। इसका इम्प्लीमेंटेशन वर्ष 2020 के बाद होना है। वर्ष 2020 तक हमारी एक इंटरनेशनल वॉलेंट्री कमिटमेंट है, वह एमीशन इंटेंसिटी को 20 से 25 प्रतिशत तक, वर्ष 2005 के लैवल के कंपेरीजन में रिड्यूस करने की है। वर्ष 2005 में जो हमारी एमीशन इंटेंसिटी ऑफ डीजीपी थी, उसमें हमें 20 से 25 प्रतिशत कमी वर्ष 2020 तक लानी है। हमने जो पिछले साल अपना मूल्यांकन यूएनएफ ट्रिपल सी को सब्मिट किया है, जो हमारी इंटरनेशनल बॉडी है और वहां पर हम लोगों ने यह पाया कि वर्ष 2005 से वर्ष 2010 तक हमने 12 प्रतिशत की रिडक्शन एचीव कर ली है। इस प्रकार जो हमारा 20 से 25 प्रतिशत तक का टारगेट है, उसे हम लोग एचीव करेंगे और इसमें जो प्रमुख भूमिका है, वह पॉवर सेक्टर की है, इनर्जी एफीशिएंसी रिडक्शन की है, जो ब्यूरो ऑफ इनर्जी एफीशिएंसी इनीशिटिव्स ले रही है उसकी है, कुछ ट्रांसपोर्ट सेक्टर की है और अर्बन डैवलपमेंट में जो पॉलिसीज हैं, उनकी कंट्रीब्यूशन इसमें है। सर, पेरिस समझौते में, हम लोगों ने जो टारगेट लिए हैं, उनके बारे में हमारे स्पेशल सैक्रेट्री महोदय ने बताया कि हमारे

कुछ टारगेट्स हैं, लेकिन ये सारे टारगेट्स ऐसे हैं, जो हमारी एग्जिस्टिंग पॉलिसीज, एग्जिस्टिंग प्रोग्राम्स के थ्रू हम वर्ष 2020 के बाद कार्यान्वित करने वाले हैं। इसमें हमने किसी एक पर्टीकुलर सेक्टर में ऐसी कोई बाध्यता नहीं रखी है। इस प्रकार कृषि क्षेत्र में भी हमारी कोई बाध्यता नहीं है, लेकिन अगर कुछ नई तकनीक, कुछ नए इम्प्रूवमेंट्स, जैसे कि सोलर पम्प्स, जैसे क्लाइमेट रिजिलेंट टेक्नॉलौजी, ये सब, जो हमारे साइंटिस्ट्स ला रहे हैं, उनका प्रयोग हम कर रहे हैं और उनसे यदि कुछ फायदा जलवायु परिवर्तन के क्षेत्र में होता है, तो उसकी कैलकुलेशन हम करते हैं। अतः ओवरऑल कृषि क्षेत्र में हमारा इंटरनेशनल कमिटमेंट कुछ नहीं है। हम लोग अपने देश की नीतियों के अनुसार जो करना चाहते हैं, कर सकते हैं और जो-जो कांट्रीब्यूशन, जो नेशनली डिटर्मिन्ड कांट्रीब्यूशन, जो पेरिस समझौते के अन्तर्गत, अन्तर्राष्ट्रीय पटल पर रखा है, उसे एचीव करने के लिए जो एक्शन-प्लान होना है, वह हम बना रहे हैं और एक वर्ष के भीतर हम इसे प्रस्तुत करेंगे।'

7.12 Further elaborating on the above issue, the representative of the Ministry of Environment, Forest and climate change has submitted as under:-

'आपको ज्ञात होगा कि वर्ष 2015 में, पिछले साल पेरिस संधि हुई। उसमें हमने भारतवर्ष की तरफ से अपना एक कमिटमेंट किया है कि हम अपनी अर्थव्यवस्था में, अपने समाज के विकास में, ग्रीन हाउस गैस एमीशंस को इस तरह से मैनेज करेंगे कि हमारी अर्थव्यवस्था की जीडीपी तो बढ़े, आय तो बढ़े, लेकिन साथ-साथ एमीशन घटे। इसको हम एमीशंस इंटेसिटी के नाम से बताते हैं। हमारी एमीशंस इंटेसिटी तो घटे लेकिन उसका अर्थ यह है कि एमीशन तो घटेगा, लेकिन जीडीपी बढ़ेगी। यह जीडीपी और एमीशन के बीच तादात्म्य स्थापित करने का हमारा प्रयास है। इसलिए हमने किसी भी खास सेक्टर के बारे में कोई कमिटमेंट नहीं लिया है। इसमें कृषि भी शामिल है। कृषि और इससे संबंधित जितने भी क्षेत्र हैं, उसके बारे में ग्रीन हाउस गैसेज को लिमिट करने कोई कमिटमेंट हमने नहीं लिया है। इसका मकसद यह है कि हम जो भी करें अपने देश के अंदर, विभिन्न सेक्टर्स में जो एमीशंस हो रहे हैं, उसमें घटाव-बढ़ाव जो भी करना है, वह हम राष्ट्रीय स्तर पर करेंगे, राष्ट्रीय नीतियों के अंतर्गत करेंगे। अगर कहीं समस्या आ रही है तो उस समस्या का निदान हम दूसरे सेक्टर में उत्सर्जन घटाकर कर सकते हैं। इस तरह से संतुलन स्थापित करेंगे, ताकि एमीशन इंटेसिटी घटे, हम अपनी इंटरनेशनल कमिटमेंट को पूरी करें, लेकिन किसी भी सेक्टर के जो स्टेक होल्डर्स हैं, उन पर कोई प्रतिकूल असर न पड़े, ऐसा हमारा प्रयास रहा है।'

7.13 On being asked about preparedness of the country to meet the obligations of climate accord, the Ministry of Environment, Forest and Climate Change has stated as under:-

"..For the implementation of India's INDC and achieve its goals, an Implementation committee and six Sub-committees, dealing with specific issues, have been constituted involving key Ministries and Departments. The first consultation meeting of the INDC Implementation committee has already been held and those of the sub-committees are being held. The sub-committees are working on the elaborate their respective INDC goals and identify specific policies and actions aimed at achieving them they are also working on the indicate the outlays and technology needed from domestic or international sources at various stages to achieve the goals.."

PART-II

Observations/Recommendations of the Committee

1. Climate plays a limiting role on development of bio-geographical variability of flora and fauna including human culture and civilization. Each society has structured its culture around historical and current climatic conditions. Human culture is basically a by-product of locally available resources and local climatic conditions. Human societies are accustomed to a normal range of conditions and may be sensitive to extremes that fall out of this range. The Committee note that various studies across the world have provided ample evidence about climate changes due to enhanced emission of Green House Gases such as Carbon Dioxide, Nitrous Oxide, Methane, Hydro-Fluoro-Carbons, etc. in the atmosphere. Anthropogenic sources such as increased fossil fuels consumption, Industrialization, increasing Pace of Urbanization, excessive use of Nitrogenous Fertilizers in agriculture sector, etc. has led to a situation which is destabilizing critical environmental balance of Earth atmospheric system and causing changes in climate/weather patterns, such as increase in intensity of heat waves, rainfall periodicity, floods, cyclones, melting of ice at Arctic and Antarctic regions, rise in sea levels etc. The Committee also observe that these climatic changes have potential to harm agriculture and allied sectors which critically depend upon climatic conditions and thereby, posing a danger to food security. The Committee in succeeding paragraphs have discussed the impact of climate-changes on agriculture and allied sectors in the country, policy of the Government towards climate change, R&D in agriculture and allied sectors for transforming Indian agriculture into climate smart agriculture, preparation of the Government to provide support to the farmers of the country in adapting them to climatic changes and in accordance with the Paris agreement on climate change.

2. The Committee note that Fifth Assessment Report (AR5) of Intergovernmental Panel on Climate Change (IPCC) has warned about warming of the climate system across the world. This Report clearly brought out impact of global warming such as warming of atmosphere and oceans, shrinking of glaciers, melting of Arctic and Antarctic ice sheets, rise of sea level etc. The Committee have been informed that as per AR5 report each of the last three decades has been getting successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was very likely the warmest 30-year period during the last 800 years in the Northern Hemisphere and likely the warmest 30-year period of the last 1400 years. Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass. Glaciers have continued to shrink almost worldwide. Northern Hemisphere spring snow cover has continued to decrease in extent. Over the period 1901-2010, global mean sea level rose by 0.19 (0.17 to 0.21)m. The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia. The Committee further note that Centre for Climate Change Research (CCCR) under the Indian Institute of Tropical Meteorology (IITM), Pune under Ministry of Earth Sciences carry out scientific studies on climate change and variability under Global and Regional Climate Change (GRCC) programme. The Committee have been informed by the Ministry of Earth Sciences that past observations from instruments and proxy data suggest that there are changes in our climate system on different time scales. There are some natural variations and there are some long term trends which can be attributed to human activities. The Committee note that Annual mean, maximum and minimum temperatures averaged over the country as a whole showed significant warming trend of 0.6^{o}C, 1^{o}C and 0.18^{o}C per hundred years, respectively. The rate of warming trend in the annual mean temperatures since 1980s is much sharper, 0.2^{o}C per decade. The warming is mostly confined to the northern, central and eastern/north-eastern parts of the country. Peninsular India experienced the least warming. The Committee have been further informed that all-India southwest monsoon rainfall does not show any long-term trend, but it exhibits significant multi-decadal variability. There are significant regional trends in southwest monsoon rainfall. Monsoon rainfall in the meteorological sub divisions of Jharkhand, Chhattisgarh and Kerala has shown significant decreasing trends. However, monsoon rainfall over Gangetic West Bengal, West Uttar Pradesh, Jammu and Kashmir, Konkan and Goa, Central Maharashtra, Rayalaseema, Coastal Andhra Pradesh and North Interior Karnataka showed increasing trends. Further, Monsoon rainfall in the month of July has shown decreasing trends over most parts of central India. However, June and August rainfall has shown increasing trend over the central and southwestern parts of the country. There is a clear pattern of decreasing frequency of very light rain and light to moderate rain events over most of the country and increasing frequency of very heavy and extreme rainfall events over northern parts of the country during the monsoon season. The Committee also note above increasing trends in heat waves during the hot weather season and decreasing trend in cold waves during the cold weather season over most parts

of the country. The Committee have also been informed that more intense droughts are mainly observed over north and northwest India.

The Committee are of view that there is a need of constantly observing changing weather conditions associated with climate change in order to take corrective steps to offset its negative effect on agriculture and allied sector in the country. The Committee also feel that there should be enhanced level of co-ordination between Ministry of Earth Sciences and Department of Agricultural Research and Education. The Committee, therefore recommend the Government to devise a mechanism to increase the quantum of collaborative research and coordination between these two important Scientific Departments associated with study of climate change. The Committee also desire the Government to provide for adequate funding and manpower for encouraging cutting edge research in this important sector so that the agriculture and allied sector in the Country may be salvaged from negative changes associated with climate change.

GREENHOUSE GAS EMMISSION FROM AGRICULTURE AND ALLIED SECTOR

3. The Committee note that Paddy fields is major sources of Green House Gases (GHGs) in the farm sector. The Committee have been informed that ICAR-IARI, New Delhi and ICAR-NRRI under National Innovations in Climate Resilient Agriculture (NICRA) projects have quantified the GHGs emissions from paddy fields and they have analyzed that overall methane emission from rice fields in India is about 3.5-4.7 Tegagram (Tg) per year and N2O emission is about 0.05 Tg per year. The Committee note that findings of research being done at these Institutes has shown that methane emission from rice field is negligible compared to other rice growing countries like America, China, eastern and far-eastern Asian countries where it ranged from 20-100 Tg per year. The Committee also note that ICAR Institutes are engaged in R&D for regulating the release of these gases from agro-ecosystems through judicious land-use and appropriate management practices that could mitigate the process of climate change. The Committee have been informed that based on study conducted at IIFSR, Modipuram for measuring methane and nitrous oxide flux from the rice field, it was found that Methane emission reduced by 19.2 % and 9.9 %, respectively with the application of neem-coated urea and sulphur-treated urea compared to prilled urea under conventional method of transplanting. N_2O emission reduced by 23.7% and 11.8%, respectively in the application of neem coated urea and sulphur-treated urea compared to prilled urea under the conventional method of transplanting. Among the establishment methods, direct seeded rice (dry) and direct seeded rice (wet) methods resulted in less emission of CH_4 by the order of 27.9 % and 26.6 %, respectively compared to conventional puddled transplanting. However, the N_2O emission reduced by 1.3 % and 4.6 %, respectively in direct seeded rice (dry) and direct seeded rice (wet) method of establishments compared to conventional puddled transplanting. The Committee have also been informed that emissions of GHGs from paddy fields can be reduced by modifying water, nutrient and tillage management. Conversion of rice straw into biochar and its application in rice fields greatly decreased the GHG emission.

The Committee are of the view that reduction in emission of GHGs from paddy field will help the country to meet its obligation under International Accord on Climate Change. The Committee, therefore, desire the ICAR to give adequate support to the ICAR institutes engaged in development of appropriate methods, variety, technology and paddy varieties which can help to reduce GHGs emission from paddy fields. The Committee also desire the Government to make an inventory of the outcome of all these research studies and transfer them to the farmers in entire country through the network of KVKs and extension network of respective State Governments so that they can also become a partner in the voluntary commitment of the country to reduce share of GHGs emission from India.

BURNING OF CROP RESIDUE

4. The Committee note that despite being banned, burning of crop residue in agricultural fields has emerged as one of the important challenges in recent times which is adding to already high level of pollutants in the environment. The Committee further note that as per assessment made by the ICAR approximately 130-140 Mt Crop residues is being burnt annually in agriculture fields out of 679 million tonne (Mt) crop residue generated in the country which is causing emission of 8.57 Mt of CO, 141.15 Mt of CO2, 0.037 Mt of SOx, 0.23 Mt of NOx, 0.12 Mt of NH3 in the atmosphere. The Committee have been informed that ICAR-Indian Institute of Soil Science has developed a technique called "Rapo-compost Technology" for faster decomposition of biodegradable waste that is able to convert biodegradable waste to quality compost in 30-45 days with the help of bio-inoculum consortia (bacteria, fungi and actinomycetes) having ligno-cellulolytic potential. The Committee observe that shortage of agricultural labour, short interval due to intensive agriculture being practised in some parts of the country and mechanized farming are forcing the farmers to take extreme step of burning the crop residue in farm field. The Committee are of considered view that there is a need to provide adequate extension and financial support to help them in adopting technology for decomposition of crop residue, conservation agriculture or utilize for making cupboard in small scale industries. The Committee, therefore, desire the Government to take this issue on priority basis and make policy/plan/ programmes for eco-friendly utilization of crop residue. The Committee also desire the ICAR for development of new technology/bio-logical methods which can reduce the period of in-situ decomposition of plant residue.

INFLUENCE ON AGRICULTURE DUE TO INGRESS OF SEA WATER

5. The Committee note that global mean sea level rose by 0.19 (0.17 to 0.21)m over the period 1901-2010 due to warming effect of rising GHGs in the atmosphere. Rise in sea surface due to effect of global warming is expected to cause submergence of significant portion of land in areas near sea in many parts of the country. The Committee further note that comprehensive study on assessment of submergence of agricultural land due to sea level rise in the Coastal region has not been carried out. However, ICAR funded NICRA project indicated that the sea levels at three stations Diamond Harbour, Garden Reach and Haldia in Sundarbans are increasing at the rate of 4.85, 8.22 and 3.0 mm/yr. A 2007 report by UNESCO "Case Studies on Climate Change and World Heritage" has predicted 45 cm rise in sea level likely by the end of the 21st century due to anthropogenic activities in the Sundarbans. A study carried out by IIT, Kharagpur revealed that during the 20th century, 34.906 sq. km of area along the Indian coast went under the sea due to the rise in sea level. The Committee also note that a significant fertile agricultural land and adjoining mangrove forests were turned in to a vast waste land due to ingress of saline sea water due to cyclone Aila in West Bengal during 2009, super cyclone in Orissa during 1999 as well as Tsunami in eastern coast in 2014 leading to reduction in agriculture productivity. The Committee have been informed that ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town, West Bengal engaged in the research and management needs of coastal salt affected soils has developed several technologies for enhancement of agricultural productivity under degraded saline coastal soils and poor water qualities . The Committee are of view that ingress of sea water into agricultural fields would lead to devastating consequences for farmers near coastal regions as high salinity in the soil as well as acute shortage of fresh water for agricultural uses pose a serious problem leading to low productivity. The Committee, therefore, recommend the ICAR to actively engage in Research on identification of soil tolerant varieties of crops and incorporation of these genes in higher yielding crop varieties so that agriculture productivity in coastal areas may maintained in coming years. The Committee desire the Government to formulate an action plan for enhancing locally suitable mangrove plantation near coastal areas so that these can act as natural barriers in case of rising sea level. The Committee also desire the Government to provide adequate agricultural extension support to the farmers in coastal regions so that they are provided suitable technologies, seeds and training for shift to paddy- fishery farming.

PEST SEVERITY AND DISEASE PROLIFERATION

6. The Committee note that incidence of insect pests and proliferation of diseases on field crops may likely to increase during future climate change periods due to elevated CO_2 and temperature. The Committee have been informed that insect pests will go for more amount of consumption (compensatory feeding) due to the dilution / decline of nutritional quality of the crop plants to meet the nutritional requirement of the insect pests under elevated CO_2 and temp conditions. This may lead to higher yield losses in different crops which in turn may affect the food security. More number of generations of insect pests are expected to occur during future climate change periods because of increased temperatures. The Committee observe that studies have been initiated to document Real Time Pest Dynamics (RTPD) in 5 crops (Rice, Pigeonpea, Groundnut, Tomato and Mango) under Strategic Research component of NICRA programme. The Committee also note that Department of Agriculture, Cooperation and Farmers Welfare and State Governments is implementing various schemes under plant protection under "Strengthening and Modernization of Pest Management Approach in India" (SMPMA). Indian Council of Agricultural Research is also evolving and implementing climate resilient plant protection technologies through its National Crop institutes. The Committee are of opinion that there is a need to give boost to deployment of cutting edge research methodologies to analyze and predict future scenario of pest development and proliferation as well as development of plant protection technologies and practices so that farmers in the country could be trained in these methods to offset decline in agricultural productivity due to change in severity of pest attack associated with climate change. The Committee, therefore, recommend the Government to provide adequate financial support to the Institutes engaged in development of pest protection technologies. The Committee also desire the Government to enhance allocations for implementation of programmes for Pest management.

AGRO-CLIMATIC CLASSIFICATION

7. The Committee note that the concept of Agro-Climatic Regions (AER) and Agro-Climatic Sub Regions (AESR) categorised on the basis of climatic conditions, local geographic parameters, landform, soils type, soil texture, depth and mineralogy help to maximise agricultural productivity if crop suitable to local conditions are sown by the farmers. The Committee note that 20 AERs and 60 AESRs were identified in the Country. However, the Committee are distressed to note that Agro-climatic classifications are not being strictly followed by the farmers in cultivation of crops. Factors such as socio economic conditions, market prices, government supports in the form of Minimum support Price (MSP) and subsidies apart from factors such as favourable climate and soil factors, farmers' preferences, consumption patterns and resources available with the farmers decide the kind of crop grown in different locations, thereby, reducing possibility of achievements of optimal production with minimum investment. The Committee have been informed that the government is giving advisory to States to educate farmers for growing crops that are suitable to a given agro-climatic situation so that risk is minimized and incomes are maximized. The Committee further observe that climatic changes associated with Global warming may necessitate refinement in concept of agro-climatic regions. The Committee therefore, recommend the Government to start a study of impact of climatic changes on different of agro-climatic regions so that new strategy may be worked out to offset negative effect associated with climatic changes. The Committee are also of considered view that policy of Minimum Support Price is promoting farming practices which are not suitable to local bio-graphical and climatic conditions, thereby, causing problems such as depletion of ground water resources, degradation of soil, loss of local bio-diversity, etc. Further, absence of an alternative and economically remunerative cropping strategy is forcing farmers to opt for prevailing water intensive cropping pattern. The Committee, therefore, desire the Government (Department of Agriculture, Cooperation and Farmers welfare) to initiate a study to analyze the effect of policy of MSP on farming practices in the country and bring suitable changes in MSP policy so that environment friendly farming practices based on the concept of agro-ecological regions may be promoted in the country. The Committee also desire the ICAR to work out an alternative cropping strategy for these regions which is economically remunerative for farmers in these regions. The Committee would like the Department to prepare such cropping strategy within three months of presentation of Report.

IMPACT OF CLIMATE CHANGE ON AGRICULTURE

8. The Committee note that fifth IPCC report clearly brought out the global and regional impacts of climate change on agriculture, water resources, natural eco-systems and food security. The Committee have been informed that climate change and its variability are emerging as major challenges facing Indian agriculture. The high inter and intra-seasonal variability in rainfall distribution, extreme temperature and rainfall events are causing crop damages and huge losses to farmers. The Committee note that modeling studies indicate that changing climate will decrease yields in major crops like wheat, rice and maize. On the other hand the impact could be neutral to positive in others like groundnut, soyabean and chickpea. The Committee also note that although there will be increased yields of rice, wheat, legumes and oilseeds by 10-20% with increase in Co2 level to 550 ppm, however, productivity of most crops is likely to decrease marginally by 2020 but by 10-40% by 2100. The Committee note with satisfaction that the Government of India has initiated and supported research in agriculture sector under National Innovations in Climate Resilient Agriculture (NICRA). However, the Committee are of considered view that since huge population of our country is dependent on agriculture, there is need to enhance allocations for the R&D under NICRA so that scientist of the country can be successful in arriving solutions to challenges posed to the agriculture and allied sectors due to climate changes associated with global warming. The Committee, therefore, recommend the Government to enhance allocations to the NICRA projects.

DEVELOPMENT OF VARIETIES OF CROPS WITH ENHANCED ABIOTIC STRESS TOLERANCE

9. Identification and development of crop varieties with enhanced abiotic stress tolerance will be the key for making Indian agriculture climate resilient . The Committee note that the ICAR through its network of institutes and State Agriculture Universities is engaged in identification and development of abiotic stress tolerant crop varieties under NARS and NICRA projects. The Committee have been informed about identification of heat tolerant gene in a Nagina-22 variety of paddy which can be used for development of advanced heat tolerant varieties through breeding process avoiding the need of use of expensive Genetic Modified technology. The Committee have also been informed about identification and development of crop varieties with advance abiotic stress tolerance by the IARI-Pusa.

The Committee have been informed that Government is encouraging use of location specific climate resilient crops varieties including heat/ water logging tolerating seed varieties among farmers by ensuring availability of quality seeds of desirable varieties; developing, demonstrating and disseminating complete package of practices to stakeholders; seed subsidies, capacity building besides bringing convergence among public and private agencies in seed chain. The Committee are of view that development of new crop varieties with higher yield potential and resistance to multiple stress (heat, drought, flood, salinity) will be the key to maintain yield stability under the challenges associated with climate changes in coming decades. The Committee, therefore, desire the ICAR to give further push to their efforts for development of crop varieties with enhanced abiotic stress tolerance.

AVAILABILITY OF SEED

10. The Committee note that Indian seed programme largely adheres to the limited generations' system for seed multiplication in a phased manner. The system recognizes three generations namely breeder, foundation and certified seeds and provides adequate safeguards for quality assurance in the seed multiplication chain to maintain the purity of the variety as it flows from the breeder to the farmer. The Committee have been informed that ICAR apart from research & development on development of varieties/hybrids for different abiotic stresses, have also been entrusted with responsibility for production of Breeder seed which is being undertaken with the help of ICAR Research Institutions, State Agricultural Universities (SAUs), National Seeds Corporation (NSC) / State Farms Corporation of India (SFCI), State Seeds Corporation (SSCs), Krishi Vigyan Kendras (KVKs), Sponsored breeders recognized by selected State Seed Corporations, and Non-Governmental Organizations. The responsibility for production of foundation seed has been entrusted to the NSC, SFCI, State Seeds Corporation, State Departments of Agriculture and private seed producers, who have the necessary infrastructure facilities, whereas the production and distribution of quality/certified seeds are primarily the responsibility of the State Governments. Certified seed production is organized through State Seed Corporation, Departmental Agricultural Farms, Cooperatives etc.

The Committee note that breeder seed production increase from 3914 quintals during 1981–82 to a level of 89266.23 quintals during 2013-14 after Launch of AICRP-NSP (Crops). During 2013-14, total production of quality seed including all classes was 6,48,325 quintals against the target of 4,75,179 quintals. Production comprises 94,953 quintals of breeder seed, 1,44,369 quintals of foundation seed, 1,63,465 quintals of certified seeds, 1,72,351 quintals of truthfully labelled seed and 73,185 quintals of planting material of field crops. In addition, 155.59 lakhs planting material and 5.60 lakh tissue culture plantlets of field crops were produced against the targets of 94.80 and 2.07 lakhs.

The Committee note that country has skewed Seed Replacement Ratio, i.e. the percentage of area sown out of total cropped area by using certified/quality seeds other than farm saved seed, as seed requirement of 65 % of the farmers are met using their own saved seed or seed distributed among themselves. Amelioration of skewed SRR is a major challenge.

The Committee also note that Central Sector Scheme 'Development and Strengthening of Infrastructure Facilities for Production and Distribution of Quality Seeds' is being implemented by the Department of Agriculture, Cooperation and Farmers Welfare since 2005-06 to ensure production and multiplication of high yielding certified/quality seeds of all crops in sufficient quantities and make the seeds available to farmers at affordable price. However, the Committee is distressed to note that despite efforts being made by the Government, private sector dominates in seed production contributing to 50-57 % of total seed production of the country. The main focus of private seed companies has been on the high-value and low-volume seeds.

The Committee are of considered view that availability of good quality seed at reasonable price is one of important factor for ensuring high productivity in agriculture and to ensure remunerative prices to the farmers. The need of timely availability of seed varieties with enhanced abiotic stress tolerance will increase in coming decades with more increasing uncertainty associated with climate change. The Committee observe that Government have not been able to fulfil its aim to ensure availability of high yielding varieties of improved seeds to the farmers in the country which is evident by low Seed Replacement Ratio and large share of Private companies in the market for high value and low volume seeds in the country. The Committee desire the Government to decentralize the process of production, procurement and distribution of improved varieties of hybrid seeds as it will help in lowering the prices and ensure easy access of farmers to procure these seeds. The Committee, therefore, recommend the Government to examine present system of seed production, procurement and distribution in the country to analyze its shortcomings and take steps for decentralizing the system, in order to enhance Seed Replacement Ratio and to achieve optimum agriculture productivity in the country. The Committee also recommend the Government to involve progressive farmers in the process of production of hybrid seeds. The Committee also desire the ICAR to initiate a study to identify high value and low volume seed varieties in which private sectors are excelling and to sponsor research & development of these seed varieties so that these could be made available to the farmers in the country at affordable price.

CONSERVATION OF INDIGENOUS VARIETIES OF SEEDS

11. The Committee note that National Bureau of Plant Genetic Resources (NBPGR) is the national institute for conservation of seeds, all germplasm collection, genetic stocks and varieties of different crops in the country. The Committee have been informed that 4.14 lakh accessions are presently conserved for long term in the National Genebank. 2.62 lakh indigenous accessions have been collected, more than 60 thousand accessions repatriated, 6.26 lakh accessions imported and tested for quarantine clearance, and more than four lakh accessions have been supplied to breeders and researchers within the country. Nearly 1.9 lakh germplasm accessions have been characterized and more than two thousand cultivars have been DNA fingerprinted. The Committee have also been informed that Intellectual property rights (IPRs) on genetic resources were facilitated by registering about 1100 unique accessions and by filing over a thousand applications with Protection of Plant Varieties and Farmers' Rights (PPV&FR) Authority for varietal registration. The Committee also note that specific set germplasm, breeding lines, varieties are being evaluated for tolerance to abiotic stresses such as heat, drought, water logging etc, which is being used in hybridization for developing new cultivars under NICRA project.

The Committee are of the view that endemic crop varieties available in our country provide the scientist an excellent opportunity to identify traits which can be used for development of crop varieties with enhanced abiotic stress tolerance thereby enabling farmers to adapt to the climate changes associated with global warming. The Committee note with satisfaction about work of cataloguing of indigenous crop varieties being done by the NBGPR and other agricultural institution. However, the Committee desire the ICAR to enhance awareness about gene banks so that this knowledge can be utilized by the agriculture scientist community across the country in order to develop region specific crop varieties which can withstand specific climatic fluctuation associated with climate change. The Committee, therefore, desire the ICAR to make efforts to enhance access to these depository of crop seed/germplasm for wider scientific community along with innovative farmers.

The Committee also observe that farmers use different nomenclature for similar crops, vegetables, fruits and medicinal plants in regional languages and dialect in regions across the Country. The Committee are of view that inventory of such nomenclature will help in the efforts for conservation and exploitation of bio-diversity. The Committee, therefore, recommend the ICAR to take steps for making an inventory such nomenclature of crops, vegetables, fruits and medicinal plants which are being used in various languages across the regions of the country.

IMPACT OF CLIMATE CHANGE ON HORTICULTURE SECTOR

12. The Committee observe that horticulture sector is an important source of income for farmers in the country. Horticulture is going to be one of the sectors which will be severely affected due to unseasonal rains and temperature variations. India, which is one of the pioneers in horticulture sector, will bear the losses caused due to climate change leading to loss of livelihood for millions of farmers.

The Committee also observe the ICAR while recognising the need have taken steps under NICRA such as development of location specific technologies for addressing climate change issues especially the impact of elevated temperature, CO_2 on the flowering behaviour, pollinators and yield losses due to variable climate including flooding and heavy rains. The Committee also note that ICAR is continuously engaged in identifying and improving varieties of horticulture crops which have inherent potential to withstand abiotic stress associated with the climate change. ICAR have since achieved success in development of water logging resistant germplasm of tomato by grafting on brinjal root stock, development of agro-techniques to overcome alternate bearing in mango, testing of environmentally safe protocols for induction of synchronized flowering in rejuvenated Alphonso mango trees in the age group of 25-40 yrs, etc. The Committee further note that proven technologies including varieties are disseminated among farmers/villages through Technology Demonstration Component (TDC) of NICRA and these technology is further being up-scaled through the support from developmental agencies of Central and State Governments.

The Committee are of view that the importance of horticulture sector in the country will further increase with increasing income and associated Dietary changes over the time. Climatic fluctuations such as draught, flodding, hailstrom etc. associated with global warming can proove disastrous to farmers engaged horticulture cropping. The Committee, therefore, recommend the ICAR to devise a long term strategy for research in horticulture sector identifying potential regions for horticulture crop expansion, identification of draught and abiotic stress tolerant varities, development of new heat stress tolerant varieties, devising improved agronomic methods, water saving irrigation methods/technologies, training of farmers etc. so that horticulture sector in the country can equip itself to successfully adapt to the changes associated with global warming and keep pace with increasing demands.

IMPACT OF CLIMATE CHANGE ON LIVESTOCK

13. The Committee note that milk production and reproductive function of cattle and buffaloes will be adversely affected by projected temperature rise of 2-6^{o}C over existing temperature during the period 2070-2099. The Committee also note that studies indicated that warming will negatively impact the productivity of indigenous cows and productivity loss will be about 0.33 million tons. The Northern India is likely to experience more negative impact of climate change on milk production. The decline in milk production will be higher in crossbreds (0.63%) followed by buffaloes (0.5%) and indigenous cattle (0.4%). The Committee have been informed that many varieties of indigenous cattle have capabilities to endure climatic changes associated with global warming. At the same time, some indigenous varieties of cattle such Rathi, Gir, Dhaliwal, Tharparkar and Red Sindhi which are high yielding and could be utilized in improvement of other indigenous varieties of cattle. The Committee observe that ICAR through its network of livestock based ICAR institutes such as ICAR-NDRI, Karnal, ICAR-IVRI, Izathnagar, ICAR, NIANP, Bengaluru and others have taken research projects to develop technologies to offset negative impact of climate change on milk production of both cattle and buffaloes due to rise in temperature by way of (i) development of tolerant/resistant breeds, (ii) improved feeds and supplements and (iii) improved shelter management. The Committee also note that Central Government programmes like National Programme for Bovine Breeding (NPBB), National Dairy Plan (NDP), National Livestock Mission (NLM) and Sub-Missions on Livestock Development, Pig Development in North-Eastern Region, etc. are being under implementation by State Department of Animal Husbandry to improve indigenous varieties of livestock.

The Committee are of considered view that animal husbandry and especially cattle rearing are important source of income for majority of farmers in India. However, the Committee observe that National Plan on Dairying has ignored indigenous varieties of cattle leading to over dependence on crossbreds varieties for milk production. They note that indigenous varieties of cattle possess many traits such as heat tolerance that can be very effective in future scenario projected for climate change. They feel that these traits can be utilized for development of improved varieties of cattle if these are crossbred with high milk yielding indigenous varieties such as Rathi, Gir, Dhaliwal, Tharparkar and Red Sindhi. The Committee, therefore, recommend the Government to start a comprehensive plan for making inventory of all indigenous varieties of cattle in country, identification and separation of their specific traits, proper breeding plan for cross breeding of indigenous varieties of cattle, vaccination, deworming etc. so that farmers of our country are equipped with wherewithal for coping with vagaries associated with climate changes in the country. The Committee also desire the Government to associate organizations, dairy industries, farmers associations etc. working in the area of cattle breed improvement in the endeavor to improve indigenous varieties of cattle.

14. The Committee note that rumen fermentation is the major source of greenhouse gas emission in farm sector. The Committee have been informed that ICAR institutes are working on various projects under National Plan on Climate Change and NICRA project to reduce GHG emissions from large and small ruminants and developed different forms of complete feed, silage, fortified feed with varied levels of antioxidants, electrolytes and osmolytes, astaxanthin, melatonin along with different types of shelters with low cost and locally available material and herbal supplements to reduce GHGs emission from rumen fermentation. These Institutes have also been successful in identification of bacteriocin producing strains of lactic acid producing bacteria, microencapsulation of Bacteriocins, release kinetics of encapsulated Bacteriocins, lignocellulosic biomass for improving feed utilization, biogeography of gut microbes, novel approaches for assessing and improving nutrient bio-availability. The Committee have been informed that Ration balancing, use of ionophores, probiotics, plant secondary metabolites (Saponins, tannins, terpenoids etc.), organic acids (fumarate, malate), essential oils, defaunation etc. have been found to reduce GHG (methane) emission to the extent of 10-15% in dairy animals. The Committee also note that increase of GHG emissions by Indian livestock was less (74% vs 82% over the period of 1961 to 2010) than the developing countries and this was due to creation of awareness, demonstration of field experiments (FLDs), encouragement provided for growing green fodder, silage making, complete feed preparation, regulations in manure management and waste disposal.

The Committee observe that significant achievement have been made by the ICAR institutions for reduction of GHGs emission from rumen fermentation. however, there is need to work for dissemination of these outcomes to the farmers and dairy entrepreneurs in the country. At the same time, there is need to give additional impetus for identification of cattle varieties which is capacity for lower emission of GHGs.

ASSESSMENT OF FOOD REQUIREMENT VIS-À-VIS FOOD AVAILABILITY

15. South Asia has been categorized as one of the most vulnerable ones to challenges associated with climate changes due to global warming. Vulnerability of Indian agriculture due to vagaries associated with climate change and low adaptation capacity of majority of Indian farmers poses risk to food security of the country. The Committee note that population of India is projected to be 1.65 billion by 2050 with 50% of people residing in the urban areas. The Committee also note that total foodgrain demand is estimated to be 291 Mt by 2025 and 377 Mt by 2050, whereas the total production is estimated to be 292 Mt by 2025 and 385 Mt by 2050, which is 2.0% more than the demand. However, production deficits are projected for other cereals, oilseeds, and pulses. The projected deficit is 33% by 2025 and 43% by 2050 for other cereals, while 3% by 2025 and 7% by 2050 for pulses.

The Committee have been informed that it has been analyzed using Infocrop Decision Support System that the impact of climate change on production of wheat, paddy, kharif, maize and rain fed Sorghum can be minimized through adaptation to climate change by sowing improved varieties and employing improved input efficiency technologies coupled with application of additional nitrogen.

The Committee note that Government have launched Food Security Mission during 2007 for additional production of food grains of 25 million tons comprising 10 million ton rice, 8 million ton wheat, 4 million ton pulses and 3 million ton of coarse cereals by the end of 12th Five Year Plan through area expansion and productivity enhancement in sustainable manner in identified districts of the country; restoring soil fertility and productivity at individual farm level; creation of employment opportunities; and enhancing farm level economy (i.e. farm profits) to restore confidence among farmers. The Committee further note that the Government aims to ensure food security in the nation through implementing National Food Security Act, 2013 by undertaking price support operations through efficient procurement of food crops, strengthening public distribution systems, increasing crop production and productivity, and enhancing resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. To meet the requirement of food commodities, particularly pulses and oilseeds, trade related measures are also undertaken by the government besides the ongoing efforts to improve the production within the country. The Committee have also been informed that National Mission for Sustainable Agriculture (NMSA) was initiated with the aims to devise strategies to make Indian agriculture more resilient to climate change. It would identify and develop new varieties of crops and alternative cropping patterns, capable of withstanding extremes of weather, long dry spells, flooding and variable moisture availability. The Government is also supporting the ICAR by funding the NICRA project with the aim of developing technologies that help minimize the adverse impacts of climate

change. The government is also adjusting the trade policies and domestic marketing policies keeping in view the food security.

The Committee are of view that the there will changes in consumption patterns in coming decades due to increasing rate of urbanization and increased income of households. Therefore, demand for fruits, vegetables, dairy products, meat, poultry and fisheries will increase at faster rate than that of food grains. Thus, there the country will need to increase crop diversification and improve allied activities such as dairying, fisheries and poultry farming alongwith maintaining the current rate of growth of food grain production. The country will be required to invest heavily in development of improved crop varieties with enhanced abiotic stress tolerance, development of improved varieties of fertilizers with less GHGs emission effect, better irrigation methods, weather forecasting, training of farmers etc. The Committee, therefore, recommend the Government to provide adequate support to the scientist of the country engaged in climate research in agriculture and weather forecasting sectors under progrmmes such NICRA and NMSA. Further, the Committee desire the Government to provide fillip to enhance the production of oil seeds and pulses in the country by taking steps for area expansion, development of high yielding varieties of pulses and oil seeds/oil palm, support to farmers etc. so that the country do not face shortage of oil and pulses in coming decades. They also desire the Government to provide adequate funds to Ministry of Agriculture and Farmers Welfare and State Governments to achieve these objectives.

R&D ON ALTERNATIVE FOOD SOURCES FOR FUTURE

16. Earth is the adobe of multitude of biological variability. The Human society across the world including India has however selected few crops such as wheat, rice, maize which constitutes their staple diet. Dominance of mono cropping and excessive reliance of selected crops can become a burden in case of any major fluctuation in climate due to global warming. Keeping in view these factors, it is important to take steps to identify and develop some alternative food sources which can withstand climatic variability and hence can be utilized as staple diet for vast population of our country. The Committee note that ICAR through its network programmes on small millets (AICRP on Small Millets), future crops (AICRN on Potential Crops), legumes (AINP on Arid Legumes) is continuously engaged in conservation of germplasms; breeding short duration, tolerant and climate resilient varieties; developing suitable location specific package of practices for potential future crops; and disseminating production and value addition technologies to the stakeholders. The Committee have been informed that ICAR is giving priority to small millet crops, viz. foxtail millet, kodo millet, proso millet, little millets, and barnyard millets through All India Coordinated Research Project on Small Millets. These crops have potential to withstand the vagaries of climate and ensure the food and nutritional security in future. The Committee have also been informed that ICAR Institutes have developed and popularized several ready-to-cook and ready-to-eat health foods based on coarse grains which have been developed under the NAIP project. The ICAR is also making efforts for developing potential crops such as pseudocereals, food legumes/pulses, oilseeds, vegetables and fodder crops through All India Coordinated Research Network on Potential Crops with objectives to find out new plant resources for food, fodder, fuel, energy and industrial uses; identify superior genotypes for cultivation in different regions; and standardize package of practice. ICAR through its ongoing programmes/projects/schemes at NBPGR New Delhi, NBAGR Hisar, NBFGR Lucknow, NBAIM Mau and other ICAR institutes is continuously participating in international project or alliances of CGAIR, FAO, SAC to share genotypes, breed or species for use in national crop/breed improvement programmes. The shared materials are maintained and preserved at respective national repositories in the country. The Committee have also been informed that Government is promoting cultivation and value addition in more efficient, climate resilient, short duration C_4 crops viz. maize, pearl millet, sorghum and finger millets in suitable regions.

The Committee observe that despite claim of the Government in taking step for promoting cultivation of coarse grain, there was a decline in cultivated area between 2004-05 and 2014-15 in sorghum (3.5 mha), pearlmillet (1.3 mha). The Committee are of considered view that there is need to shift from mono cropping pattern of agriculture to diversified agriculture in order to enhance biodiversity. Enhanced crop biodiversity will help the country to ensure food security in case of any unforeseen consequences of climate change. The Committee desire the Government to actively encourage the cultivation of coarse grain, apart from

providing support to research on coarse grains and other potential food crops for future. The Committee, therefore, call upon the Government to make a comprehensive plan for providing funds, seeds, and other agriculture extension support to the farmers for encouraging farming of coarse cereals in the country. The Committee also desire the Government to take an awareness campaign about health benefits of coarse grain in order to enhance its consumption in the country. The Committee are also of view that there is need to involve farmers especially in rainfed agriculture, hill and tribal areas so that traditional foods being used in these areas can be properly analyzed and beneficial germplasm can be stored for further research. There is also need to focus on research on tuber crops which are traditionally being cultivated and used as food source in different parts of country. The Committee, therefore, desire the ICAR to take necessary steps in this direction.

AGROFORESTRY

17. The Committee note that National Agroforestry Policy (NAFP) announced in 2014 aims at conservation of natural resources, diversification of land use and farming systems to meet the demands of fuel, fodder, timber, and thus promoting economic transformation of farmers. The Committee have been informed that NAFP with objective to protect and stabilize ecosystems and promote resilient cropping and farming systems to minimize the risk during extreme climatic events will complement achieving the target of increasing forest/tree cover to promote ecological stability especially in the vulnerable regions. The Committee also note that apart from agroforestry development and promotion programmes of State Forest Departments, Central Government has initiated various programmes on research & development through ICAR- Central Agroforestry Research Institute (CAFRI) Jhansi, ICAR- All India Coordinated Research Project on Agroforestry (AICRPAF) and Indian Council of Forestry Research and Education (ICFRI), Dehradun. The Committee have also been informed that programmes for capacity building of farmers and other stakeholders are also being implemented.

The Committee are of the view that agroforestry programmes, if implemented in scientific manner and proper support to the farmers, can emerge as significant income multiplier for small and marginal farmers of the country. However, agroforestry programmes have been implemented in the country without taking care of requirement of farmers, local economy and environment. These agroforestry programmes have so far been at meeting the target of plantation without proper support for post plantation care and resulted in the loss of majority of saplings and huge losses to the farmers. The Committee are of considered opinion that a meticulously-planned nationwide programme for agroforestry based on region-wise environmental and economic factors will go a long way to protect environment along with enhancing income of farmers. The Committee, therefore, recommend the Government to plan a nation-wide programme for agroforestry after consultation with all the stakeholders including State Governments and farmers. The Committee would like to be apprized about the steps taken in this direction within three months of presentation of this report.

18. The Committee note that stress on exotic plants in agroforestry programmes was one of the reasons for their failure across the country. These plants despite their property for fast growth, affect local biodiversity and hydrology. However, the Committee in this regard have been informed that various studies have shown that exotic species such as Eucalyptus is more water efficient than other tree species for the per gram biomass production. The Committee have been informed that ICAR-CAFRI, Jhansi has identified suitable tree species for different agro-climatic regions of the country. Further, research institutes are also engaged in identification of tree species which is suitable for local environment and farming system. The Committee are of view that agroforestry programmes should be planned after proper study of local bio-diversity, farming system and availability of market for agroforestry products. It is also important to involve farmers and other stakeholders in planning of agroforestry programmes. The Committee are also of view that there should be stress on use of indigenous plant species in agroforestry as our country has tremendous biodiversity which, if properly studied, can bring forth many local plant species suitable for agroforestry. The Committee, therefore, recommend the Government to issue advisory/notification to the State/UTs Governments for use of indigenous plant species in agroforestry programme. The Committee also desire the Government to focus on Research & Development for identification of locally suitable plant species for agroforestry programmes.

WATER RESOURCES MANAGEMENT

19. Water is one of the fundamental natural resources which is critical for development of human society. There are increasing evidences that climatic changes associated with global warming will affect rainfall pattern across the globe thereby affecting availability of water in different continents. Therefore, it becomes imperative to analyze availability of water resources in our country and prepare an efficient water resource management plan to effectively preparedness to augment water resources for agriculture sector to face the climatic changes associated with global warming.

The Committee note that our country with around 18% of world population has only 4% of the global renewable water resources. The Committee have been informed that despite receiving 4,000 billion average rainfall and snowfall average, availability of water from surface water and replenishable ground water sources in the country is only 1,869 billion cubic metre. However, only about 60% of this i.e. 690 billion cubic metre from surface water and 432 billion cubic metre from ground water can be put to beneficial use because of topographical and other constraints.

The Committee note that irrigation facilities for agriculture in the country are far below the requirement. In this regard, the Committee have been informed that only 65 million hectare out of the 140 million hectare of net sown area in the country is covered under irrigation facility leaving 75 million hectares under rainfed farming. The Committee were also informed that Even after completing all irrigation projects and covering the potentially irrigable area, nearly 50% of the cultivated area will continue to remain rain dependent. Ensuring availability of adequate water in monsoon dependant Rainfed agriculture area is a daunting task which can become a serious problem if climate changes affect intensity and timing of Monsoon rains in India.

The Committee in this regard have been informed that various studies on Indian subcontinent monsoon have indicated strong sensitivity to global warming under the projected climate change scenarios. It is projected that the rainfall magnitude will increase over core monsoon zone in future climate along with lengthening of the season due to late withdrawal. On inter-annual timescales, the severity and frequency of both strong monsoon (SM) and weak monsoon (WM) might increase in future climate. Substantial changes in the daily variability of ISM are also projected which are largely associated with the increase in heavy rainfall events and decrease in number of wet days during future monsoon. Both extreme wet and dry episodes are likely to intensify and regionally extend in future climate with enhanced tendency of long dry spells. The Commiitee note that projected change in rainfall pattern will create stress to majority of small and marginal farmers dependent on Rainfed farming. The Committee are of view that there is need of comprehensive policy for sustaining rainfed farming in the country which can take into account of future projection for Monsoon rainfall changes. The Committee, therefore, recommend the Government to make a

comprehensive perspective plan for sustainable development of Rainfed farming in the country.

AUGMENTATION OF WATER RESOURCES IN THE COUNTRY

20. The Committee note that Prime Minister Krishi Sinchayi Yojana (PMKSY) has been launched by amalgamating ongoing schemes, viz. Accelerated Irrigation Benefit Programme (AIBP) of the Ministry of Water Resources, River Development & Ganga Rejuvenation (MoWR,RD&GR), Integrated Watershed Management Programme (IWMP) of Department of Land Resources (DoLR) and the On Farm Water Management (OFWM) of Department of Agriculture and Cooperation (DAC). The aim of PMKSY is to achieve convergence of investments in irrigation at the field level, expand cultivable area under assured irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance the adoption of precision irrigation and other water saving technologies (More crop per drop), enhance recharge of aquifers and introduce sustainable water conservation practices by exploring the feasibility of reusing treated municipal waste water for peri-urban agriculture and attract greater private investment in precision irrigation system. The scheme will be implemented by Ministries of Agriculture, Water Resources and Rural Development. The Ministry of Rural Development will undertake rain water conservation, construction of farm pond, water harvesting structures, small check dams, contour bunding, etc. The MoWR, RD &GR will undertake various measures for creation of assured irrigation source, construction of diversion canals, field channels, water diversion/lift irrigation, including development of water distribution systems. The Ministry of Agriculture will promote efficient water conveyance and precision water application devices like drips, sprinklers, pivots, rain-guns in the farm "(Jal Sinchan)", construction of micro-irrigation structures to supplement source creation activities, extension activities for promotion of scientific moisture conservation and agronomic measures.

The Committee have also been informed that PMKSY envisage decentralized 'State level planning and projectised execution' structure that allow States to draw up their own irrigation development plans based on District Irrigation Plan (DIP) and State Irrigation Plan (SIP). It aims to act as convergence platform for all water sector activities including drinking water & sanitation, MGNREGA, application of science & technology, etc. through comprehensive plan. State Level Sanctioning Committee (SLSC) chaired by the Chief Secretary of the State will be vested with the authority to oversee its implementation and sanction projects.The programme is being supervised and monitored at Central level by an Inter-Ministerial National Steering Committee (NSC) constituted under the Chairmanship of Prime Minister with Union Ministers from concerned Ministries. A National Executive Committee (NEC) constituted under the Chairmanship of Vice Chairman, NITI Aayog is overseeing programme implementation, allocation of resources, inter-

ministerial coordination, monitoring & performance assessment, addressing administrative issues, etc.

The Committee have also been informed by the Ministry of Water Resources, River Development and Ganga Rejuvenation that they have included various components such as Minor Irrigation scheme below 2000 Hectare, repair, renovation and restoration of water bodies, command area development and water management, use of recycle water and ground water schemes proposed by the State Governments under PMKSY for development of irrigation facilities in the Country. The Committee have been assured that State Governments have been given full autonomy to plan schemes for irrigation facilities in their States under PMKSY and the Government is Committed to fund the projects as per funding pattern.

The Committee are of view that convergence of scheme as envisaged in PMKSY will go a long way to optimize utilization of funds for irrigation development schemes. However, the Government is required to allocate sufficient funds to Ministries involved for execution of schemes within stipulated time. The Committee, therefore, recommends the Government to make adequate allocation of funds for implementation of projects under the scheme. The State Governments should also be provided support for adequate technical support for planning of District irrigation plan and State irrigation plan and execution of projects under the scheme. The Committee, therefore, recommend the Government to constitute a technical support team to assist at the Central Level to assist the State Government in planning and implementation of projects under the PMKSY. The Committee also desire the Government to take steps for demarcation of beneficiary at District and Block level. The Committee would also like to be apprised about the steps taken in this regard within three months of presentation of scheme.

INTERLINKING OF RIVERS

21. The Committee note that interlinking of river envisage transfer of water from surplus to water deficit areas in the country. Inter-Linking River Programme will help saving the people living in drought-prone zones from hunger and people living in flood-prone areas from the destruction caused by floods. The Committee were informed that implementation of interlinking would give benefits of 25 million ha of irrigation from surface water, 10 million ha by increased use of ground water, raising the ultimate irrigation potential from 140 million ha to 175 million ha and generation of 34 million KW of power apart from other benefits. However, the Committee are distressed to know that despite considerable lapse of time, the Government is yet to made any significant headway towards interlinking of rivers in the country except two projects namely Ken-Betwa Project and Pancheswar Project wherein, understanding has been reached between the Government of Uttar Pradesh and Madhya Pradesh and with Government of Nepal respectively. In this regard, the Committee were informed that constitutional provisions regarding division of Water resources restrict power of Central Government for planning and implementation of projects on water resources management such as interlinking of rivers. The Committee were also informed that many State Governments have raised objections on these projects.

The Committee are of view that projects for interlinking of river are crucial to solve the problems of water scarcity in various parts of country. It will also be crucial to face challenges related to water resource management due to climatic changes associated with global warming. The Committee are, therefore, of opinion that Government should comprehensively examine environmental, socio-economic and financial aspects related to interlinking of rivers and formulate a detailed project for interlinking of rivers in order to effectively utilize water resources of the country for the benefit of the masses. further, the Committee are not convinced with government's contention about limitation posed on Central Government for interlinking of rivers due to constitutional provisions. The Committee are of view that had sincere efforts been made in consultation with the State Governments concerned, consensus could have reached among all stakeholders for interlinking of rivers as it being a win-win formula for all. The Committee, therefore, recommend the Government (Ministry of Water Resources, River Development & Ganga Rejuvenation) to initiate the process of consultations with all stakeholders for constitution of an Empowered Group of State Ministers on Interlinking of Rivers on the pattern of Empowered Group of State Finance Ministers on Goods and Services Tax. The Committee hope that constitution of such group by the Central Government will help in examining all facets related to interlinking of rivers and achieve the desired goal.

REJUVENATION OF TRADITIONAL WATER STORAGE SYSTEM

22. Traditional water bodies such as tanks, ponds, baories etc. in various parts of the country has served as important source not only to meet the requirement of drinking water but also as an important source of irrigation. These structures have also served as excellent water harvesting mechanism maintaining ground water level. However, the Committee are distressed to observe that majority of traditional water storage structures have disappeared due to lack of maintenance and illegal encroachment. In this regard, the Committee have been informed that the Government have started a scheme for Repair, Renovation and Restoration (RRR) of water bodies since Tenth Plan for comprehensive improvement and restoration of water bodies thereby increasing tank storage capacity, Ground Water Recharge, increased availability of drinking water, improvement in agriculture/horticulture productivity, etc. However, the Committee are distressed to note that the Government have been able to complete repair renovation and restoration of 11640 water bodies against the target of 15,326 under the scheme.

The Committee are of opinion that traditional water bodies are prime example of our knowledge and engineering skill of our ancestors which enabled them to face the challenges of water shortage. Restoration and rejuvenation of traditional water bodies can emerge as one of bulwark of our preparedness for making Indian agriculture climate resilient. The Committee, therefore, recommend the Government (Ministry of Water Resources, River Development & Ganga Rejuvenation) to enhance the target for repair, renovation and Rejuvenation of traditional water storage structure based upon a comprehensive study for identification of all traditional water storage structure in the country. The Committee also desire the Government to include the rejuvenation of dead stream of rivers and numerous small rivers in the country under the scheme through construction of check dams so that water resources of these rivers can be utilized for the benefit of farmers. The Committee would like to be apprised of the steps taken in this regard within three months of presentation of Report.

GROUND WATER RESOURCES MANAGEMENT

23. The Committee note that about 60% of the ground water in the country i.e. 432 billion cubic meter from can be put to beneficial use. total groundwater resources over the years, due to enhanced availability of energy sources such as electricity and petroleum, groundwater emerged as a secure source of supply for irrigation and become one of backbone of green revolution in the country. However, due to indiscriminate use has led to environmental consequences such as groundwater depletion, pollution and water quality deterioration. The Committee have been informed that Central Ground Water Board (CGWB) has identified 1071 blocks/talukas under over exploited category for ground water. They have also notified about 150 blocks/talukas as most vulnerable areas which witness serious scarcity of water and are vulnerable even to sustain drinking water requirement unless addressed for ground water recharge and its regulated use. The Committee also note that situation of ground water exploitation in many States is more than ground water replenishment. Level of ground water development in States/UTs like Punjab, Rajsthan, Delhi and Haryana are at the level of 172%, 137%, 137%, and 133% respectively. The Committee also note that situation in Tamilnadu, Uttar Pradesh and Himachal Pradesh is critical since ground water development are at the level of 77%, 74% and 71% respectively. The Committee also note that study on excess ground water exploitation conducted by ICAR has also confirmed decreasing level of ground water. The study have also shown sea water intrusion in South Saurashtra coast of Gujrat due to over exploitation of ground water.

The Committee note that regulation of ground water withdrawal, artificial recharge of ground water, rain water harvesting, proper implementation of Watershed management programmes, Roof top water harvesting in urban areas and conjunctive use of surface water with ground water are some of the ways whereby, ground water level can be maintained. The Committee also note that Government is implementing schemes such as Integrated Watershed Management Programmes (IWMP), artificial recharge project under central sector scheme and Rooftop rainwater harvesting scheme for enhancement of ground water level in the country. The Committee have been informed that 8,214 watershed projects covering an area of 39.07 million hectare have been sanctioned under Integrated Watershed Management Programme which has now been subsumed as watershed development component of 'Pradhan Mantri krishi Sinchayee Yojana'. The Committee also note that Central Ground Water Board (CGWB) has taken steps such as notification of Blocks for regulation of ground water development and management, appointed Authorized Officer(s) under section 4 of the Environment Protection Act, 1986 to oversee ground water management, framed guidelines for ground water abstraction to accord 'No Objection Certificate' to Industries/Infrastructure/Mining proposal, criteria for recharge of ground water by Water Intensive Industries', etc. The CGWB has submitted EFC proposal for artificial recharge in 6 over exploited ground water Blocks in Andhra Pradesh, Madhya Pradesh, Punjab, Tamilnadu, and Uttar Pradesh. Additionally, CGWB has also submitted plan for artificial recharge in 442

over exploited ground water Blocks in Andhra Pradesh, Harayana, Karnataka, Maharashtra, Punjab, Rajasthan,Tamilnadu, Telangana and Uttar Pradesh.

The Committee are of view that Ground water, being one of the important source of fresh water on earth, should be effectively managed. Over exploitation of ground water above the replenishment rate not only hampers equitable distribution of water but also causes problems such as water pollution, intrusion of sea water,etc., thus affecting the quality of water. Further, indiscriminate use of ground water in over-exploited Blocks of the country by the water extensive industries put life of residents in danger by denying them access to drinking water. The Committee, therefore, recommend the Government (Ministry of Water Resources, River Development and Ganga Rejuvination and Central Gorund Water Board) to strictly implement guidelines for use of ground water in the country and issuance of 'No Objection Certificate (NOC)' to water intensive Industries.The Committee desire the Government to submit a report on NOC to the industries for withdrawal of ground water in notified area by the Authorised Officers appointed by the CGWB and compliance of conditions attached within one month of presentation of this report. The Committee also desire the Government to take steps for timely completion of sanctioned watershed projects within stipulated time period so that ground water level could be restored in over exploited ground water areas.

The Committee are also of view that farming of less water intensive crops should be promoted in over exploited ground water Blocks in the country in order to maintain ground water level. There is also need for financial assistance to the farmers for for farming of less water intensive crops and adoption of advanced irrigation methods such as sprinkler or drip irrigation. The Committee, therefore, recommend the Government (Department of Agriculture, Cooperation & Farmers welfare) to make efforts for awareness of farmers regarding problems associated with indiscriminate use of ground water for farming. The Committee also desire the Government to formulate a plan in consultation with the State Government concerned for providing financial assistance to farmers in over exploited ground water blocks in the country for farming of less water intensive crops and adoption of advanced irrigation methods such as sprinkler or drip irrigation.

APPROACH FOR MAKING INDIAN AGRICULTURE CLIMATE RESILIENT

24. The Committee note that National Mission on Sustainable Agriculture (NMSA) aims to make Indian agriculture more productive, sustainable, and remunerative and climate resilient. NMSA has many objectives such as conservation of natural resources through appropriate soil and moisture conservation measures, Soil health management, optimization of water use efficiency in agriculture, capacity building of farmers and other stakeholders in the domain of climate change adaptation and mitigation measures, improving productivity of rainfed farming by mainstreaming rainfed technologies, and establishing an effective, inter and intra Departmental/Ministerial co-ordination for accomplishing key deliverables of National Mission for Sustainable Agriculture under the aegis of NAPCC.

The Committee have been informed that promoting integrated farming system covering crops, livestock & fishery, plantation and pasture based composite farming, popularizing on-farm and off-farm resource conservation technologies and introducing practices that will support mitigation efforts in times of extreme climatic events, promoting location and crop specific integrated nutrient management practices, promoting effective management of available water resources, enhancing water use efficiency, encouraging improved agronomic practices for higher farm productivity, involving knowledge institutions and professionals in developing climate change adaptation and mitigation strategies for specific agro climatic situations and promoting them through appropriate farming systems are some of strategies being used to achieve objectives of NMSA.

The Committee are of opinion that our farmers who had helped in securing food security of the country, need support in order to face the challenges of climatic changes due to global warming. Indian agriculture need interventions in the area of irrigation facilities, water efficient irrigation methods, improved abiotic stress tolerant seed varieties, cost effective and environment friendly fertilizers and pesticides, capacity building of farmers and other stakeholders, efficient and advanced agriculture extension services in order to make it climatic resilient and enable it to secure food security of the country. The Committee are of considered view that huge investment will be need in the agriculture sector if the Government wants to achieve objectives set under National Mission on Sustainable Agriculture (NMSA). Since, agriculture is a State subject, the Committee call for the need of better co-ordination between the Central and the State Governments for planning and resource mobilization for implementing schemes to achieve objectives of NMSA. The Committee, therefore, recommend the Government to constitute high powered committee involving representatives of Central and State Governments, subject specialists and other stakeholders for planning and implementation of schemes to achieve objectives set under NMSA. The Committee also desire the Government to start a dedicated fund for implementation of schemes under NMSA so that these schemes do not suffer due to want of funds.

NATIONAL INNOVATIONS ON CLIMATE RESILIENT AGRICULTURE (NICRA)

25. The Committee note that National Innovations on Climate Resilient Agriculture (NICRA) initiated by ICAR as a network project since 2010-11 encompasses multi-pronged strategic research, technology development, capacity building of stakeholders and technology demonstrations at farmer's fields. The Committee have been informed that NICRA has three components namely strategic research, Technology Demonstration and Institutional Intervention.

The Committee note that strategic research component under NICRA aims to evolve crop varieties tolerant to climatic stresses like floods, droughts, frost, inundation due to cyclones and heat waves. The Committee have been informed that 40 Research Institutes of ICAR are conducting research under Strategic Research Component covering various research theme areas viz., development of multiple stress Tolerant Crop Genotypes, Natural Resource Management, Green House Gas Emissions, Climate Resilient Horticulture, Marine, Brackish and inland Fisheries, Heat tolerant Livestock, Small Ruminants and Poultry. The Committee have also been informed that NICRA projects helped to create infrastructure and necessary modern equipments such as high through-put pheno-typing platforms, free air temperature elevation (FATE), carbon dioxide and temperature gradient tunnels (CTGC), high performance computers, automatic weather stations, growth chambers, large glass houses, animal calorimeter, shipping vessel, flux towers and satellite receiving station in ICAR institutes involved in NICRA projects. The Committee note that these institutes have completed 32 out of 52 research projects sanctioned under NICRA. The Committee also note that ICAR is making efforts to involve State Agricultural Universities/research Institutes in public/private sectors as 11-State Agricultural Universities from different states of the country and 2 Research Institutes in private sectors as a partner in NICRA projects.

The Committee note that Technology Demonstration Component (TDC) under NICRA aims at demonstration of location specific practices and technologies to enable farmers cope with current climatic variability. Demonstration of available location-specific technologies related to natural resource management, crop production, livestock and fisheries is being taken up in the climatically vulnerable districts for enhancing the adaptive capacity and resilience against climatic variability. The Committee have been informed that technologies with a potential to cope with climate variability are being demonstrated under Technology Demonstration Component (TDC) in 121 most vulnerable districts selected across the country through Krishi Vigyan Kendras (KVKs).

The Committee note that institutional intervention Component under NICRA aims at creating enabling support system in the village comprising of strengthening of existing institutions or initiating new ones (Village Level Climate

Risk Management Committees (VCRMC)), establishment and management of Custom Hiring Centers (CHCs) for farm implements, seed bank, fodder bank, creation of commodity groups, water sharing groups, community nursery and initiating collective marketing by tapping value chains. The Committee have been informed that 100 custom hiring centers (CHCs) for farm machinery were setup under NICRA project which are being managed by Village Climate Risk Management Committee (VCRMC) comprising of villagers. The Committee have also been informed that a module on use of ICT for knowledge empowerment of the communities in terms of climate risk management is also being planned in select KVKs for generation of locally relevant content and its dissemination in text and voice enabled formats. The Committee also note that 121 KVKs associated under NICRA projects have also taken initiatives such as participatory village level seed production of short duration, drought and flood tolerant varieties, establishment of seed banks involving these varieties were established in the KVKs, demonstration and of improved varieties of fodder seeds and establishment of fodder bank in NICRA villages.

The Committee are of considered view that investment in research and development in agriculture is pre-requisite for making Indian agriculture climate resilient. There is urgent need for enhancing public investment in agriculture research to make it at forefront of country's effort to ensure food security of country threatened by risk associate with climatic changes. Against this background, National Innovations on Climate Resilient Agriculture (NICRA) projects which tries to link strategic research with technology demonstration and capacity building of farmers and other stakeholders could help the country to emerge as pioneer country in agriculture filed in coming decades. However, the Committee are of opinion that there is need to enhance allocations under the NICRA so that scientists do not face resource crunch in their pursuit to solve problems of Indian agriculture and to make it climate resilient. The Committee, therefore, recommend the Government to enhance allocations for NICRA scheme in upcoming fiscals. The Committee also desire the ICAR to analyze performance of NICRA projects to make it more outcome oriented. Impact of institutional intervention such as technology demonstrations custom hiring, seed banks, fodder banks etc. on capacity building of farmers and enhancing agriculture productivity should be analyzed so that these can be replicated at all India level. The Committee like to be apprized about the outcomes of evaluation of NICRA projects within three months of presentation of this report.

DISTRICT AGRICULTURAL CONTINGENCY PLAN

26. The Committee note that ICAR-CRIDA has prepared Agricultural Contingency Plans for 614 districts recommending location specific climate resilient crops and varieties for use by the farmers. These agricultural contingency plans cover situation like delay in monsoon onset, breaks in monsoon leading to early, mid and late-season droughts, delayed or limited release of water for irrigation, floods, unseasonal rains and extreme weather events such as heat wave, cold wave, frost, hailstorm, cyclone etc. The contingency plans provide information on technological interventions to be made during weather aberrations such as alternate crops/ varieties, management practices etc. which could be followed by farmers. The Committee have been informed that ICAR-CRIDA along with other ICAR institutes regularly interact with officials of the State Government for Crop planning based on agricultural contingency plan. The Committee have also been informed that States of Andhra Pradesh, Telangana, Karnataka, Maharashtra, Madhya Pradesh, Gujarat, Rajasthan, Jharkhand, Assam, Meghalaya and West Bengal are making use of District Agricultural Contingency Plan.

The Committee are of view that Agricultural Contingency Plans prepared the ICAR-CRIDA are one of the important contribution which address unmet needs of intervention required in rainfed based agriculture prevalent in our country. There is need to mainstreaming these agricultural contingency plans for planning and management of agricultural operation in our country. The Committee, therefore, desire the Government to impress upon states to utilize these Contingency plans and disseminate information among farmers to safeguard their crops in case of any unforeseen weather conditions. The Committee also desire the Government to take steps for enhancing awareness among farmers regarding District Agricultural Contingency plans.

The Committee are also of view that these contingency plan will be also useful to face the challenges associated with climatic changes. However, there is need for regular revision/updation of agricultural contingency plan based on feedback obtained from their implementation in different States. The Committee, therefore, desire the ICAR to periodically review these contingency plans based on inputs obtained from field and latest technological inventions. The Committee also recommend the Government to allocate additional fund for this purpose to the ICAR-CRIDA.

AGRICULTURAL EXTENSION SERVICES

27. The Committee note that existence of a robust system of agriculture extension services is critical for making Indian agriculture climate resilient. The Committee have been informed that responsibility for providing of extension services to farmers lies with the State Governments. However, Central Government is facilitating the efforts of State Governments through a network of 665 Krishi Vigyan Kendra (KVKs) , Agricultural Technology Management Agency (ATMA) and Agri clinic and Agri-business scheme. The Committee note that KVKs are engaged in on-farm testing to identify the location specificity of technology under various farming systems, frontline demonstration to establish the production potential of improved agricultural technologies on the farmers fields, Capacity development of farmers and extension personnel to update their knowledge and skills and Providing farm advisories on varied subjects of interest to farmers. The KVKs also provide farm inputs such as seeds, planting materials and other technology to the farmers. The Committee note that ATMA Scheme is under implementation in 652 districts in 29 States and 3 UTs in the country with provision for active participation of farmers/farmer-groups, NGOs, KVK, Panchayati Raj Institutions and other stakeholders operating at district level and below. The Committee have also been informed that Mass Media Support to Agriculture Extension' scheme is being implemented to strengthen the reach of farm information to farming community through the wide network of Doordarshan, DD Kisan channel and All India Radio.

However, the Committee are distressed to note that funding provided to these agriculture extension schemes are not sufficient to make them an effective platform for the benefit of farmers. The Committee in their previous reports on Demands for Grants have repeatedly brought out these facts and recommended the Government to enhance the allocations to these schemes suitably in order to equip KVKs with all necessary infrastructure and manpower. The Committee are of the considered view that condition of farmers of country cannot be improved unless they are provided information and other necessary inputs for making agriculture remunerative. The Committee, therefore recommend the Government to suitably enhance funding to these schemes. The Committee are also of view that construction of a 'Krishi Bhavan' at Panchayat level will help to strengthen the agriculture extension services in the country. Construction of such bhavan with adequate infrastructure, equipments and mass media facilities with regular visits of scientists of ICAR, subject matter specialists of KVKs, progressive farmers etc. will help it to emerge a hub for farmers and solve their problems related to agriculture. The Committee, therefore, recommend the Government to take steps for construction of 'Kisan Bhavan' at Panchayat level.

28. The Committee are of view that there is need for a dynamic and vibrant system of Agriculture extension services in order to face the climatic challenges associated with global warming. Farmers of the country need to be supported through an extensive agriculture extension services whereby they can be provided with all necessary inputs such as weather advisory, crop selection, technologies, expert advice etc. However, the Committee are of opinion that present system of Agriculture Extension Services being implemented through State Governments and supplemented through Central Government are not in position to provide required support to the farmers in every nook and corner of the country. The present system of agriculture extension is deficient in their accessibility, infrastructure facilities, subject matter specialists and flexibility required to solve challenges of modern day agriculture facing climatic uncertainties associated with global warming. There is also need to make agriculture extension services in every village of the country. The Committee are of considered opinion that there is need for reorientation of agriculture extension system, if country intends to make Indian agriculture climate resilient. The Committee, therefore, recommend the Government to take steps for modernization of agriculture extension system in the country. The Committee desire the Government to hold consultation with all State Governments in order to revitalize the Agriculture Extension Services in the Country. The Committee would like to be apprised about the steps taken by the Government within three months of presentation of this Report.

MECHANIZATION OF AGRICULTURE

29. The Committee observe that agriculture sector is facing problem of shortage of labour due to diversification of economy and higher prospect of earning in other sectors. Further, climatic fluctuation due to global warming will require shorter duration crops and hence, there will be need of enhanced mechanization in agriculture sector to offset problem of shortage of labour. The Committee have been informed that overall level of mechanization in country's agriculture sector is about 40-45%. However, the Committee are distressed to note that Department did not maintain information regarding State-wise level of mechanization. The Committee were further informed that important agriculture operations mechanized include seed-bed preparation (40%), seeding/ planting (29%), plant protection (34%), irrigation (37%), harvesting and threshing (60-70% for wheat & rice and less than 5% for other crops).

The Committee note that Government has launched a Sub-Mission on Agricultural Mechanization to extend the benefit of mechanization to small and marginal farmers through establishment of custom hiring centres. This mission also intend to create high tech hubs for high value farm equipment and creating awareness amongst the stakeholders through demonstration and capacity building activities. The Committee were informed that the Government is providing subsidy ranging from 25 to 50% for establishment of these centres. The Committee also note that 10% additional subsidy is provided to ST, ST and women/small-marginal farmers of NEH state beneficiaries under this scheme.
The Committee were also informed that ICAR-Central Institute of Agricultural Engineering, Bhopal is engaged in conducting basic and applied research for development of new machines and technologies including harvesting machines in the country. The Committee also note that All India Coordinated Research Project (AICRP) on Farm Implements & Machinery while working on development of cost effective harvesters and other farm equipments in association with private manufacturers has developed various agricultural equipments such as Multi-purpose Self Propelled Hydraulic Platform, Tractor Mounted Fodder Harvester, Root Crop Harvester, Tractor Operated Groundnut Digger Shaker, Tractor Operated Coconut Harvester etc.

The Committee observe that across the world, mechanization is considered as one of the important method to enhance farm productivity and reduce post harvest crop losses. The Committee are also of opinion that due to small size of farm holding and weak economic condition of majority of small and marginal farmers in the country, there is need to focus on research to develop efficient farm equipments which are suitable to unique agricultural conditions of the country. Further, the Committee are of view that increasing the level of mechanization of Indian agriculture can be adopted as one of the way to reduce cost of cultivation in country, and thereby enhancing the income of farmers. The Committee are however, distressed to note that level of mechanization in agricultural operations in the country is only 40-45%, which is quite low as

compared to agriculturally advanced country such as USA, Brazil, China etc. The Committee, therefore, recommend the Government (Department of Agriculture, Cooperation& Farmers Welfare) to widen the ambit of Sub-Mission on Agricultural Mechanization to set a definite time frame for enhancing level of agricultural mechanization in the country. The Committee desire the Government to adequately enhance allocations of funds for scheme in order to establish custom hiring centers in each Gram Panchayat.

The Committee also recommend the ICAR to suitably reorient AICRP-Farm Implements & Machinery to develop cost efficient and effective farm equipments suitable for farming practices of all agro-climatic regions of the country. The Committee desire ICAR to develop small farm equipments which can reduce drudgery while utilizing human power. The committee would like to be apprised about the steps taken in this direction within three months of presentation of report.

INTERNATIONAL ACCORD ON CLIMATE CHANGE AND INDIA' COMMITMENT

30. The Committee note that our country has ratified Paris Agreement on climate change within the United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gases emissions mitigation, adaptation and finance starting in the year 2020. The Committee also note that Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. The Committee have been informed that it is a legally binding agreement that covers all countries, developed and developing, with the aim to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty. The Committee also note that Paris Agreement also mandate to contribute funds amounting to US $ 100 Billion by 2020 by the Developed countries along with provisions for providing appropriate technology and capacity building support for mitigation and adaptation efforts to be undertaken by the developing countries.

The Committee note that Paris Agreement reflects the principle of equity and common but differentiated responsibilities and respective capabilities. The Agreement acknowledges the development imperatives of developing countries and recognize the developing countries' right to development and their efforts to harmonize development with environment, while protecting the interests of the most vulnerable. The Committee have been informed that India has submitted its Intended Nationally Determined Contribution (INDC) which is country driven initiatives for undertaking mitigation strategies for reduction of green house gases emission which aims to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level. The Committee have been assured that no INDC does not include any commitment for reduction of GHGs emission from agriculture sector.

The Committee note that despite having no binding mitigation obligations as per the Convention, India declared a voluntary goal of reducing its emissions intensity of its GDP by 20-25% over 2005 levels by 2020. The Committee also note that Government of India is implementing the National Action Plan on Climate Change (NAPCC) which enshrines eight national missions in specific areas of Solar Energy, Enhanced Energy Efficiency, and Sustainable Habitat, Water Sustaining the Himalayan Ecosystem, Green India, Sustainable Agriculture and Strategic knowledge for Climate Change. The Committee have also been informed that voluntary measures undertaken by the Government to promote low carbon strategies and Renewable Energy has resulted in the decline of emission intensity of our GDP by 12% between 2005 and 2010 which have been recognized by the United Nations Environment Programme (UNEP) in its Emission Gap Report 2014.

The Committee are of view that voluntary steps undertaken by the Government for reduction of GHGs emission and to make it a low energy economy under Paris agreement are in interest of Indian Economy. However, the Committee are of view there is need to provide adequate support to the Indian industry and allied sectors in the form of technologies, professional support and tax rebate in order to emerge as low carbon intensive sector as well as competitive in worlds market. The Committee, therefore, recommend the Government to constitute a dedicated cell for transfer of technologies and other support to Indian Industry and allied sector. The Committee also desire the Government to provide tax rebate to industries which invest for Research & Development of green technologies in the country. The Committee also recommend the Government to engage diplomatically with other countries so that developed countries fulfill their commitment for transfer of clean technologies and dedicated funds as mandated under Paris Agreement.

STEPS FOR AUGMENTATION OF FUNDS FOR MAKING INDIA A LOW ENERGY ECONOMY

31. The Committee have further been informed that National Clean Energy Fund (NCEF) was created in 2010 by the Government for the purpose of financing and promoting clean energy initiatives and funding research in the area of clean energy in the country. The corpus of the fund is built by levying a cess of INR 400 per tonne of coal produced domestically or imported. This fund is being used for financing schemes like installation of solar photovoltaic (SPV) Lights and small capacity lights, installation of SPV water pumping under Jawaharlal Nehru National Solar Mission (JNNSM), projects relating to R&D to replace existing technologies with more environment friendly ones under National Mission on Strategic Knowledge for Climate Change (NMSKCC), Grid Interactive and Distributive renewable power and Research Design and Development in Renewable Energy of Ministry of New and Renewable Energy. Similarly, National Adaptation Fund for Climate Change (NAFCC) with allocations of Rs. 531 crore has been launched in 2015 to provide financial and technical support for concrete adaptation activities to be implemented under State Action Plan on Climate Change (SAPCC), funds for adaptation activities in agriculture, water, health, infrastructure, forests, bio-diversity and coastal systems etc. and to reduce the vulnerability and associated risks. The Committee also note that Government has allocated Rs.100 crores to set up a National Mission on Himalayan Studies with the objective of enhancing natural and human capital in the Himalayan region under National Mission on Sustaining Himalayan Ecosystem (NMSHE).

The Committee have been informed that National Mission for Sustainable Agriculture (NMSA) has been initiated with aims to devise strategies to make Indian agriculture more resilient to climate change. The NMSA would identify and develop new varieties of crops and alternative cropping patterns, capable of withstanding extremes of weather, long dry spells, flooding and variable moisture availability. The Committee have also been informed that climate resilient interventions strategies have been embedded and mainstreamed into Missions/Programmes/Schemes of Department of Agriculture & Farmers Welfare (DAC & FW). The Government has emphasized that new credit and insurance mechanisms are being devised to facilitate adoption of desired practices by the Indian farmers.

The Committee are of view that there will be need for huge investment in form of infrastructure, research, and finance support if they aim to make Indian Agriculture climate resilient. However, the Committee are distressed to note that allocations for climate change programmes are too meager to make any significant impact. The Committee in their previous reports on demands for Grants have stressed the need to provide adequate funds for research & Development sector in agriculture, to provide farm inputs and for establishment of an efficient and modern agriculture extension services to the farmers. The Committee are of considered opinion that investment in agriculture sector is utmost necessary to make it climate resilient. The Committee, therefore,

recommend the government to formulate a dedicated schemes for providing support to the farmers so that they can invest in adaptation mechanism at farm level to face challenges associated with the climatic change. The Committee also desire the government to enhance allocations for research and development activities in agriculture sector in order to develop improved varieties of seeds, environment friendly fertilizers and pesticides.

CONSTITUTION OF DISTRICT LEVEL AGRICULTURE VIGILANCE COMMITTEE

32. The Committee are of the view that constitution of a specific District level Agriculture Vigilance Committee will go a long way to improve implementation of various schemes being implemented by the Central Government. The Committee feel that it will be helpful to assess ground realities and problems being faced by the small and marginal farmers so that various schemes implemented by the Government are reviewed, evaluated and improved/modified in order to address the difficulties of the farmers comprehensively. The Committee, therefore, recommend the Government to take steps for constitution of District level Agriculture Vigilance Committee under the Chairmanship of a senior Member of Parliament at the District Level for review, monitoring and evaluation of all schemes related to agriculture. The Committee should consist of Agriculture Officers from District to Block level, KVK Functionaries and Chairman of the Advisory Committee of ATMA. The Committee desire the Government to initiate discussion with State Governments for constitution of District level Agriculture Vigilance Committee.

REORIENTATION OF AGRICULTURAL EDUCATION SYSTEM

33. The Committee observe that Agriculture Education System as of now, do not focus on short term courses which can be helpful to provide agriculture foot soldiers in the country. The Committee are of view that Short term courses of six - twelfth months can be very useful offering solution to problems faced by the farmers in every nook and corner of the country. The Committee, therefore, recommend the Government to start discussion with State Governments to start such courses in the field of agriculture. The Government may explore option of linking such short term courses with National Skill Development Mission. Further, the Committee desire reorientation of Agricultural education system as per prevailing social, economic, psychological and practical conditions of farmers of the country. The Committee also desire that priority should be given to person of rural aptitude in operation and management of Agricultural Universities in the country.

The Committee are also of view that there is need to bring more practicality in agricultural education system in the country. The Committee, desire the ICAR to incorporate provisions for mandatory assignment to students which should be completed while staying among farmers in villages. Students along with Professors should be assigned time bound task for improving agricultural productivity and income of farmers. Those groups achieving the task should be given financial remuneration and awards.

NEW DELHI;
August, 2017
Shravana, 1939 (Saka)

HUKM DEO NARAYAN YADAV
Chairperson,
Standing Committee on Agriculture

Annexure-I

District wise droughts during 2010-16 (Details declared by State)

YEAR	STATE	DISTRICTS
2010	Bihar	Araria, Arwal, Aurangabad, Banka, Begusarai, Bhagalpur, Bhojpur, Buxar, Darbhanga, Gaya, Gopalganj, Jamui, Jehanabad, Kaimur, Katihar, Khagaria, Kishanganj, Lakhisaria, Madhepura, Madhubani, Munger, Muzaffarpur, Nalanda, Nawadha, Pashchim champaran, Patna, Purba champaran, Purnea, Rohtas, Saharsa, Samastipur, Saran, Shekhpura, Sheohar, Sitamarhi, Siwan, Supaul, Vaishali
	Jharkhand	Bokaro, Chatra, Deoghar, Dhanbad, Dumka, East singhbhum, Garhwa, Giridih, Godda, Gumla, Hazaribagh, Jamtara, Khunti, Kodarma, Latehar, Lohardaga, Pakur, Palamu, Ramgarh, Ranchi, Sahibganj, Seraikela, Simdega, West singhbhum
	Odisha	Anugul, Balangir, Balasore, Bargarh, Baudh, Bhadrak, Debagarh, Dhenkanal, Jajapur, Jharsuguda, Kedrapara, Keonjhar, Mayurbhanj, Puri, Sambalpur, Sundargarh
	West Bengal	Bankura, Birbhum, Hooghly, Maldah, Murshidabad, Nadia, North 24-parganas, Paschim Medinipur, Purba Medinipur, Purulia, South 24-parganas
2011	Andhra Pradesh	Anantpur, Chittoor, Cuddepah, EastGodavari, Guntur, Krishna, Kurnool, Nellore, Prakasam, Srikakulam, Visakhapatnam, Vizianagarm, West Godavari
	Karnataka	Bagalkot, Bangalore Rural, Belgaum, Bellary, Bidar, Bijapur, Chamarajanagar, Chikkaballapur, Chikmagalur, Chitradurga Davanagere, Dharwad, Gadag, Gulbarga, Hassan, Haveri, Kolar, Koppal, Mandya, Mysore, Raichur, Ramanagara, Tumkur, Yadagiri
	Maharashtra	Ahmednagar, Amravati, Buldana, Dhule, Gadchiroli, Gondiya, Latur, Nagpur, Nandurbar, Nasik, Osmanabad, Pune, Sangli, Satara, Solapur
2012	Andhra Pradesh	Anantpur, Chittoor, Guntur, Kurnool, Nellore, Prakasam
	Gujarat	Ahmadabad, Amreli, Anand, Banas Kantha, Bharuch, Bhavnagar, Gandhinagar, Jamnagar, Junagadh, Kheda, Mahesana, Patan, Porbandar, Rajkot, Surendranagar, Vadodara
	Karnataka	Bagalkot, Bangalore, Bangalore Rural, Belgaum, Bellary, Bidar, Bijapur, Chamarajanagar, Chikkaballapur, Chikmagalur, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Hassan Haveri, Kolar, Koppal, Mandya, Mysore, Raichur, Ramanagara, Shimoga, Tumkur, Yadagiri
	Kerala	Alappuzha, Ernakulam, Idukki, Kannur, Kasargod, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thrissur, Trivandrum, Wayanad
	Maharashtra	Ahmednagar, Aurangabad, Beed,Buldana, Dhule, Hingoli, Jalgaon, Jalna, Latur, Nanded, Nasik, Osmanabad, Parbhani, Pune, Sangli, Satara, Solapur
	Rajasthan	Ajmer, Banswara, Barmer, Bikaner, Churu, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Rajsamand, Sikar

	Tamil Nadu	Ariyalur, Coimbatore, Cuddalore, Dharmapuri, Dindigul, Erode, Kancheepuram, Kanniya Kumari, Karur, Krishnagiri, Madurai, Nagapattinam, Namakkal, Perambalur, Pudukkottai, Ramanathapuram, Salem, Sivaganga, Thanjavur, The Nilgiris Theni, Thiruvallur, Thiruvarur, Thoothukudi, Tiruchirappalli, Tirunelveli, Tirupur, Tiruvannamalai, Vellore, Villuppuram, Virudhunagar
2013	Andhra Pradesh	Anantpur, chittoor, vizianagarm
	Bihar	Aurangabad, Begusarai, Bhagalpur, Bhojpur ,Buxar, Darbhanga, Gaya, Gopalganj, Jamuim, Jehanabad, Kaimur, Katihar, Khagaria, Lakhisaria, Madhepura, Madhubani, Munger, Muzaffarpur, Nalanda, Nawadha, Pashchim Champaran, Patna, Purba Champaran, Urnea, Saharsa, Samastipur, Saran,Shekhpura Sheohar, Sitamarhi,Siwan,Supaul, Vaishali
	Karnataka	BagalkotBangalore, Belgaum, Bellary,Bijapur, Hamarajanagar, Chikkaballapur, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Hassan, Haveri, Kolar, Koppal, Mandya, Mysore, Ramanagara, Tumkur ,Uttarakannada, Yadagiri
	Rajasthan	Ajmer, Alwar, Banswara,Baran ,Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittaurgarh, Churu, Dausa, Dungarpur,Ganganagar,Hanumangarh, Jaipur,Jaisalmer ,Jhalawar, Jhunjhunu, Jodhpur ,Karauli, Kota, Nagaur, Pali Pratapgarh, Sawai Madhopur, Sikar, Sirohi, Tonk
2014	Andhra Pradesh	Anantpur, Chittoor. Guntur,Kurnool, Nellore, Prakasam
	Haryana	Ambala,bhiwani,Faridabad, Fatehabad, Gurgaon, Hissar,Jhajjar, Jind, Kaithal, Karnal, Kurkshetra, Mahendra garh, Mewat, Palwal,Panchkula, Panipat, Rewari,Rohtak, Sirsa, Sonepat, Yamuna nagar
	Karnataka	Bangalore, Bangalore rural ,Bidar, Chikkaballapur, Gulbarga,hassan, Kolar, Ramanagara, Tumkur
	Maharashtra	Ahmadnagar , Akola, Amravati,Aurangabad, Beed, Bhandara ,Buldana, Chandrapur, Dhule, Gadchiroli, Gondiya, Hingoli, Jalgaon, Jalna,mlatur, Nagpur, Nanded, Nandurbar, Nasik, Osmanabad, Parbhani, Pune, Satara, Wardha, Washim, Yevatmal
	Uttar Pradesh	Agra , Aligarh ,Amethi (shahu ji maharaj), Auraiya ,Azamgarh, Badaun, Banda, Bareilly, Bulandshahar, Chitrakoot, Deoria, Etah, Etawah, Faizabad, Farrukhabad, Fatehpur, Firozabad, Gautam buddha nagar, Ghaziabad, Hamirpur,Hapur (panchsheel nagar), Hardoi, Jalaun, Jaunpur, Jhansi, Kannauj, Kanpur city, Kanpur dehat, Kaus, Hambi, Kushi nagar, Maharahganj, Mahoba, Mainpuri, Mathura, Mau, Meerut, Muzaffarnagar,Pilibhit, Rampur, Saharanpur, Shamli (prabudh nager), Sonbhadraunnao
2015	Arunachal Pradesh	East kameng, Tawang
	Nagaland	Mokokchung, Phek
	Mizoram	Kolasib, Lunglei
	Bihar	Bhojpur, Purnia, Sitamarhi

	Uttar Pradesh	Ambedkar nagar, Barabanki , Deoria, Faizabad , Farrukhabad, Fatehpur, Gorakhpur ,Kannauj ,Kanpur nagar, Kanpur dehat, Kaushambi, Kushinagar, Lucknow, Maharajganj, Mau, Rae bareli, Sultanpur, Unnao, Agra, Auraiya, Etah, Hamirpur, Jalaun, Jhansi, Lalitpur, Mahoba, Mainpuri, Pilibhit, Rampur, Pithoragarh
	Haryana	Fatehabad, Kaithal, Kurukshetra, Mahendragarh, Panchkula, Rohtak
	Punjab	Firozpur, Jalandhar, Mansa
	Himachal Pradesh	Lahul & spiti
	Daman and Diu	Daman
	Maharashtra	Kolhapur, Parbhani
	Andhra Pradesh	Medak
2016	Arunachal Pradesh	East kameng, Tawang, West kameng
	Meghalaya	Jaintia hills, South garo hills, West khasi hills
	Uttar Pradesh	Farrukhabad, Kannauj, Kanpur dehat, Kushinagar, Ghaziabad, Mainpuri
	Haryana	Ambala, Kurukshetra, Panchkula, Panipat, Rohtak, Sonipat
	Delhi (UT)	North East Delhi
	Punjab	Fatehgarh sahib, Firozpur, Patiala
	Himachal Pradesh	Chamba Kinnaur, Lahul&Spiti
	Karnataka	Chamarajanagar
	Kerala	Wayanad

Source: 1. Department of Agriculture from different states

2. India Meteorological Department.

Annexure-II

Districtwise Floods during 2010 – 2016

Year	State	District
2010	Punjab	Patiala, Sangrur
	Haryana	Khaital, Fatehabad
2011	Assam	Lakhimpur, Marigaon, Golaghat, Goalpara
	Bihar	East Champaran, Muzafarpur, Sitamarhi, Madhubani, Darbhanga, Samastipur, Khagaria, Katihar, Banka, Munger, Madhepura, Patna, Lakhisarai, Shekhpura, Nalanda, Bhojpur, Chapra, Buxar
	West Bengal	Murshidabad, Birbhum, Bardhaman, Paschim Mednipur, North 24 Paraganas, Malda
	Odisha	Bhadra, Dhenkanal, Cuttack, Puri, Kendrapara
2012	Assam	Lakhimpur, Dibrugarh, Sonitpur, Marigaon, Darrang, Kamrup, Golpara, Bongaigaon, Dhubri, Karimganj, Dhemaji
	Bihar	East Champaran, Darbhanga, Muzaffarpur, Samastipur, Saharsa, Madhepura, Patna, Bhojpur, Sitamarhi
	Andhra Pradesh	Guntur, Prakasam, East Godavari, Nellore
	Tamilnadu	Thiruvarur, Kadalore
2013	Andhra Pradesh	Prakasam, Guntur
	Telangana	Khammam
	Assam	Dhemaji, Dibrugarh, Sibsagar, jorhat, Golaghat, Lakhimpur, Sonitpur, Nagaon, Marigaon, Kamrup, Darrang, Bongaigaon, Dhubri, Karimganj
	Bihar	Araria, Katihar, Purnia, Munger, Khagaria, Shekpura, Begusarai, Darbhanga, Muzaffarpur, Madhubani, East Champaran, Siwan, Buxar, Bhojpur, Chatra, Banka, Munger, lakhisarai, Shekhpura, Patna, Seohar
	Delhi	North East Delhi, North west Delhi
	Gujarat	Bharuch
	Maharashtra	Chandrapur
	Uttarakhand	Haridwar, Rudhaprayag
	Uttara Pradesh	Muzaffarnagar, Meerut, Sitapur, Bharaich, Siddarthnagar, Sant Kabir Nagar, Gorakhpur, Kaushambi, Varanasi, Ghazipur, Ballia
	West Bengal	Dakshin Dinajpur, Paschim Mednipur
2014	Andhra Pradesh	Vizianagaram, Visakhapatnam

	Assam	Lakhimpur, Dibrugarh, Sonitpur, Marigaon, Darrang, Kamrup, Golpara, Bongaigaon, Dhubri, Karimganj, Dhemaji, Karbi Anglong
	Bihar	Patna, Nalanda, Shekhpura, Munger, Begusarai, Madhepura, Khagaria, Darbhanga, Sitamarhi, Chapra, Saharsa, Siwan
	Uttar Pradesh	Ballia, Ambedkarnagar,Gorakhpur, Siddharthanagar, Balrampur, Bahraich, Shravasti, Gonda, Sitapur, Barabanki
	Odisha	Baleswar, Bhadrak, kendrapara, Jaipur, Cuttack, Puri, Khordha, Jagatsinghpur
	Jammu & Kashmir	Pulwama, Badagaon, Baramulla
2015	Andhra Pradesh	Nellore, Chittoor, Prakasam
	Assam	Lakhimpur, Dibrugarh, Sonitpur, Marigaon, Darrang, Kamrup, Golpara, Bongaigaon, Dhubri, Karimganj, Dhemaji
	Bihar	East Chmaparan, Muzaffarpur, Darbhanga, Begusarai, Khagaria
	Gujarat	Gandhinagar, Surendranagar, Amreli
	West Bengal	Birbhum, Hugli, Paschim Mednipur, North 24 Paraganas
	Odisha	Bhadrak
	Jammu & Kashmir	Baramulla, Sapore, Badgaon, Phulwama
	Manipur	Thoubal
	Tamilnadu	Thiruvallur, Kanchipuram,Chennai, Kadalore, Thirunalveli, Virudhunagar
	Madhya Pradesh	Sehore

District information has been collected from the Maps provided by NRSC under Bhuvan (http:// bhuvan-noeda.nrsc.gov.in /disaster /disaster / disaster.php #). This information may kindly be cross confirmed with state government agencies for any practical purpose.

ANNEXURE-III

WILL BE ADDED LATER ON

Annexure-IV

The high yielding varieties that can withstand severe change in weather pattern including deficient rainfall/drought and varieties suitable for biotic and abiotic stresses

Food Crops

Varieties	Traits	Zone / State
Rice		
Hybrid 6129	Resistant to Blast, brown spot and brown plant hopper	Irrigated areas of Punjab & Tamil Nadu
Improved Samba Mahsuri	Resistant to bacterial blight	Irrigated/shallow lowlands of Andhra Pradesh, Chhattisgarh, Jharkhand, Orissa, Bihar, Gujarat, Maharashtra
Improved Pusa Basmati 1	Resistant to blast	Basmati-growing areas of Delhi, Punjab, Jammu and Kashmir, Uttarakhand
SahabhagiDhan, Vandana, Anjali, Satyabhama, DRR Dhan 42,BirsaVikasDhan 203, BirsaVikasDhan 111, RajendraBhagwati,JaldiDhan 6, IR64 Drt I	Drought tolerance	Upland rice areas
CSR 27, CSR 30, CSR 36, NarendarUshar, Shankar Dhan 3, Lunishri	Salinity stress tolerance	Inland Saline areas
CR Dhan 402, CR Dhan 403	Salinity stress tolerance	Coastal areas
Swarna Sub1, Savitri Sub1, CR Dan 401 and Chakaakhi	Submergence tolerance (can sustain flood and flash flood upto 7-12 days)	Flood prone shallow lands areas
CR Dhan 500, Varshadhan, Hanseswari, CR Dhan 505, Jayantidhan, Jalamani and Durga	Waterlogging condition upto 75 – 100 cm	Flood prone shallow lands areas
CR Dhan 201	Moderately resistant to leaf blast, sheath rot, stem borer, leaf folder, whorl maggot and rice thrips	Chhattisgarh & Bihar under aerobic condition
CR Dhan 202	Moderately resistant to stem borer, leaf folder, whorl maggot and rice thrips	Jharkhand and Odisha under aerobic condition
CR Dhan 407	Moderate resistance to BLB, Leaf Blast	Odisha and West Bengal under rainfed shallow lowlands
CR Dhan 505	Moderately resistant to leaf blast, sheath rot, sheath blight & rice tungro virus.	Odisha and Assam under deep water condition
Pusa Basmati 1509	Improved short duration basmati	Western Uttar Pradesh and Delhi under irrigated transplanted condition
Wheat		
PBW550	Resistant to yellow rust	Punjab, Haryana, West Uttar Pradesh (except Jhansi division)
VL 892	Medium fertility and restricted	Hills of Himachal Pradesh and

	irrigation condition	Uttarakhand
H1 1544	High fertility and irrigated conditions	Madhya Pradesh, Rajasthan (Kota and Udaipur divisions) and Gujarat
PBW 527	Drought tolerance	North west plains
HI 1531, HI 1500, HI 8627	Drought tolerance	Central Zone
HD 2888	Drought tolerance	Eastern India
HPW 349, PBW 644, WH 1080, HD 3043, PBW 396, K 9465, K 8962, MP 3288, HD 4672, NIAW 1415, HD 2987	Drought tolerance	Northern and central wheat growing areas
NIAW 34	High temperature stress tolerance	Peninsular zone late sown conditions
Raj 3765	High temperature stress tolerance	North western plain for late sown conditions
Raj 4037	High temperature stress tolerance	Peninsular India for normal sown conditions
KRL 14, KRL 19, KRL 210, KRL 213	Salinity stress tolerance	Inland saline areas
HD 2967	Rusts resistance	North Western Plain Zone and North Eastern Plain Zone
Narendra Wheat 4018	Resistant to brown rust and leaf blight	Uttar Pradesh
Maize		
QPM Hybrid HQPM7	Quality protein single-cross hybrids	Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra
QPM Vivek 9	Early maturing and quality protein	Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Andhra Pradesh
Buland	High temperature stress tolerance	Northern parts of India
PMH 1	High temperature stress tolerance	Irrigated areas of Punjab
PMH 3	High temperature stress tolerance	Northern parts of India
HM 9	High temperature stress tolerance	Bihar, Jharkhand, Orissa
Pusa hybrid Makka 1	Drought tolerance	Rajasthan, Gujarat, Madhya Pradesh
HM 4	Drought tolerance	Punjab, Haryana, Uttar Pradesh, Andhra Pradesh, Maharashtra, Tamil Nadu and Goa
Pusa hybrid Makka 5	Drought tolerance	Whole of India
DHM 121 (BH 41009)	Medium maturity, yellow, semi-dent and tolerant to moisture stress conditions	Odisha, Bihar, Jharkhand, West Bengal , Gujarat, Rajasthan, Chhattisgarh and Madhya Pradesh in kharif season
HM-5, Seed Tech-2324, HM-10, PMH-2	Deep water/submergence/water logging tolerance	Maize growing areas
Sorghum		
CSH 25	Dual purpose and tolerant to grain mold diseases	Maharashtra, Andhra Pradesh, Madhya Pradesh, Karnataka and Gujarat
CSH 19 R, CSV 18	Drought tolerance	All rabi sorghum area
CSH 15 R	Drought tolerance	Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu
Millets		
(i) Pearl Millet HHB 67 improved, GHB 757, GHB 538, GHB 719, Dhanshakti, HHB 234, MandorBajra Composite	Drought tolerance	All dry areas of Western Rajasthan and Gujarat

2, HHB-226, RHB-177, Pusa Composite 443		
(ii) Finger Millet GPU 67, DHRS 1, PRM-2, KMr-301, VL Mandua 347, Indira Ragi-1, Dapoli safed-1, HIMA, KMR 204, VL Mandua-352 (VL352), Phule Nachani-1 (KOPN-235)	Drought tolerance	Millets growing dry regions
(iii) Foxtail Millet Sia 3085, SiA 3156	Drought tolerance	Millets growing dry regions
(iv) Barnyard Millet CO(KV)2	Drought tolerance	Millets growing dry regions
(v) Kodo Millet Indira Kodo-1	Drought tolerance	Millets growing dry regions
Barley		
RD 2660, K603	Drought tolerance	North west plains region

Pulses

Variety	**Trait**	**Zone**
Chickpea		
Karnal Chana	Tolerance to salinity	North West Plain Zone
CO1, ICCV 10	Drought tolerance	Southern Zone
Vijay, Vikas	Drought tolerance	Central Zone
RSG 14 , RSG 888	Drought tolerance	North West Plain Zone
PKV Kabuli 4, IPCK 2004-29, Phule G 0517	Extra large seeded Kabuli	Central Zone
MNK 1	Extra large seeded Kabuli	South Zone
JG 6, JG 14	Resistance to wilt	Central Zone
DCP 92-3	Lodging tolerance	Central Zone
GNG 16	Lodging tolerance	North West Plain Zone
Pigeonpea		
BSMR 736, BSMR 175, Asha	Wilt/Sterility mosaic disease tolerance	Central Zone
NDA 1, MAL 13	Wilt/Sterility mosaic disease tolerance	North East Plain Zone
Pusa 992, PA 291, PAU 881	Short duration suitable for multiple cropping	North west plain Zone
Mungbean		
HUM 1	Yellow mosaic virus tolerance	Central and Southern Zone
CO6	Yellow mosaic virus tolerance	South Zone
IPM 02-3	Yellow mosaic virus tolerance	North East Plain Zone
Samrat, IPM 2-3, Meha, SML 668	Early maturing suitable for spring/summer	North west plain zone and North East Plain zone
IPM2-14, TM96-2, LGG 460, LGG 410	Resistant to powdery mildew suitable for rabi/spring	South Zone
Urdbean		
WBU 109, PantU31, Azad Urd 1	Short duration suitable for multiple cropping	North East Plain zone
IPU-02-43, LBG 625, Vamban 4, WBG 26	Resistant to powdery mildew suitable for rabi/spring	South Zone
Lentil		
HUL57,KLS218,PL8	Resistance to rust	North East Plain Zone

DPL 62, PL 6, PL7, IPL 406, IPL 315,IPL316	Large seeded	Central Zone and North Western plain Zone

Oilseeds

Variety	Trait	Zone
Castor		
DCH 519	Resistance to wilt and leaf hoppers	All castor growing zones
GC 3	Resistant to wilt	Gujarat
Jwala	Tolerance to salinity and resistance to wilt	All castor growing zones
Rapeseed Mustard		
NRCDR2	High temperature tolerance	North West Plain Zone
LET-18, Pusa Mustard 21, Pusa Mustard 24, RLC1	Low erucic acid	North West Plain Zone
NRCDR 601	High temperature and salinity tolerance	North West Plain Zone
VL toria 3	Tolerance to cold	North Hill Zone
Soybean		
JS97-52	Resistance to Yellow mosaic virus and collar rot	Central Zone and North Eastern Zone
NRC7	Pod shattering resistance	All soybean growing zones
SL668, JS 97-52	Yellow mosaic resistance	All soybean growing zones
NRC-7, JS 71-05	Pod shattering and drought tolerance	All soybean growing zones
NARI 38, SSF 658	Resistant to wilt	All castor growing zones
JS 97-52, JS 20-38 and PK 472	Suitable for water logging condition.	Soybean growing zones
NRC 7, JS 95-60	Drought tolerance	Soybean growing zones
Groundnut		
Ajiya, Girnar1, TAG-24, GG20, Kadiri 6, ICGV 91114	Drought Tolerance	Central and South zone
Girnar2, Kadiri9, Kadiri,Haritandhra, Greeshma	Short duration suitable for rabi/spring	South Zone

Commercial Crops

Variety/Hybrid	Traits	Zone
Cotton		
HD 324	Tolerance to Fusarium wilt and Leaf curl virus	North Zone
Hybrid Kalyan	Tolerant to Cotton Leaf curl virus	North zone
G.Cot.Hy 12	Tolerant to aphids and jassids	Central Zone
LRA 5166	Tolerance to drought	Central Zone
KC 3	Tolerance to drought	South Zone
Kanchana, L - 604	Resistance to whitefly	South Zone
MCU 5 VT, Surabhi	Resistance to verticillium wilt	South zone
Suraj	Long staple with jassid tolerance	South and Central zone irrigated conditions
HD 324, CICR-1, Raj DH 7, Jawahar Tapti,	Drought Tolerant	Cotton growing areas

PratapKapi, Suraj, Surabhi, Veena, AK 235		
Sugarcane		
Co 94008 (Shyama)	Tolerant to drought and salinity	Peninsular Zone
Co 2001-3 (Sulabh)	Moderately resistant to red rot, smut and wilt	Peninsular Zone
Co 98014 (Karan-1)	Tolerant to drought, water-logging	North West Zone
CoS 96268 (Mithas)	Moderately resistant to red rot and good ratooner	North West Zone
CoSe 6436 (Jalpari)	Tolerant to water-logging and good ratooner	North Central Zone
Co 0233(Kosi)	Moderately resistant to red rot and smut	North Central Zone
CoC 01061	Moderately resistant to red rot.	East Cost Zone
CoLk 94184 (Birendra)	Tolerant to drought and waterlogging with good rationing	North Central Zone
Co 0118	High sucrose content and resistant to red rot, wilt and smut, tolerant to water logging	Punjab, Haryana, Rajasthan, Central and Western Uttar Pradesh and Uttarakhand
Co 0239, Co 0238, Co 06927, Co 0403, Co 86032	Tolerant to drought	Southern and central zone
Jute		
JRO 204 (Suren), JBO-2003-H (IRA)	Early sowing suitability with fine fibre quality	Tossa jute belt
JRC-532 (Sashi)	Very fine fibre fineness white jute	White jute belt
JRC 80 (Mitali)	Premature flowering resistance	White jute belt
JBO 1 (Sudhangsu)	Drought tolerance	Tossa jute belt of West Bengal, Assam, Bihar & Orissa
S19, Tarun, JRO 7835, JRO 524, JRO 878, JRC 321, JRC 7447, JRC 532, JRC 517, Bidhan Pat - 1	Suitable for water logging condition.	Jute growing belts

Appendix- I

COMMITTEE ON AGRICULTURE
(2015-16)

MINUTES OF THE SIXTH SITTING OF THE COMMITTEE
*****

The Committee sat on Monday, the 19th October, 2015 from 1500 hours to 1715 hours in Committee Room 'E', Parliament House Annexe, New Delhi.

PRESENT

Shri Hukm Deo Narayan Yadav - Chairperson

MEMBER

LOK SABHA

2. Md. Badaruddoza Khan
3. Dr. Tapas Mandal
4. Shri Dalpat Singh Paraste
5. Shri Arjun Charan Sethi
6. Shri Satyapal Singh (Sambhal)
7. Shri Virendra Singh
8. Shri Jay Prakash Narayan Yadav

RAJYA SABHA

9. Shri A.W. Rabi Bernard
10. Shri Janardan Dwivedi
11. Shri Vinay Katiyar
12. Shri Rajpal Singh Saini
13. Shri Ram Nath Thakur
14. Shri Shankarbhai N. Vegad

SECRETARIAT

1. Shri U.B.S. Negi - Joint Secretary
2. Smt. Juby Amar - Additional Director
3. Shri Sumesh Kumar - Under Secretary

WITNESSES
MINISTRY OF AGRICULTURE & FARMERS WELFARE
(DEPARTMENT OF AGRICULTURE RESEARCH AND EDUCATION

1.	Dr. S. Ayyappan	Secretary (DARE) & DG (ICAR)
2.	Dr. A.K. Sikka	Dy. Director General (NRM)
3.	Dr. J.S. Sandhu	Dy. Director General (Crop Science)
4.	Dr. N.K. Krishna Kumar	Dy. Director General (Horticulture)
5.	Dr. A.K. Singh	Dy. Director General (Extension)
6.	Dr. Narendra Singh Rathore	Dy. Director General (Education)
7.	Dr. K. Alagusundaram	Dy. Director General (Engg.)
8.	Dr. K.M.L. Pathak	Dy. Director General (NRM)
9.	Dr. S.K. Choudhari	Assistant Director General (SW&M)
10.	Dr. B.S. Prakash	Assistant Director General
11.	Dr. A.K. Vashisht	ADG (PIM)
12.		

CENTRAL RESEARCH INSTITUTE FOR DRYLAND AGRICULTURE (CRIDA)

1.	Dr. Ch Srinivasa Rao	Director

INDIAN INSTITUTE OF FARMING SYSTEM RESEARCH (IIFSR)

1.	Dr. J.P. Singh	Director

INDIAN AGRICULTURE RESEARCH INSTITUTE (IARI)

1.	Dr. Himanshu Pathak	Principal Scientist

2. At the outset, the Chairperson welcomed the Members of the Committee to the sitting convened for briefing on the Subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country". Thereafter, the representatives of Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) were ushered in. After welcoming the representatives of the Ministry of Agriculture and Farmers Welfare to the sitting, the Chairperson apprised them of the provisions of the Directions 55 (1) and 58 of the Directions by the Speaker, Lok Sabha regarding confidentiality of the proceedings.

3. After the witnesses introduced themselves, one of the representatives of Department made a power point presentation and briefed the Committee on the subject. Thereafter, the Chairperson and the Members of the committee raised several issues/points as briefly mentioned below and sought clarification/information of the Department thereon:

(i) Impact of climate change on rain, fertility of soil etc. and the measures undertaken to address them.

(ii) Ignorance of farmers about scientific research in the field of agriculture.

(iii) Comprehensive training of farmers and extension of scientific research.

(iv) Need to give instructions to State Governments to impart intensive training to the farmers.

(v) Dissemination of information to the farmers aware about the adverse impact of climate change on production of certain crops or possible increase in production of other crops.

(vi) Scientific evaluation of impact of rise in temperature of sea and river water on fish breeding, migration and harvests.

(vii) Impact of rise in temperature on milk production and remedial measures undertaken to address the issue.

(viii) Need to establish strong mechanism for dissemination of information for prioritization, initiation and extension of land based development programmes.

(ix) Need to study the problems being faced by the poor small and marginal farmers and scientific measures to address their problems.

(x) Need to develop infrastructure of Krishi Vigyan Kendra and strengthen its manpower for dissemination of information to the farmers.

(xi) Need to undertake research to develop seeds which could withstand climatic stresses/Shortcomings.

(xii) Selection of crops in accordance with climate change to maintain crop production.

(xiii) Measures to be undertaken to control impact of insects/ pests due to climate change.

(xiv) Need for management of water and conservation and renovation and revival of dead water resources/bodies.

(xv) Development of ways to augment production of fishery in less water and demonstration of technology and its extension to the farmers.

(xvi) Management of food security keeping in view climate change.

(xvii) Farmers be trained in traditional treatment of livestock.

(xviii) Need for creation of water reservoirs on river banks.

(xix) Need for development of scientific thinking to save crops from wild animals.

(xx) Need for development of network for production of high quality seeds.

(xxi) Formation of Scheme for farmers for production of milk.

(xxii) Training of farmers for production of fodder.

(xxiv) Need to produce crops like Madua, Kodo, Sanwa, Tangun.

(xxv) Need to do research to produce crops as per the climate change.

(xxvi) Dissemination of information to farmers through KVK at Block level to maintain production.

(xxvii) Extension of drip procedure to augment production of crops with less water.

(xxviii) Adoption of climate resilient agriculture.

(xxix) Inadequacy of ICAR institutes in the country.

(xxx) Very little research undertaken on harvesting of water.

(xxxi) Need for research and development of Kand-Mool as an optional food.

(xxxii) Encouragement of farmers to undertake production of pulses.

(xxxiii) Availability of insecticides/pesticides to check damage of pulses from insects/pests.

(xxxiv) Need for development of varieties of pulses which may give crops in shorter time.

4. The Representatives of the Department responded to most of the queries raised by the members. The chairperson thanked the witnesses for sharing valuable information with the Committee on the subject and directed them to furnish the requisite information in writing on the points/items, which was not readily available with them to the Secretariat of the Committee at the earliest.

5. A copy of verbatim proceedings of the sitting has been kept separately.

The Committee then adjourned.

Appendix- II

COMMITTEE ON AGRICULTURE
(2015-16)

MINUTES OF THE EIGHTH SITTING OF THE COMMITTEE

*****

The Committee sat on Monday, the 06th November, 2015 from 1500 hours to 1700 hours in Committee Room 'E', Parliament House Annexe, New Delhi.

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS

LOK SABHA

2. Prof. Richard Hay
3. Md. Badaruddoza Khan
4. Shri Ajay Nishad
5. Shri Dalpat Singh Paraste
6. Shri Nityanand Rai
7. Shri Mukesh Rajput
8. Shri C.L. Ruala
9. Shri Virendra Singh

RAJYA SABHA

9. Shri A.W. Rabi Bernard
10. Smt. Renuka Chowdhury
11. Shri Janardan Dwivedi
12. Shri Vinay Katiyar
13. Shri Modh. Ali Khan
14. Shri Rajpal Singh Saini
15. Shri Ram Nath Thakur
16. Shri Darshan Singh Yadav

SECRETARIAT

1. Shri U.B.S. Negi - Joint Secretary
2. Shri Arun K. Kaushik - Director
3. Shri Sumesh Kumar - Under Secretary

WITNESSES
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION

S.No.	Name of the Officer	Designation
1.	Shri Nikhilesh Jha	Mission Director, National Water Mission
2.	Shri Pradeep Kumar	Commissioner (SP)

2. At the outset, the Chairperson welcomed the Members of the Committee to the Sitting convened for briefing on the Subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country". Thereafter, the representatives of Ministry of Water Resources, River Development and Ganga Rejuvenation were ushered in. After welcoming the representatives of the Ministry to the Sitting, the Chairperson apprised them of the provisions of the Directions 55 (1) and 58 of the Directions by the Speaker, Lok Sabha regarding confidentiality of the proceedings.

3. After the witnesses introduced themselves, the Mission Director, National Water Mission one of the representatives briefed the Committee on the subject. Thereafter, the Chairperson and the Members of the Committee raised several issues/points as briefly mentioned below and sought clarification/information of the Department thereon:-

I. Steps being taken by the Government to face the challenges of fluctuation in availability of water for agriculture as predicted by various climate change models;
II. Steps being taken to survey the numbers and condition of traditional sources of water bodies;
III. Need to undertake survey on dead streams of river across the Country and steps being taken to rejuvenate these dead streams so that these can be converted into water resources.
IV. Steps being taken to survey traditional resources of water which are illegally encroached and steps being taken for their rejuvenation;
V. Need to promote construction of small check dams on seasonal rivers;
VI. Steps being taken to solve problem of water logging caused due to construction of large irrigation canal;
VII. Need to augment water availability for agriculture;
VIII. Need to promote drip/sprinkler irrigation among small and marginal farmers;
IX. Need of time bound and planned completion of works of large irrigation schemes;
X. Need of meticulous planning for construction of dams/ irrigation schemes based on physical verification at ground situation;
XI. Steps being taken for scientific management of water resources available in Country;
XII. Schemes pending before the Government regarding running of State motor tube wells and channels;

XIII. Steps being taken to augment water sources of Sambhal Lok Sabha Constituency so that farmers can be provided water for agriculture;
XIV. Steps being taken to provide water in hilly areas;
XV. Steps being taken for arranging of irrigation facility to farmers displaced due to construction of dams on Narmada and Son in Madhya Pradesh;
XVI. Steps being taken for rejuvenation of Bhagirathi river in West Bengal;
XVII. Steps being taken for dredging of Gandak river in Bihar;
XVIII. Steps being taken for resolving water disputes among States;
XIX. Need to encourage rain water harvesting;
XX. Need to suggest State for ban on ground water extraction in Krishna river basin due to drought;
XXI. Need to control exploitation of ground water resources by the water bottling companies;
XXII. Need to frame vision documents for management of water resources in the Country;
XXIII. Progress made on project for interlinking of rivers in the Country;
XXIV. Need of detailed scientific study on the issue of local geological balances *vis-à-vis* river interlinking project; and
XXV. Need to promote coordination between Central and State Government for water management;
XXVI. Impact of flooding and water logging on soil fertility.
XXVII. Status of Barrage on Kosi River.

4. The Representatives of the Department responded to most of the queries raised by the Members. The Chairperson thanked the witnesses for sharing valuable information with the Committee on the subject and directed them to furnish the requisite information on the points/items, which was not readily available with them to the Secretariat of the Committee at the earliest.

5. **A copy of the verbatim proceedings of the sitting has been kept separately.**

The Committee then adjourned.

Appendix- III

STANDING COMMITTEE ON AGRICULTURE
(2016-17)

MINUTES OF THE TWENTIETH SITTING OF THE COMMITTEE

*****

The Committee sat on Friday, the 8th April, 2016 from 1500 hours to 1700 hours in Room No. "62", Parliament House, New Delhi

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS
LOK SABHA

2. Prof. Ravindra Vishwanath
3. Dr. Tapas Mandal
4. Shri Janardan Mishra
5. Shri Ajay Nishad
6. Shri Dalpat Singh Paraste
7. Shri Nityanand Rai
8. Shri Mukesh Rajput
9. Shri C.L.Ruala
10. Shri Satyapal Singh (Sambhal)
11. Shri Virendra Singh
12. Shri Dharmendra Yadav
13. Shri Jai Prakash Narayan Yadav
14. Shri B.S.Yeddyurappa

RAJYA SABHA

15. Shri A.W.Rabi Bernard
16. Shrimati Renuka Chowdhury
17. Sardar Sukhdev Singh Dhindsa
18. Shri Janardan Dwivedi
19. Mohd. Ali Khan
20. Shri Rajpal Singh Saini
21. Shri Ram Nath Thakur
22. Shri Shankarbhai N.Vegad
23. Shri Darshan Singh Yadav

SECRETARIAT

1.	Shri U.B.S. Negi	-	Joint Secretary
2.	Shri Arun K. Kaushik	-	Director
3.	Shri Sumesh Kumar	-	Under Secretary

LIST OF WITNESSES

S.No.	NAME OF THE OFFICER	DESIGNATION
1	Dr. Trilocan Mohapatra	Secretary (DARE) & DG (ICAR)
2	Dr. S.K. Chaudhary	ADG (NRM)
3	Dr Ravinder Kaur	Project Director
4	Dr. S.V. Ngachan	ICAR Research Complex for NEH Region
5.	Dr. B.P. Bhatt	ICAR Research Complex for Eastern Region

2. At the outset the Chairperson welcomed the members to the Sitting of the Committee. The Chairperson stated that the meeting has been called to have a evidence on the subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country" with the representatives of the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education).

3. After the introduction, the Chairperson initiated the discussion which was taken forward by the representatives of the Department and the Members of the Standing Committee. The Committee raised several issues such as achievements of Indian Agricultural Research Institute, Pusa, ICAR-NEHR, Barapani and ICAR-Eastern Region, Patna on R&D being taken to make the Indian Agriculture climate resilient; steps being taken to estimate requirement of food grains, vegetable, Meat and Poultry in the country in next 50 years; need of research for development of heat resistant varieties of crops; need to enhance production of seeds of heat resistant varieties of crops; need of seed multiplication farm at Block level; need of mechanization of Indian Agriculture; need to provide financial support to farmer for adopting drip/sprinkler irrigation system; need of R&D on development of hybrid of indigenous varieties of crops; need of R&D on improvement of indigenous breeds of crops; need to promote cultivation of coarse cereals; need to promote research on development of farming system suitable for North-Eastern parts of the country; need of R&D to develop short duration varieties of crops; need of R&D to develop alternatives for green manure for animal fodder; need to promote water harvesting system in rural areas for agriculture; need to revive traditional water harvesting system etc.

The Representatives of the Department responded to most of the queries raised by the members.

4. The Chairperson then thanked the witnesses for sharing valuable information with the Committee and directed them to send, in writing, the requisite information on the points or items, which was not readily available with them to the Secretariat at the earliest.

5. A copy of the verbatim proceedings of the sitting has been kept separately.

The Committee then adjourned.

Appendix- IV

STANDING COMMITTEE ON AGRICULTURE
(2016-17)

MINUTES OF THE TWNETY FIRST SITTING OF THE COMMITTEE

*****

The Committee sat on Thursday, the 21st April, 2016 from 1100 hours to 1310 hours in Room No. "B", Parliament House Annexe New Delhi

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS
LOK SABHA

2. Dr. Tapas Mandal
3. Shri Janardan Mishra
4. Shri Ajay Nishad
5. Shri Nityanand Rai
6. Shri Mukesh Rajput
7. Shri C.L.Ruala
8. Shri Satyapal Singh (Sambhal)
9. Shri Jai Prakash Narayan Yadav

RAJYA SABHA

10. Shri Janardan Dwivedi
11. Shri Modh. Ali Khan
12. Shri. Rajpal Singh Saini
13. Shri Ram Nath Thakur
14. Shri Darshan Singh Yadav

SECRETARIAT

1.	Shri U.B.S. Negi	-	Joint Secretary
2.	Shri Arun K. Kaushik	-	Director
3.	Smt. Juby Amar	-	Additional Director
4.	Shri Sumesh Kumar	-	Under Secretary

LIST OF WITNESSES

S.No.	NAME OF THE OFFICER	DESIGNATION
1	Dr. Anil K. Singh	Vice Chancellor, Rajmata Vijayarajescindia Krishi Vishwa Vidhayala, Gwalior
2	Dr. Ch. Srinivasa Rao	Director, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
3	Mr. Crispino Lobo	Managing Trustee, WOTR
4	Shri G.G Sohani	Vice President, BAIF Development Research Foundation

2. At the outset the Chairperson welcomed the members to the Sitting of the Committee convened for evidence of representatives of Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) on the subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country"

3. After the introduction, the Chairperson initiated the discussion which was taken forward by the representatives of the Department and the Members of the Standing Committee. The Committee raised several issues such as, works done by the Rajmata Vijayarajescindia Krishi Vishwa Vidhalaya, Gwalior, ICAR-Central Research Institute For Dryland Agriculture, Watershed Organization Trust (WOTR) And BAIF Development Research Foundation on the issue of impact of climatic changes on Indian Agriculture and its impact on food security of the country; R&D work on development of heat resilient varieties of seed as per pattern of rising temperature; need of R&D to serve problems of small and marginal farmers; Need to develop cost efficient and effective irrigation equipments; Steps being taken for dissemination of research outcome such crop varieties Agriculture equipments etc. among farming community; Steps being taken to develop ways for maintenance of ponds; Efforts being made by CRIDA (Central Research Institute for Dryland Agriculture) for coordination with State Agricultural Universities, KVKs (Krishi Vigyan Kendras) and ATMA (Agricultural Technology Management Agency) for dissemination of information about research outcome of the Institute. The Representatives of the Rajmata Vijayarajescindia Krishi Vishwa Vidhalaya and ICAR- Central Research Institute For Dryland Agriculture responded to most of the queries raised by the members.

4. Thereafter, representatives of WOTR made a PowerPoint presentation on the Works being done by them in the field of agriculture. Later on, representatives of BAIF made a Power Point presentation on the Works being done by them in the field of agriculture and conservation of indigenous breed of

cattles. They have also emphasized need to control indiscriminate cross breeding of indigenous breed of cattle's with exotic breeds of cattle; Need to conserve and improve indigenous verities of cattle. etc.

5. The Chairperson then thanked the witnesses for sharing valuable information with the Committee and directed them to send, in writing, the requisite information on the points or items, which was not readily available with them to the Secretariat at the earliest.

6. A copy of the verbatim proceedings of the sitting has been kept separately.

The Committee then adjourned.

Appendix- V

STANDING COMMITTEE ON AGRICULTURE
(2016-17)

MINUTES OF THE THIRTY FIRST SITTING OF THE COMMITTEE

*****

The Committee sat on Wednesday, the 31st August, 2016 from 1100 hours to 1400 hours in Room No. "62",Parliament House New Delhi

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS
LOK SABHA

2. Prof. Ravindra Vishwanath
3. Shri Janardan Mishra
4. Shri Mukesh Rajput
5. Shri Konakalla Narayana Rao
6. Shri C.L.Ruala
7. Shri Satyapal Singh (Sambhal)

RAJYA SABHA

8. Shri Janardan Dwivedi
9. Shri Meghraj Jain
10. Shri Vinay Katiyar
11. Shri Modh. Ali Khan
12. Shri Ram Nath Thakur
13. Shri Shankarbhai N. Vegad
14. Shri Darshan Singh Yadav

SECRETARIAT

1.	Shri U.B.S. Negi	-	Joint Secretary
2.	Shri Arun K. Kaushik	-	Director
3.	Shri Sumesh Kumar	-	Under Secretary

LIST OF WITNESSES

S.No.	NAME OF THE OFFICER	DESIGNATION
1	Shri Jalaj Shrivastava	Additional Secretary
2	Shri R.B. Sinha	Joint Secretary
3	Dr. K. Alagusundaram	Deputy Director General (NRM),ICAR
4	Dr. S. Bhaskar	Assistant Director General (AAF&CC), ICAR
5.	Dr. Ch Srinivasa Rao	Director, Central Research Institute for Dryland Agriculture, Hyderabad

CROP CARE FEDERATION OF INDIA

1.	Shri Rajju Shroff	Chairman, CCFI
2.	Shri S. Ganesan	Advisor,(Public and Policy Affairs) CCFI
3.	Shri P.S. Rawat	VP, CCFI
4.	Smt. Nirmala Pathrawal	Head, CCFI

2. At the outset the Chairperson welcomed the members to the Sitting of the Committee convened for evidence of representatives of Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) and Crop Care Federation of India on the subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country".

3. After the introduction, one of the representatives of Crop Care Federation of India has briefed the Committee on importance of domestic pesticides sector to the India Agriculture. They have emphasized on issues such as absence of proper research on impact of pesticides on health, fallacious propaganda about harmful impact of use of pesticides in Agriculture in the Country, absence of level playing field to Indian farmers in Agriculture Export due to phyto-sanitary and pesticides residue restrictions imposed by importing countries, absence of adequate facilities for testing of pesticides residue in agriculture products being imported in the country, need of public-private partnership for training of farmers; need of branding and marketing of Indian Agriculture Produce in the export market; etc..

4. Thereafter, the members of the Committee raised some queries such as steps being taken by the Government to develop capacity building of farmers and other stakeholders to face the challenges associated with the climatic changes; steps being taken by the ICAR to provide research support to the pesticide sector in the country; use of DDT in agriculture sector; steps being taken to educate farmers on balance used of pesticides in agriculture farms; steps being taken to ban sale of spurious/inferior quality pesticides in the market; etc. The Representatives of the Department responded to most of the queries raised by the members.

5. The Chairperson then thanked the witnesses for sharing valuable information with the Committee and directed them to send, in writing, the requisite information on the points or items, which was not readily available with them to the Secretariat at the earliest.

6. A copy of the verbatim proceedings of the sitting has been kept separately.

The Committee then adjourned

Appendix- VI

STANDING COMMITTEE ON AGRICULTURE
(2016-17)

MINUTES OF THE THIRD SITTING OF THE COMMITTEE

*****

The Committee sat on Wednesday, the 05th October, 2016 from 1500 hours to 1710 hours in Committee Room "E", Parliament House Annexe, New Delhi

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS

LOK SABHA

2. Prof. Ravindra Vishwanath
3. Md. Badaruddoza Khan
4. Shri C. Mahendran
5. Shri Janardan Mishra
6. Shri Mukesh Rajput
7. Shri Neiphiu Rio
8. Shri C.L.Ruala
9. Shri Satyapal Singh (Sambhal)
10. Shri Virendra Singh
11. Shri Jai Prakash Narayan Yadav

RAJYA SABHA

12. Shri A.W.Rabi Bernard
13. Shrimati Renuka Chowdhury
14. Shri Sambhaji Chhatrapati
15. Sardar Sukhdev Singh Dhindsa
16. Shri Janardan Dwivedi
17. Shri Vinay Katiyar
19. Mohd. Ali Khan

SECRETARIAT

1.	Shri U.B.S. Negi	-	Joint Secretary
2.	Shri Arun K. Kaushik	-	Director
3.	Shri Sumesh Kumar	-	Under Secretary

LIST OF WITNESSES

S.No.	NAME OF THE OFFICER	DESIGNATION
1.	Dr. Trilochan Mohapatra	Secretary (DARE) & DG (ICAR)
2.	Dr.K.Alagusundaram	Deputy Director General (NRM),ICAR
3.	Dr. S.Bhaskar	Assistant Director General (AAF&CC),ICAR

2. At the outset the Chairperson welcomed the members to the Sitting of the Committee convened for evidence of representatives of Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) on the subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country"

3. After the introduction, the Chairperson initiated the discussion which was taken forward by the representatives of the Department and the Members of the Standing Committee. The Committee raised several issues such as, need to prepare plan on Agro-forestry according to local environment and farming practices, stress on plantation of indigenous tree species in Agro-Forestry Programme; Steps being taken to improve soil health so that it can witnessed climatic changes; Steps taken for R&D to safeguard crops from Hailstorm; Need to focus on North-East India for enforcing agriculture production; Need to start short term certificate courses in Agriculture, need to enhanced coverage of weather advised; Need of research on improvement of indigenous breeds of cattle; Need to promote organic farming in country; Need to enhance target for training of farmers to make Indian agriculture climatic resilient; Need to R&D on alternative use of crop residue; etc. The Representatives of the Department responded to most of the queries raised by the members.

4. The Chairperson then thanked the witnesses for sharing valuable information with the Committee and directed them to send, in writing, the requisite information on the points or items, which was not readily available with them to the Secretariat at the earliest.

5. A copy of the verbatim proceedings of the sitting has been kept separately.

The Committee then adjourned.

Appendix- VII

STANDING COMMITTEE ON AGRICULTURE
(2016-17)

MINUTES OF THE FIFTH SITTING OF THE COMMITTEE

*****

The Committee sat on Friday, the 28th October, 2016 from 1100 hours to 1315 hours in Committee Room 'B', Ground Floor, Parliament House Annexe, New Delhi.

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS

LOK SABHA

2. Shri Sanganna Karadi
3. Md. Badaruddoza Khan
4. Shri Janardan Mishra
5. Shri Nityanand Rai
6. Shri Mukesh Rajput
7. Shri C.L.Ruala
8. Shri Satyapal Singh (Sambhal)
9. Shri Jai Prakash Narayan Yadav
10. Shri B.S.Yeddyurappa

RAJYA SABHA

11. Shri Sambhaji Shahu Chhatrapati
12. Shri Janardan Dwivedi
13. Shri Meghraj Jain
14 Shri Vinay Katiyar
15. Shri Modh. Ali Khan
16. Shri Ram Nath Thakur
17. Shri Shankarbhai N.Vegad

SECRETARIAT

1.	Shri Arun K. Kaushik	-	Director
2.	Smt.Juby Amar	-	Additional Director

LIST OF WITNESSES

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

S.No.	NAME OF THE OFFICER	DESIGNATION
1.	Shri R.R.Rashmi	Special Secretary
2.	Shri Ravi Shankar Prasad	Joint Secretary
3.	Dr.J.R.Bhatt	Advisor

MINISTRY OF EARTH SCIENCES

1.	Dr.M.Rajeevan	Secretary
2.	Dr.K.J.Ramesh	DG,IMD
3.	Shri Anand S. Khati	Joint Secretary
4.	Dr. Gopal Raman Iyengar	Advisor

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

2. At the outset the Chairperson welcomed the members to the Sitting of the Committee. The Chairperson stated that the meeting has been called to have a Evidence on the Subject 'Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country'. with the representatives of the Ministry of Environment, Forest and Climate Change

3. After the introduction, one of the representatives of the Departments briefed the Committee on the Subject. Thereafter, the Chairperson initiated the discussion which was taken forward by the representatives of the Department and the Members of the Standing Committee. The Committee raised several issues/points which have been briefly mentioned below and sought opinion of the Department on the same:

I. Need to study the changes in climatic pattern to mitigate the damage to the crops;

II. Need to find solutions for depleting water resources due to climatic changes;

III. Need to quantify the profit or loss occurred to the farmers due to climatic change;
IV. Effort to be made to preserve wet lands and bring about changes in the pattern cultivation in wet lands;
V. Steps to be taken to minimize the effects of rising temperature of Earth;
VI. Need to increase funds and resources of Ministry of Environment and Forest so that the Ministry could carry out the work related to climate change more effectively;
VII. Need to have a coordinated research between Ministry of Agriculture & Farmers Welfare and Ministry of Environment and Forest and Climate change;
VIII. Need to issue an advisory to the States regarding plantation of trees like *Sababool*, *Eucalyptus* etc;
IX. Need to build consensus on national level after discussion with representatives of States and species of trees to be implanted;
X. Need to devise means to eradicate *Sababool trees* from the Country.

4. The Representatives of the Department responded to most of the queries raised by the Members. The Chairperson then thanked the witnesses for sharing valuable information with the Committee on the subject and directed them to send, in writing, the requisite information in points/items, which was not readily available with them to the Secretariat of the Committee at his earliest.

A copy of the verbatim proceedings of the sitting has been kept separately.

MINISTRY OF EARTH SCIENCES

1. After discussion with the representatives of the Ministry of Environment, Forest and Climate Change, the representatives of the Ministry of Earth Sciences were ushered in. The Chairperson stated that the meeting has been called to have a Evidence on the Subject 'Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country'. with the representatives of the Ministry of Earth Sciences.

2. After the introduction, one of the representatives of the Departments briefed the Committee on the Subject. Thereafter, the Chairperson initiated the discussion which was taken forward by the representatives of the Department and the Members of the Standing Committee. The Committee raised several issues/points which have been briefly mentioned below and sought opinion of the Department on the same:

I Steps taken to mitigate the effects of climate change and research carried out to control the rising temperature of earth;

Need to expand the system of Weather forecast so that the farmers could get information;

iii Need to identify the plants, trees and their species that could resist climate change;

iv Need to coordinate with Ministry of Environment Forest and Climate change to conduct research on bio diversity due to climate change.

v. Need to coordinate with states to institute a fund for Green House and Ply House farm.

3. The Representatives of the Department responded to most of the queries raised by the Members. The Chairperson then thanked the witnesses for sharing valuable information with the Committee on the subject and directed them to send, in writing, the requisite information in points/items, which was not readily available with them to the Secretariat of the Committee at his earliest.

A copy of the verbatim proceedings of the sitting has been kept separately.

The Committee then adjourned.

Appendix- VIII

STANDING COMMITTEE ON AGRICULTURE
(2016-17)
MINUTES OF THE TWENTY FIFTH SITTING OF THE COMMITTEE

*****

The Committee sat on Thursday, the 03rd August, 2017 from 1500 hrs. to 1700 hrs. in Committee Room No. 1 (Block-A), Extension to Parliament House Annexe Building, New Delhi.

PRESENT

Shri Hukm Deo Narayan Yadav – Chairperson

MEMBERS
LOK SABHA

2. Prof. Ravindra Vishwanath Gaikwad
3. Shri Nalin Kumar Kateel
4. Smt. Raksha Khadse
5. Md. Badaruddoza Khan
6. Shri Janardan Mishra
7. Shri Neiphiu Rio
8. Shri B. S. Yeddyurappa

RAJYA SABHA

9. Shri Sambhaji Chhatrapati
10. Shri Janardan Dwivedi
11. Shri Mohd. Ali Khan
12. Shri Ram Nath Thakur

SECRETARIAT

1.	Shri D.S. Malha	-	Joint Secretary
2.	Shri Arun K. Kaushik	-	Director
3.	Smt. Juby Amar	-	Additional Director
4.	Shri C. Vanlalruata	-	Deputy Secretary
5.	Shri Sumesh Kumar	-	Under Secretary

LIST OF WITNESSES

MINISTRY OF AGRICULTURE AND FARMERS WELFARE
(DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION)

S.No.	NAME OF THE OFFICER	DESIGNATION
1.	Dr.Trilochan Mohapatra	Secretary (DARE) &DG (ICAR)
2.	Dr. K. Alagusundaram	Deputy Director General (NRM), ICAR
3.	Dr. S.K. Chaudhari	Assistant Director General (SWM), ICAR
4.	Dr. P.K. Chakrabarty	Assistant Director General (PP&B), ICAR
5.	Dr. P.P. Biswas	Principal Scientist (Soils), ICAR
6.	Dr. Krishan K. Sharma	Principal Scientist, IAR, New Delhi
7.	Shri B.S.Phogat	Additional Plant Protection Advisor
8.	Shri D.D.K.Sharma	Secretary, Central Board of Insecticides & Registration Committee

MINISTRY OF AGRICULTURE AND FARMERS WELFARE
(DEPARTMENT OF AGRICULTURE, COOPERATION AND FARMERS WELFARE)

1.	Shri Shobhana Pattanayak	Secretary
2.	Shri Ashwani Kumar	Joint Secretary

MINISTRY OF CHEMICALS & FERTILIZERS
(DEPARTMENT OF CHEMICALS & PETROCHEMICALS)

1.	Shri Rajeev Kapoor	Secretary (Department of Chemicals & Petrochemicals)
2.	Shri Samir Kumar Biswas	Joint Secretary (Chemicals)
3.	Dr. Jitendra Kumar	Director (IPFT)
4.	Shri S.P.Mohanty	Chairman & Managing Director (HIL)

MINISTRY OF CHEMICALS & FERTILIZERS
(DEPARTMENT OF FERTILIZERS)

1.	Shri Dharam Pal	Addl.Secretary

2. At the outset, the Chairperson welcomed the Members to the Sitting of the Standing Committee. Then, the Committee took up the following draft Reports for consideration and adoption:

(i) Draft Report on the Subject "Comprehensive Agriculture Research based on Geographical Conditions and Impact of Climatic Changes to ensure Food Security in the Country" pertaining to the Ministry of Agriculture and Farmers Welfare (Department of Agricultural Research and Education) (English Version);

*(ii) xxx xxx xxx xxx xxx xxx

*(iii) xxx xxx xxx xxx xxx xxx

*(iv) xxx xxx xxx xxx xxx xxx

3. After some deliberations, the Committee adopted the draft Reports without any amendments and authorized the Chairperson to finalise the Reports and present the same to Parliament.

[WITNESSES WERE USHERED IN]

*4. xxx xxx xxx xxx xxx xxx

*5. xxx xxx xxx xxx xxx xxx

*6. xxx xxx xxx xxx xxx xxx

A verbatim record of the proceedings has been kept separately.

The Committee then adjourned.

*** Matter not related to this report.**