

Immediate

No. 9/1/2014-DM-I (Pt.)
Government of India
Ministry of Agriculture and Farmers Welfare
Department of Agriculture, Cooperation & Farmers Welfare
(Drought Management Division)

Krishi Bhawan, New Delhi
Dated the 28th December, 2016

To

The Chief Secretary
Government of
(Andhra Pradesh/Arunachal Pradesh/Assam/Bihar/Chhattisgarh/Goa/Gujarat/Haryana/ Himachal Pradesh/Jammu & Kashmir/Jharkhand/Karnataka/Kerala/Madhya Pradesh/ Maharashtra/Manipur/Meghalaya/Mizoram/Nagaland/Odisha/Punjab/Rajasthan/Sikkim/ Tamil Nadu/Telangana/Tripura/Uttarakhand/Uttar Pradesh/West Bengal)_

Subject: Revision of Manual for Drought Management – forwarding copy of Manual for Drought Management, 2016.

Sir/Madam,

I am directed to forward a copy of the Manual for Drought Management 2016, for information and necessary action.

Yours faithfully,

(Vijay Rajmohan)

Director (DM)

Tel.: 23386681

Email: vijay.rajmohan@nic.in

Encl: As above.

Copy, with a copy of the enclosure, forwarded to Secretary (Disaster Management)/ Secretary (Revenue) / Relief Commissioner, of all State Governments, for information and necessary action.

2. Copy also to:

- (i) PS to Hon'ble AM/PS to MoS(SSA)/PS to MoS(PR)/PS to MoS(SB).
- (ii) Secretary, DAC&FW/Additional Secretary (DM), DAC&FW.
- (iii) Shri Vijay Soni, US (DMC), DAC&FW, for uploading in website of DAC&FW.

(Vijay Rajmohan)

Director (DM)

MANUAL FOR
DROUGHT
MANAGEMENT

DECEMBER 2016



सत्यमेव जयते

Department of Agriculture, Cooperation & Farmers Welfare
Ministry of Agriculture & Farmers Welfare
Government of India
New Delhi

Layout design & printed by:

M/s. Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi-110028

CONTENTS

<i>Preface from Hon'ble Minister of Agriculture and Farmers Welfare, Government of India</i>	vii
<i>Foreword from Hon'ble Minister of State for Agriculture and Farmers Welfare, Government of India</i>	viii
<i>Foreword from Secretary, Department of Agriculture, Cooperation and Farmers Welfare, Government of India</i>	ix-x
<i>Acknowledgements</i>	xi
Chapter 1: Understanding Drought	1
1.1 <i>What is Drought?</i>	3
1.2 <i>Drought in India</i>	4
1.2.1 <i>Characteristics of Drought</i>	5
1.2.1.1 <i>Seasonal characteristics and intra-seasonal variability</i>	5
1.2.2 <i>Successive Droughts</i>	9
1.2.2.1 <i>Causes of Recurring Drought in India</i>	9
1.2.2.2 <i>The scenario</i>	12
1.2.3 <i>Geographical spread of drought</i>	14
1.3 <i>Impact of Drought</i>	16
Chapter 2: Drought Monitoring & Early Warning	17
2.1 <i>Monitoring and early warning systems</i>	19
2.1.1 <i>Need</i>	19
2.1.2 <i>Institutional structures</i>	19
2.1.3 <i>Key variables for monitoring drought</i>	23
Chapter 3: Drought Declaration	29
3.1 <i>Rationale and objectives</i>	31
3.2 <i>Broad indices and factors</i>	32
3.2.1 <i>Rainfall related indices</i>	32
3.2.2 <i>Remote sensing based vegetation indices</i>	34

3.2.3 Crop situation related indices	36
3.2.3.1 Area under sowing	36
3.2.3.2 Soil moisture based indices	37
3.2.4 Hydrological indices	39
3.2.4.1 Reservoir storage index	39
3.2.4.2 Groundwater drought index	40
3.2.4.3 Stream flow drought index.....	41
3.2.5 Other factors.....	42
3.2.6 Ground truthing or verification.....	42
3.3 Process for the determination of drought	43
3.3.1 Steps in the determination of drought	43
3.4 Declaration of drought	45
3.5 Memorandum for Financial Assistance	45
3.6 Timelines.....	46
3.7 Direct Benefit Transfer.....	46
Chapter 4: Drought Response and Relief.....	47
4.1 Contingency Planning: Preparedness and real-time implementation.....	50
4.1.1 Near real-time implementation of contingency plans.....	53
4.1.2 Implementation of DACPs.....	55
Relief Employment	57
Water Resources Management.....	62
Food Security.....	68
Nutrition Aspects of Food Security.....	70
Gratuitous Assistance.....	71
Waivers and Concessions	73
Cattle Camps and Fodder Supply.....	74
Health and Hygiene.....	78
Institutional Response	79
Financing Relief Expenditure.....	83
Information Management and Media Coordination	86

<i>Drought Preparedness and Response Checklist</i>	89
Chapter 5: Drought Mitigation	93
<i>Current Drought Mitigation Programmes - PMKSY</i>	95
<i>National Rainfed Area Programme</i>	98
<i>Mahatma Gandhi National Rural Employment Guarantee Scheme</i>	99
<i>Drought Mitigation Measures</i>	101
<i>Water Saving Technologies: Drip and Sprinkler Irrigation Systems</i>	111
<i>Improved Water Saving Farm Practices</i>	112
<i>Long-term Irrigation Management</i>	112
<i>Afforestation</i>	114
<i>Crop Insurance</i>	115
<i>Community Participation in Drought Mitigation</i>	115
<i>Climate Variability and Adaptation</i>	116
<i>Power supply in vulnerable area; Public distribution system</i>	117
<i>Crop management practices; Indigenous knowledge</i>	117
<i>Documentation of best practices; Awareness and capacity building</i>	118
<i>Monitoring of drought mitigation; Drought vulnerability and risk mapping</i>	118
<i>Decision support system for drought management</i>	120
<i>Impact assessment and evaluation</i>	120
<i>Promote Education and awareness of mitigation policies and measures</i>	120
<i>Encourage community-level plans for drought mitigation</i>	120
Bibliography	122
Annexures	125
<i>Annexure 1: Drought Forms</i>	127
<i>Annexure2: Drought Monitoring Centres Mandate and Organization</i>	142
<i>Annexure3: Drought Declaration Certificates</i>	144
<i>Annexure4: Preparation of Memorandum to GoI for assistance from NDRF</i>	145
Abbreviations and Acronyms	147
Glossary of Terms	151

राधा मोहन सिंह
RADHA MOHAN SINGH



कृषि एवं किसान कल्याण मंत्री
भारत सरकार
MINISTER OF AGRICULTURE
& FARMERS WELFARE
GOVERNMENT OF INDIA

PREFACE

21 DEC 2016

The varied agro-climatic context of Indian agriculture and its general dependence on monsoon rains makes it particularly vulnerable to droughts. Significant public investments in irrigation and research in appropriate technologies, development of drought resilient seed varieties, strengthening of food security and public distribution networks, widening of social security nets and availability of employment guarantee schemes have contributed to the containment of many of the maladies, traditionally associated with droughts. Yet, droughts continue to be the most vicious and persistent natural calamity, afflicting some part of the country or the other, almost on a yearly basis. Drought is acknowledged as a phenomenon characterized by a high degree of complexity and therefore the challenges related to prevention, mitigation and management of this calamity require scientific appreciation of the symptoms, careful planning, concerted action and coordination on the part of the Central and State governments.

The 'Manual for Drought Management' brought out by the Department of Agriculture, Cooperation and Farmers Welfare in 2009 helped assist Central Ministries, State Governments, diverse agencies and other stakeholders in developing an objective and holistic understanding of droughts. However, seven years have elapsed since the publication of the Manual and it is time that the relevance of this document is enhanced through the introduction of new scientific and technical tools of early forecasting and determination and new strategies for mitigation and management so that the distress and disruption caused to the socio-economic fabric of rural communities can be minimised.

I am sure that policy makers, administrators and field level functionaries will find the Manual very useful. I compliment the Central Ministries, State Governments and scientists and experts from diverse scientific bodies and institutions for making the revision of the Manual possible in a very short period of time.


(RADHA MOHAN SINGH)

Office : Room No. 120, Krishi Bhawan, New Delhi-110 001 Tel.: 23383370, 23782691 Fax : 23384129

एस. एस. अहलुवालिया
S. S. AHLUWALIA



कृषि एवं किसान कल्याण और
संसदीय कार्य राज्य मंत्री
भारत सरकार
MINISTER OF STATE FOR AGRICULTURE
& FARMERS WELFARE AND
PARLIAMENTARY AFFAIRS
GOVERNMENT OF INDIA

42 DEC 2016

Foreword

The Manual for Drought Management published by the Department of Agriculture, Cooperation and Farmers Welfare in 2009, was the first attempt of its kind at putting together expert knowledge on the nature of drought, scientific parameters for early detection of the symptoms and eventual declaration of drought, methodologies and strategies for response and mitigation, in one document. The Manual for Management of Drought 2009 has helped both Central and State Governments in developing a better understanding of drought management.

I have been informed that a team of eminent scientists and policy makers have prepared a revised National Drought Manual incorporating knowledge of modern scientific tools and of institutional structures in the Central and State Governments to track the drought and initiate prompt response to it. Drought impact mitigation measures have also been discussed in detail by drawing inputs from programmes and schemes of the government. I am sure that this Manual will be well received by policy makers and field functionaries and contribute towards prompt and effective response to a drought situation. I compliment all experts from Central and State Governments and premier scientific institutions for their valuable suggestion, guidance and support in the revision of the Manual.


(S.S. Ahluwalia)

Off. 1 : 199Q, Krishi Bhawan, New Delhi-110001 / Off. 2 : Room No. 56, Parliament House, New Delhi-110001
Resi. : 10, Gurudwara Rakab Ganj Road, New Delhi-110001
Tel. : +91-11-23782343 (KB), 23034638 (PH), 23720747 (R), Fax : 23074190, 23731977
e-mail : ssamin@gov.in

S.K. PATTANAYAK
SECRETARY



भारत सरकार
कृषि एवं किसान कल्याण मंत्रालय
कृषि, सहकारिता एवं किसान कल्याण विभाग
Government of India
Ministry of Agriculture & Farmers Welfare
Department of Agriculture, Cooperation
& Farmers Welfare

FOREWORD

Date : 23-12-2016

Drought is a recurrent calamity that has bedevilled Indian agriculture over decades and centuries. The pernicious effects of drought are manifest in the sharp drop in agricultural production and farm incomes. Shrinkage in opportunities for rural employment cause widespread immiseration among farmers, farm labourers, rural artisans and small rural businesses. The inimical impacts of drought are also reflected in deteriorating nutrition status, out migration from rural areas and distress among cattle and farm animals. In addition, droughts tend to corrode the food security of the nation, decelerate consumption and industrial growth, deflate market sentiments and stymie the overall performance of the economy.

Large parts of our country have been traditionally susceptible to droughts owing to the extreme dependence of agricultural operations on the monsoon rainfall and poor endowment of surface and ground water resources. As such, Central and State Governments have committed considerable resources in strengthening resilience to droughts through the creation of irrigation potential, promotion of conservation and efficient harvesting of water, espousal of the watershed management approach, development of abiotic stress tolerant varieties of crops, improved agronomic practices etc. All these efforts have undoubtedly blunted the vicious edge of droughts to a large extent, yet the distress and disruption in the lives of vulnerable sections of the rural society is unmistakable. It is well recognised that a combination of long and medium term mitigation measures complemented by a system of early detection of drought symptoms and timely prophylactic action are the *sin qua non* for effective state response to a calamity like drought.

The revised Manual for Drought Management, 2016 is a much needed guide for governments and agencies engaged in the prevention, mitigation and management of drought. The present revised and updated version of the earlier "Manual for Drought Management, 2009", seeks to gain from the knowledge and experiences of the past seven years. Vulnerable areas and drought hotspots have been depicted to draw attention to regions in our country that deserve greater convergence in the planning and implementation of drought risk reduction interventions. Suggestions have been offered for creation of institutional structures in the Central and State Governments for better management. New scientific indices and parameters, such as hydrological indicators, have been introduced for a more accurate assessment of drought. Contextual asymmetries among states that might have a bearing on drought e.g., extent of irrigation coverage, have also been factored in while suggesting a methodology for the determination of the severity of drought. While acknowledging the great

Continuation Sheet

advantage to be derived from the employment of science based indicators in making an objective and timely determination of drought, care has also been taken to alert authorities against the pitfalls of an unquestioning dependence on technical indicators. A quick and time-bound sample field survey has been recommended for confirmation of the technical indicators of drought in order to secure a holistic understanding of the ground realities. The revised Manual prescribes timelines for declaration of drought and follow up actions. The response mechanisms and mitigation strategies in the context of extant programmes and schemes of the government have been discussed in detail.

It is hoped that the revised National Manual for Drought Management, 2016 will bring value to the task of drought management and be extensively consulted by Central and State Governments and their agencies.

I take this opportunity to extend deep appreciation to scientists of ICAR, IMD, ISRO, NRSC, CRIDA, NIH Roorkee, CWC, CGWB, IARI, MNCFC and Ministries of Agriculture and Farmers Welfare, Ministry of Water Resources River Development and Ganga Rejuvenation, Ministry of Rural Development, Ministry of Food and Consumer Affairs, Ministry of Human Resource Development, Ministry of Home Affairs, Ministry of Finance, and the State Governments, particularly Tamil Nadu, Rajasthan, Bihar for their tireless efforts and valuable suggestions, in making revision of the Manual possible.



(S.K. Pattanayak)

ACKNOWLEDGEMENTS

1. **Shri Utpal Kumar Singh**, Additional Secretary (Drought Management) and Central Drought Relief Commissioner, Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW), Government of India.
2. **Smt. I. Rani Kumudini**, Joint Secretary (Drought Management), Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW), Government of India.
3. **Shri Vijay Rajmohan**, Director (Drought Management), Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW), Government of India.
4. **Shri Rohit Kumar**, Secretary (Disaster Management & Relief), Government of Rajasthan.
5. **Prof. Santosh Kumar**, Executive Director, National Institute of Disaster Management (NIDM), New Delhi.
6. **Dr. Surya Prakash**, Associate Professor, National Institute of Disaster Management (NIDM), New Delhi.
7. **Dr. Shibendu S. Ray**, Director, Mahalanobis National Crop Forecast Centre (MNCFC), Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW), Government of India.
8. **Dr. V. K. Sehgal**, Principal Scientist, Indian Agricultural Research Institute (IARI), New Delhi.
9. **Dr. G. Ravindra Chary**, Project Coordinator, AICRP for Dryland Agriculture, ICAR-CRIDA, Hyderabad.
10. **Dr. C. S. Murthy**, Head (Crop Monitoring & Assessment Division), National Remote Sensing Centre (NRSC), ISRO, Hyderabad.
11. **Dr. R. P. Pandey**, Scientist, National Institute of Hydrology (NIH), Roorkee.
12. **Dr. V. S. Prakash**, Adviser, International Institute of Information Technology (IIIT) & Former Special Director, Karnataka State Natural Disaster Monitoring Centre, Bengaluru.
13. **Dr. Anil Gupta**, Associate Professor, National Institute of Disaster Management (NIDM), New Delhi.
14. **Shri Anup Kumar Srivastava**, Consultant, National Disaster Management Authority (NDMA), New Delhi.
15. **Dr. K. K. Singh**, Head (Agromet Services), IMD, New Delhi.
16. **Shri Anirudh Kumar**, Joint Secretary, Department of Disaster Management, Government of Bihar.
17. **Shri R.R. Banga**, Deputy Director, WM Dte., Central Water Commission, New Delhi.
18. **Shri S. Janakiraman**, Consultant (Drought Management), Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW).

CHAPTER-1

UNDERSTANDING DROUGHT



Objectives:

- What is a drought ?
- Impacts of a drought
- Droughts in India, classification and characteristics
- Why do droughts recur in India

1.1 WHAT IS DROUGHT ?

Drought is a temporary aberration, unlike aridity or even seasonal aridity (in terms of a well-defined dry season), which is a permanent feature of climate. Drought in contrast is a recurrent, yet sporadic feature of climate, known to occur under all climatic regimes and is usually characterized by variability in terms of its spatial expanse, intensity and duration. Conditions of drought appear primarily, though not solely, on account of substantial rainfall deviation from the normal and / or the skewed nature of the spatial / temporal distribution to a degree that inflicts an adverse impact on crops over an agricultural season or successive seasons. What is universally accepted is that drought stems from a deficiency or erratic distribution in rainfall but the spread and intensity of the calamity is contingent on several factors, including the status of surface and ground water resources, agro-climatic features, cropping choices and patterns, socio-economic vulnerabilities of the local population etc. It is difficult to provide a precise and universally accepted definition of drought due to its complex nature and varying characteristics that manifest across different agro-climatic regions of the world in a myriad different ways.

Drought differs from other natural hazards such as cyclones, floods, earthquakes, volcanic eruptions, and tsunamis in that:

- There is no universally accepted definition that can encapsulate the complexity of this phenomenon adequately;
- It is difficult to determine the beginning and end of a drought episode because of the slow, 'creepy' onset, silent spread and gradual withdrawal. In India, it is generally considered to be coterminous with the monsoons;
- An episode could spill over months or even years with or without any accompanying shift in the geographical arena;
- There is no indicator or index which can precisely forecast the advent and severity of a drought event, nor project its possible impacts;
- Spatial expanse tends to be far greater than in the case of other natural calamities, which when compounded by the difficulties associated with the impact assessment of the disaster, makes effective response highly challenging;
- Impacts are generally non-structural and difficult to quantify e.g. the damage to the ecology, the disruption of socio-economic fabric of communities, the long term effects of mal-nutrition on health and morbidity etc.;
- The impact tends to get magnified in the event of successive droughts.

1.2 DROUGHT IN INDIA

Droughts during the colonial period, tended to degenerate into severe famines causing massive human losses. According to one estimate, in the latter half of the 19th century, there were approximately 25 major famines across India, which killed 30-40 million people. The first Bengal famine of 1770 is estimated to have wiped out nearly one third of the population. The famines continued until Independence in 1947, with the Bengal famine of 1943–44 which affected 3-4 million people, being among the most devastating.

The situation improved remarkably in post-independent India. Investment in irrigation works, promotion and availability of quality inputs, focus on research & extension led to increased agricultural productivity and greater resilience among the farming communities. This development did not only render the country self-sufficient in food production but to a considerable extent, famine proof. Though population quadrupled since Independence, the country did not witness a famine in the past 69 years and in fact, India has become a major exporter of agricultural produce in the world.

With the liberalization of the Indian economy in the 1990s, accelerated growth in industry and services saw the share of agriculture in Gross Domestic Product (GDP) shrink to less than 15% (half its share from a few decades ago), yet the country continued to be largely self-sufficient in food and agri-commodities, gained greater resiliences in absorbing the impact of drought.

The history of meteorological drought in India is given in Box 1.

Box 1: Meteorological History of Droughts in India

During 1871–2015, there were 25 major drought years, defined as years with All India Summer Monsoon Rainfall (AISMR) less than one standard deviation below the mean (i.e. anomaly below –10 percent): 1873, 1877, 1899, 1901, 1904, 1905, 1911, 1918, 1920, 1941, 1951, 1965, 1966, 1968, 1972, 1974, 1979, 1982, 1985, 1986, 1987, 2002, 2009, 2014 and 2015. The frequency of drought has varied over the decades. From 1899 to 1920, there were seven drought years. The incidence of drought came down between 1941 and 1965 when the country witnessed just three drought years. However, during the 21 years, between 1965 and 1987, there were 10 drought years which was attributed to the El Nino Southern Oscillation (ENSO).

Among the many drought events since Independence, the one in 1987 was one of the worst, with an overall rainfall deficiency of 19% which affected 59–60% of the normal cropped area and a population of 285 million. This was repeated in 2002 when the overall rainfall deficiency for the country as a whole was 19%. Over 300 million people spread over 18 States were affected by drought along with around 150 million cattle. Food grains production registered an unprecedented steep fall of 29 million tonnes. In 2009, the overall rainfall deficiency for the country as a whole was 22%, which resulted in decrease of food grain production by 16 million tonnes. During 2014-15 and 2015-16 large parts of the country were affected by drought causing widespread hardships to the affected population since the calamity encompassed major agricultural States in the country.

Source: Samra, 2004; NRAA, 2012, DAC&FW data.

1.2.1 Characteristics of Drought

The occurrence of drought is contingent on a number of factors such as cropping choices and agronomic practices, soil types, drainage and ground water profiles, to name a few. However, rainfall deficiency and spatial and temporal distribution, duration and dry spells are acknowledged as the most important triggers for drought.

1.2.1.1 Seasonal Characteristics and Intra-Seasonal Variability

India receives most of its rainfall (73%) from the South-West or “summer” Monsoon i.e., (the rainfall received between June and September). The summer monsoon sets in during the first week of June in the south-west corner of India and gradually proceeds towards the north-west region covering the entire country by the second week of July. The withdrawal of the Monsoon commences in the first week of September from the west and north and recedes from most parts of the country by the month-end. Even when the overall rainfall in the country was normal, large variations were noticed across regions, within States, and sometimes, even within districts. IMD set up 36 meteorological sub-divisions straddling over the territories of a dozen districts on an average, in each of the sub-divisions. Rainfall is categorised as excess, normal, deficient or scanty and the possibility of drought arises in the event of deficient or scanty rainfall.

This pattern of onset (Map 1.1) and withdrawal (Map 1.2) ensures that the duration of the rainy season in the north-west region of the country is less than a month on account of the late arrival and early cessation of monsoon activities. Conversely, Kerala and north-eastern parts of India receive more than 4 months of rainfall due to the wide window afforded by the early arrival and late withdrawal of the monsoons.

Coastal areas of peninsular India and Tamil Nadu, in particular, receive bulk of its annual rainfall from October to December, from the receding monsoon and periodic cyclonic disturbances in the Bay of Bengal, but primarily on account of the North-East monsoons. The broad seasonal distribution of rainfall in India is presented in Table 1.1.

Table 1.1: Seasonal Distribution of Rainfall in India

Season	Period	Percentage of Distribution
Pre-monsoon	March-May	10.4
South-west monsoon	June-September	73.4
Post-monsoon (Northeast Monsoon)	October-December	13.3
Winter rains	January-February	2.9

Source: India Meteorological Department, Government of India.

The Table 1.2 below throws light on the spatial and temporal extent of rainfall deficiencies in the South West Monsoon season recorded across meteorological subdivisions in the country during the drought years. It would appear that the geographical spread of the drought over meteorological subdivisions was the maximum in 1987 and 2002 among the drought events in the recent past (Table 1.2). The drought in 2015 too had a very wide coverage, and the impact substantially magnified, by the pervasiveness of the ill effects of a major drought during the immediately preceding year.

Table 1.2: Meteorological Sub-Division wise Distribution of Deficient Rainfall during Major Drought Events (Number of meteorological sub-divisions = 36)

Drought year	Mid-July	Mid-August	Mid-September
1966	19	14	16
1972	13	21	21
1979	17	15	15
1987	25	25	21
2002	25	25	21
2009	15	19	16
2014	16	14	13
2015	23	23	14

Source: India Meteorological Department

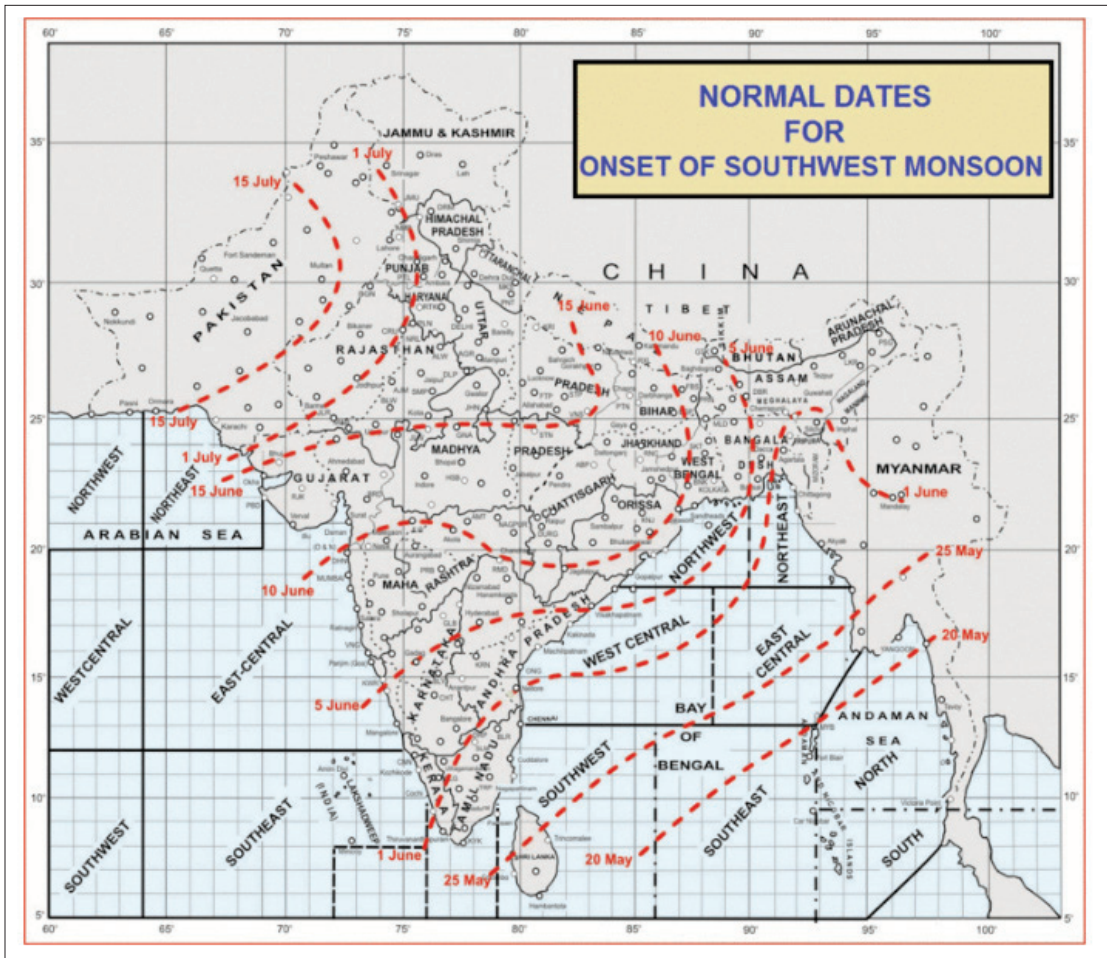
Table 1.3 provides a comparison of the extent of departure of rainfall from the normal during the recent major droughts in 1972, 1979, 1987, 2002, 2014, 2015. Rainfall variation in 2009 appears to be higher compared to other drought years at an all India level. The South West Monsoon Season in 2009 opened in June with an ominous rainfall deficiency of 47%, which was further aggravated by continuing shortfalls in the remaining months. Earlier, during the drought years of 1972, 1979 and 1987 too, a similar pattern was noticed when each of the four months between June and September recorded deficient rainfall at an all India level. In 2014, the first three months of the South West Monsoon were characterized by deficient rainfall to an extent that the late season rally in September was not sufficient to revive agriculture in most parts of the country. In contrast, the 2015 season started with normal rainfall, prompting farmers to undertake large scale agricultural operations, before the situation turned progressively adverse into a serious drought in the remaining 3 months, causing serious damage to agriculture and losses to the farmers.

Table 1.3: Month-wise All India Rainfall Distribution (Percentage departure for the country as a whole in recent major drought years)

Year	June	July	August	September	June-Sept
1972	-27	-31	-14	-24	-24
1979	-15	-16	-19	-28	-19
1987	-22	-29	-4	-25	-19
2002	+4	-51	-4	-10	-19
2009	-47	-4	-27	-20	-22
2014	-42	-10	-10	+8	-12
2015	+16	-16	-22	-24	-14

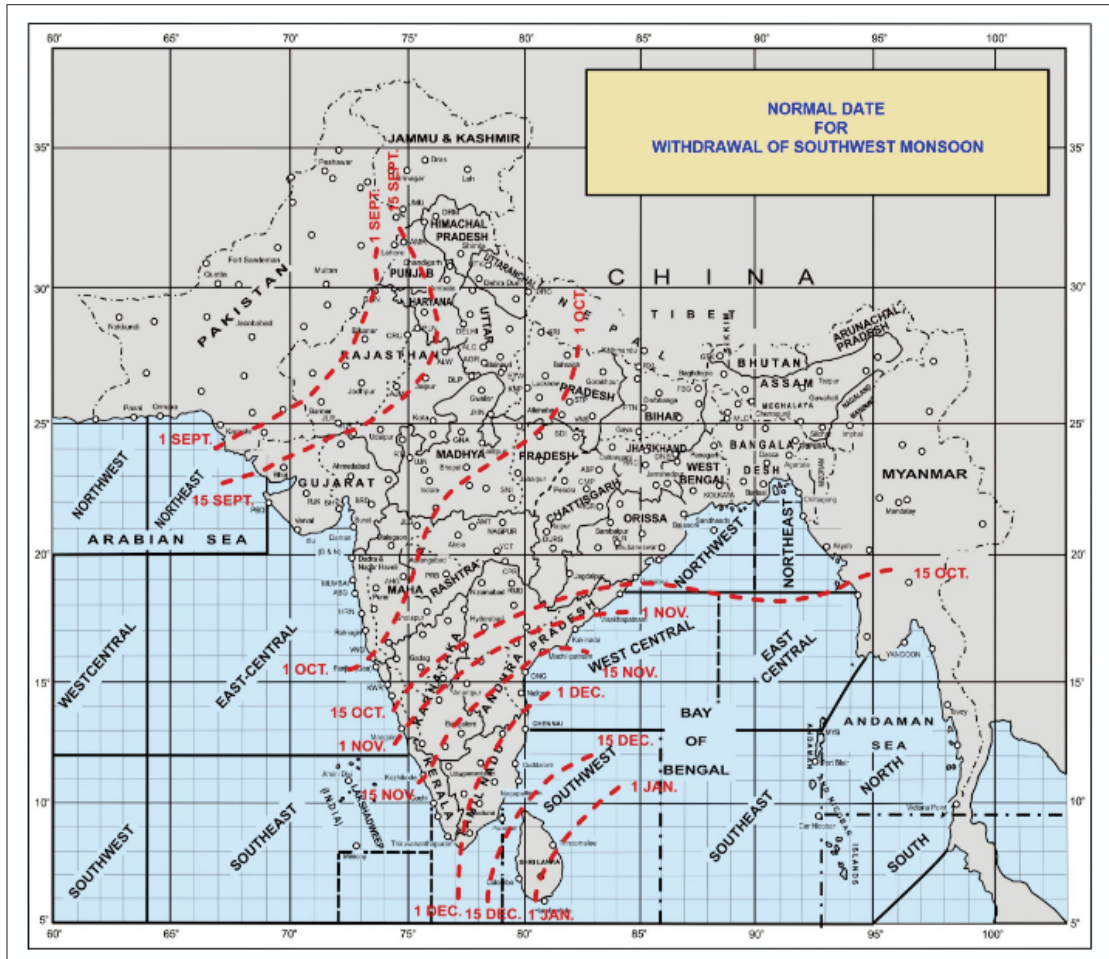
Source: India Meteorological Department

Map 1.1: Normal Dates for Onset of Southwest Monsoon



Source: India Meteorological Department

Map 1.2: Normal Dates for withdrawal of Southwest Monsoon



Source: India Meteorological Department

1.2.2 Successive Droughts

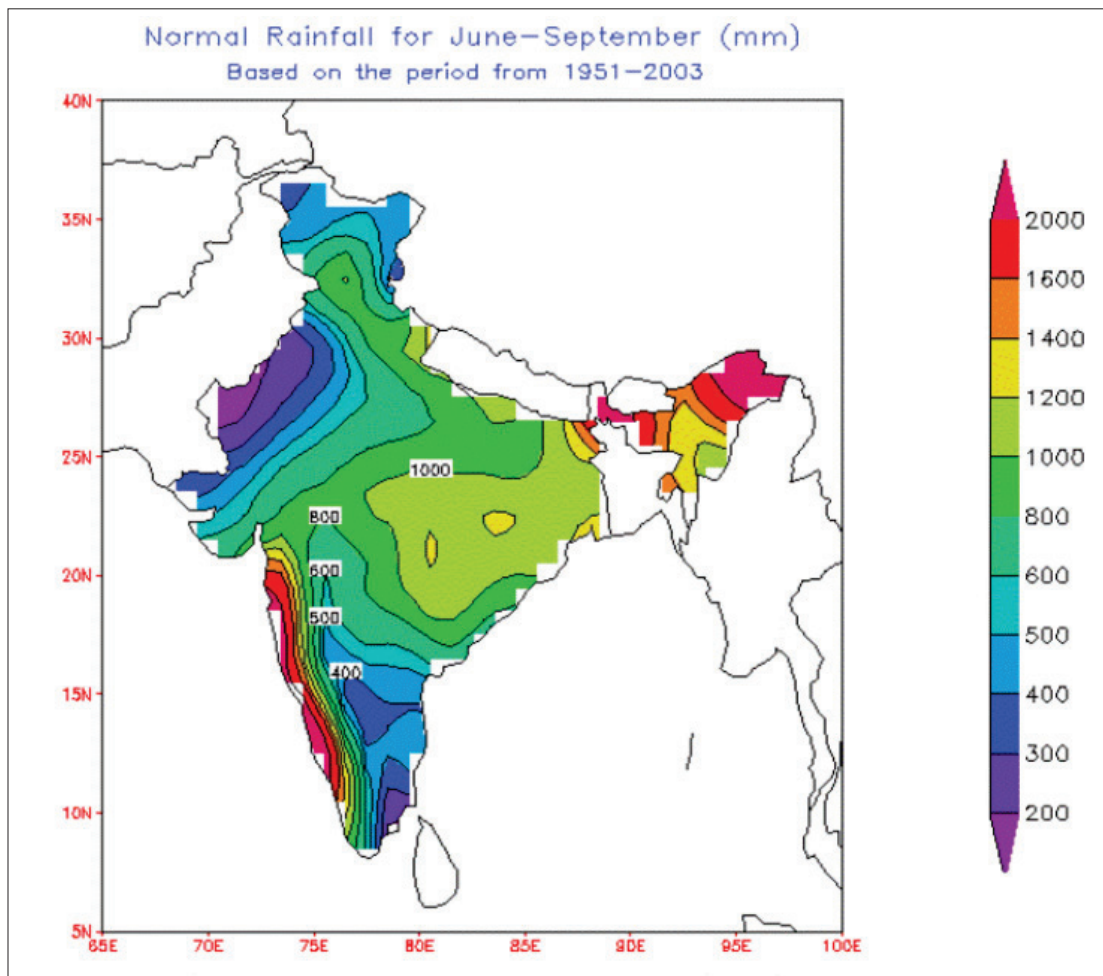
1.2.2.1 Causes of Recurring Drought in India

A deficiency in rainfall causes depletion of soil moisture, fall in surface and ground water levels which in turn is likely to have a deleterious effect on agricultural operations, due to insufficient availability of water for the crops, especially during the critical stages of plant growth. The correlation between quantum of rainfall and the trigger for drought in India vary across agro-climatic zones. In the semi-arid regions, even a well distributed 400 mm rainfall during a crop season could be adequate for the sustenance of crops, while in high rainfall regions like Assam, an annual rainfall of 1,000 mm could still create a potential for drought like development. Though deficient rainfall is considered to be the primary instigating factor for drought, yet the occurrence, spread and intensity is determined by several factors including susceptibilities introduced by climate change, hydrological and soil profiles, availability of soil moisture, choice of crops and agricultural practices, availability of fodder, socio-economic vulnerabilities etc.

The recurrence of drought in India is owed largely to the unique physical and climatic susceptibilities of the country, which include:

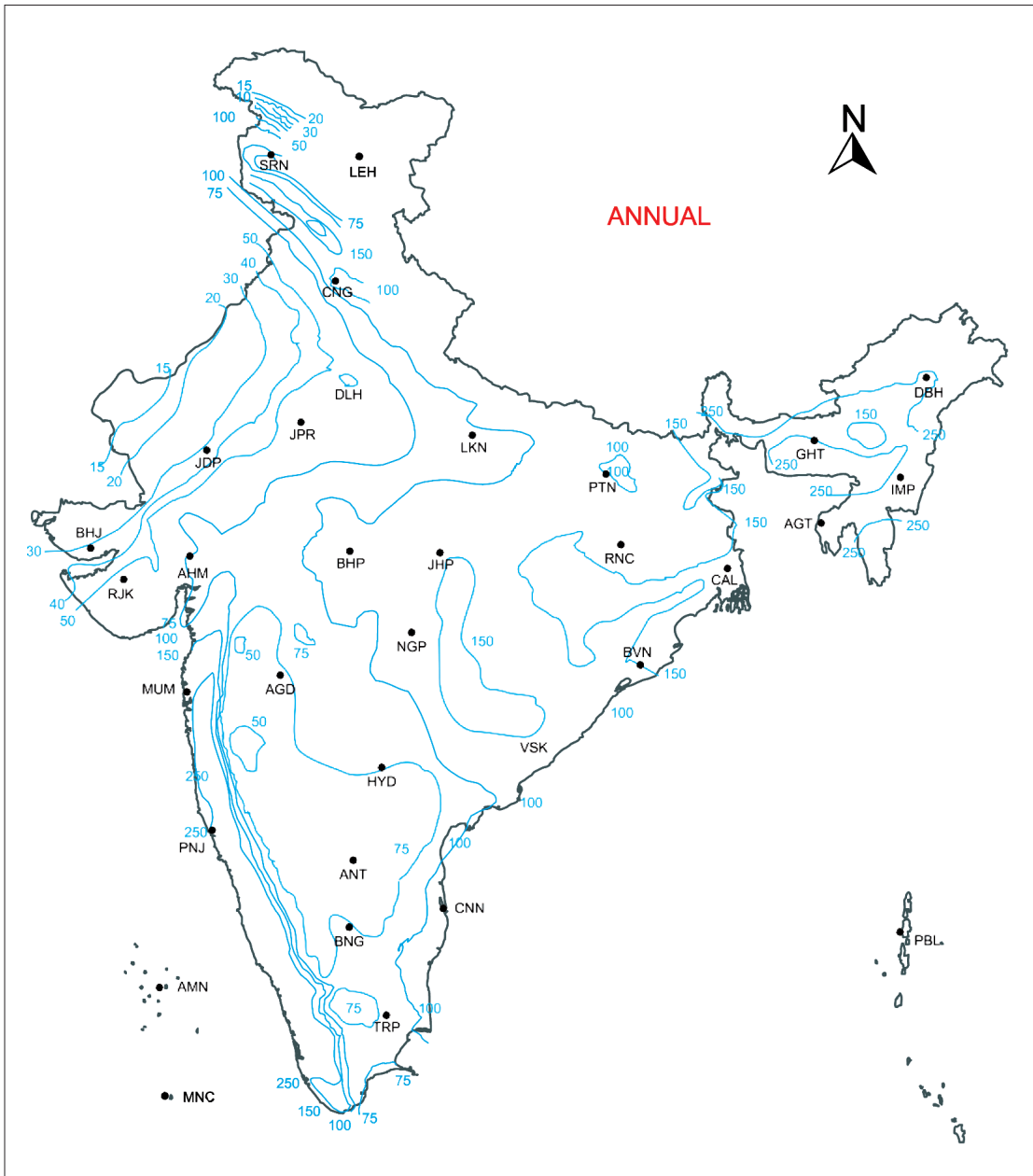
- Considerable annual / seasonal/regional variations in spite of a high average annual rainfall of around 1,150 mm. The mean annual rainfall across the country is shown in Map. 1.4;
- A relatively short window of less than 100 days during the South-West Monsoon season (June to September) when about 73% of the total annual rainfall of the country is received. The normal rainfall in various parts of the country is shown in Map 1.3;
- Uneven distribution of rainfall over different parts of the country in that some parts bear an inordinately high risk of shortfalls, while others tend to receive excessive rainfall. Even though India receives abundant rain on an average, for the country as a whole, much of the excess water, which otherwise could have contributed towards enhancing natural resilience towards drought, gets lost as run-offs. The variability in rainfall exceeds 30% in large areas of the country when compared to Long Period Average (LPA) and exceeds 50% in parts of drought- prone Saurashtra, Kutch and Rajasthan;
- Low average annual rainfall of 750 mm over 33% of the cropped area in the country heightens the susceptibility to drought;
- Over-exploitation of ground water and sub-optimum conservation and storage capacity of surface water leading to inadequate water availability for irrigation, particularly in the years of rainfall deficiency. Steady decline in per capita water availability for humans and animals even in non-drought years;
- Out migration of cattle and other animals from drought hit areas heightens the pressure on resources in surrounding regions.
- Limited irrigation coverage (net irrigated area in the country is less than 50%) exacerbates the impact of drought on account of complete dependence of agriculture in such areas on rainfall (Map 1.6).

Map 1.3: Normal Rainfall for June – September (mm)



Source: India Meteorological Department

Map 1.4: Normal Annual Rainfall (cm) Map of India



Source: India Meteorological Department

1.2.2.2 The Senario

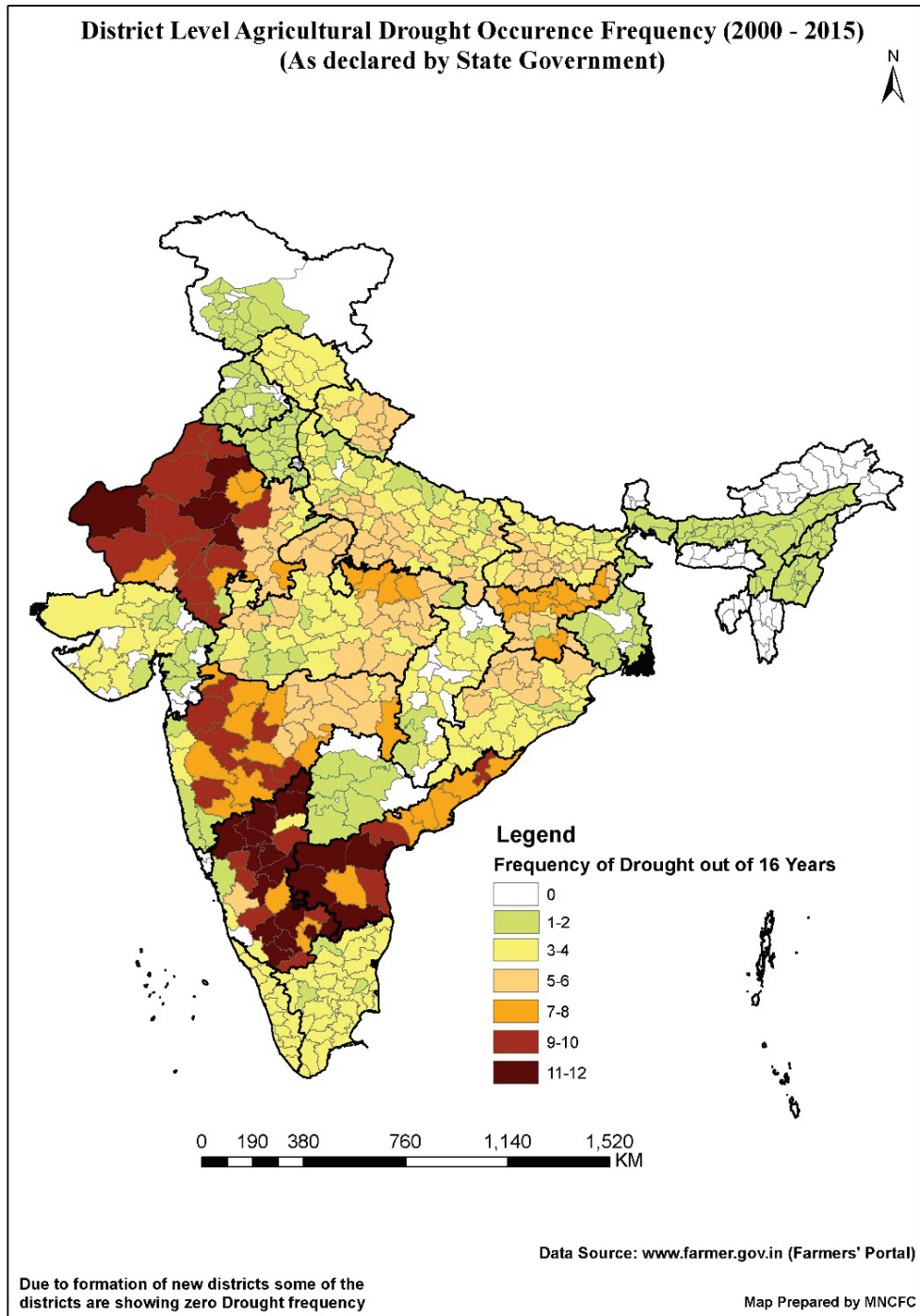
Poor rainfall in successive years tend to compound the adverse effect of drought by reducing scope for the recharge of surface and ground water resources, replenishment of soil moisture and recovery of financial capacity of agriculturists to make investments in agricultural operations. Table 1.4 shows the extent of departure of rainfall in the Kharif season during successive drought years.

Table 1.4: *%age Departure of Rainfall from Normal for Country as a Whole (SW Monsoon) during successive Drought years.*

Year	Percentage Departure from Normal
1965	-18
1966	-16
1985	-7
1986	-13
1987	-19
1999	-4
2000	-5
2001	-8
2002	-19
2014	-12
2015	-14

It is evident from Table 1.4 that at the macro-level, the serious droughts in 1966, 1987, 2002 and 2015 were a culmination of the build up of adverse rainfall events of the preceding years. It is worth noting that in several instances, the low rainfall spells have continued over several years e.g. 1985-87 and 1999-2002 periods. The map 1.5 in Chapter 1 provides a pictographic representation of the frequency of drought occurrences in districts between 2000-2015. The frequencies are derived from the number of occasions when droughts were declared in such districts by State Governments during the 15-year period. It is hoped that the map will help provide guidance to policy makers in identifying areas that are most susceptible to drought for the establishment of monitoring and early warning systems. In addition, the map will help focus attention of the Central and State Governments to particularly vulnerable areas in order to plan and prioritize mitigation measures through urgent execution of District Irrigation Plans, Crop Contingency Plans, Drinking water and MGNREGS related activities etc. It would appear that certain parts of Karnataka, Andhra Pradesh, Maharashtra, Rajasthan have been particularly susceptible to drought episodes.

Map 1.5: Frequency of Occurrence of Drought (2000-2015)



1.2.3 Geographical Spread of Drought

It has been shown that about 68% of cropped area in India is vulnerable to drought, of which 33% receives less than 750 mm of mean annual rainfall and is classified as “chronically drought-prone” while 35% which receive mean annual rainfall of 750-1125 mm is classified as “drought-prone”. The drought-prone areas of the country are confined primarily to the arid, semi-arid, and sub-humid regions of peninsular and western India.

Table 1.5: *Cropped Area Falling Under Various Ranges of Rainfall in India*

No.	Mean Annual Rainfall Ranges	Classification	%
1	Less than 750 mm	Low rainfall	33%
2	750 mm to 1125 mm	Medium rainfall	35%
3	1126 mm to 2000 mm	High rainfall	24%
4	Above 2000 mm	Very high rainfall	8%

Source: *Drought 2002, A Report, Ministry of Agriculture, Government of India*

Table 1.6 below indicates that while the droughts in 1965-67 and 1979-80 impacted comparatively high rainfall regions, whereas the droughts during 1972, 1987, and 2002 affected mostly semi-arid and sub-humid regions. In recent years, central, north-west and peninsular India appear to have suffered frequent drought occurrences. These are traditionally low rainfall zones and the frequent failure of monsoons seems to have aggravated the intensity of droughts in these regions.

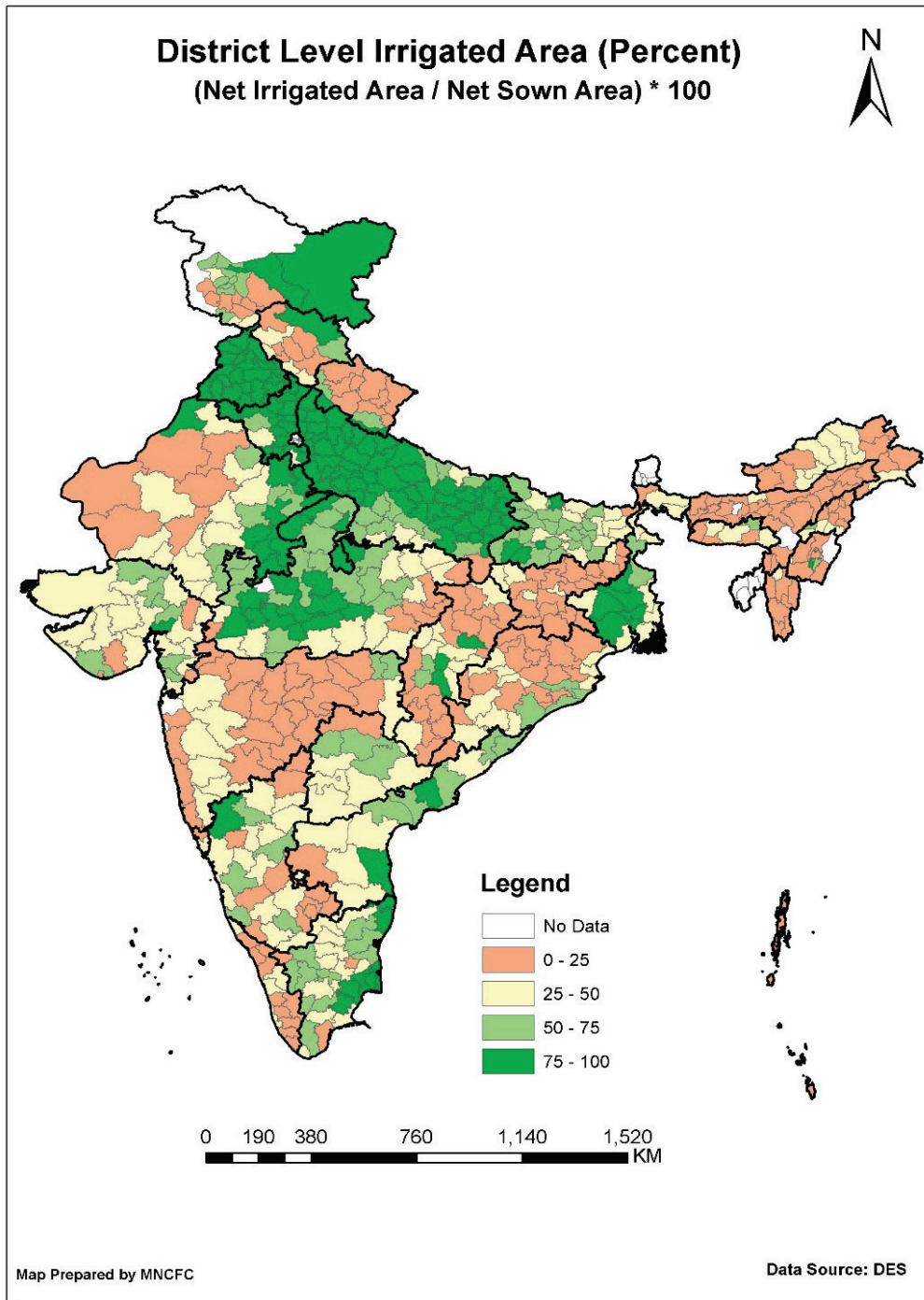
Table 1.6: *Region-wise Percentage of Departure of Rainfall from Long-term Average during SW Monsoon in Major Drought Years*

Region	1918	1965	1972	1979	1987	2002	2009	2014	2015
All India	-24.9	-18.2	-23.9	-19	-19.4	-19.2	-21.8	-11.9	-14.3
North-west	-46.9	-35.4	-31.3	-41.7	-43.9	-26.1	-35.5	-21.5	-17
Central	19.3	1.7	-18.7	-6.9	26.2	-6.7	-24.1	-10.1	-8.4
East	-31.1	-23	-24.5	-17.9	-29.4	-16.9	-20.1	-9.6	-16.3
Peninsular	-38.7	-8	-19.6	-4.9	-18.9	-32.5	-5.6	-7	-15.4

Source: *India Meteorological Department*

Irrigation systems are well developed in some parts of the country as depicted in Map 1.6. It has been noticed that regions bestowed with assured irrigation have tended to escape the adverse impact of poor monsoon rainfall to a large extent, as is often the case with many districts of Haryana and Punjab.

Map 1.6: District Level Irrigation Percentage Map (Data Source: DES, DAC&FW)



DES-Directorate of Economics & Statistics

1.3 IMPACT OF DROUGHT

Drought produces wide-ranging impacts that span across many sectors of the economy. The reverberations are felt by the society and economy much beyond the areas actually experiencing the onslaughts of physical drought because agricultural production and water resources are integral to our ability to produce goods and services. Drought affects the overall economy of the country at macro and micro economic levels, both directly and indirectly. Direct impacts are usually visible in falling agricultural production and heightened food insecurity among poor and vulnerable sections; depleted water levels; higher livestock and wildlife mortality; cattle and animal migration; damage to ecosystem from indiscriminate exploitation; increased fire hazards etc. Indirect impacts of drought can be gauged from the reduction in incomes for farmers and agribusinesses, increased prices for food and fodder, reduction in purchasing capacity and slump in consumption, default on agricultural loans, distress sale of agricultural land & livestock, rural unrest, shrinkage in avenues for agricultural employment etc. These deleterious impulses have huge negative multiplier effects in the economy and society. The impacts of drought are generally categorized as economic, environmental, and social.

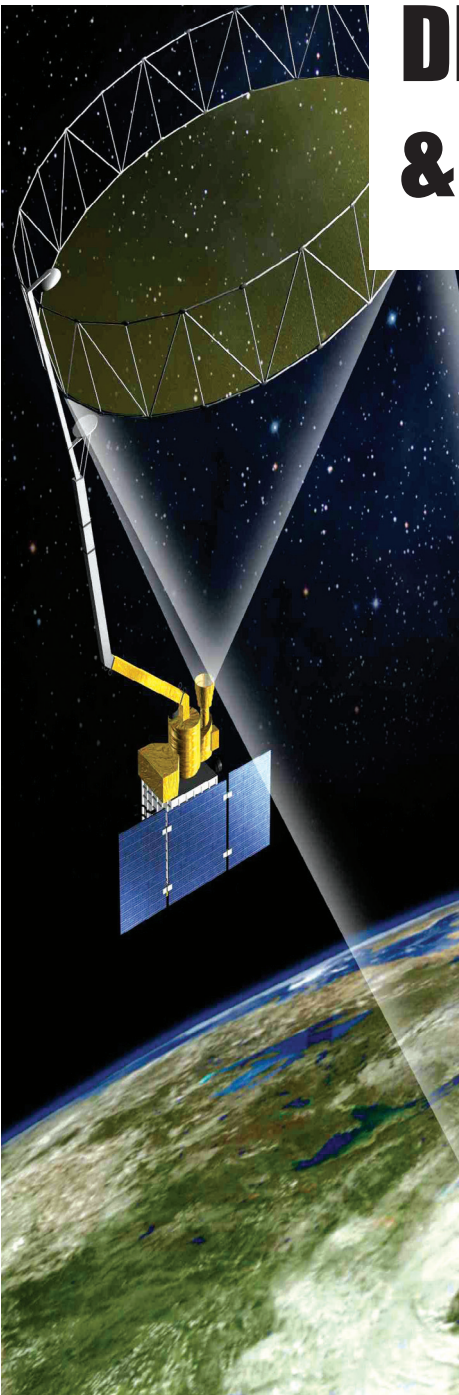
Economic impacts refer to production losses in agriculture and related sectors, especially animal husbandry, dairy, poultry, horticulture and fisheries. It affects livelihoods and quality of life for the majority of farmers, share croppers, farm labourers, artisans, small rural businesses and rural population in general that is dependent on agriculture. All industries dependent upon the primary sector for raw materials suffer on account of reduced supplies and hardening prices. Drought thus causes a dampening impact on the economy by squeezing profit margins, drying up income and revenue streams and constricting employment avenues through disruption caused to supply chain managements, slowing down flow of credit and tax collections, depressing industrial and consumer demand, increased dependence on imports, and lowering of overall market sentiments.

Environmental impacts can be gauged from low water levels in ground water and surface reservoirs, lakes and ponds, reduced flows in springs, streams and rivers, loss of forest cover, migration of wildlife and sharpening man-animal conflicts and general stress on biodiversity. Reduced stream flow and loss of wetlands may affect levels of salinity. Increased groundwater depletion rates, and reduced recharge may damage aquifers and adversely affect the quality of water (e.g., salt concentration, acidity, dissolved oxygen, turbidity) which in turn may lead to a permanent loss of biological productivity of soils.

Social impacts are manifest in widespread disruption in rural society on account of out-migration of the population from drought affected areas, rise in school dropout rates, greater immiseration and indebtedness, alienation of land and livestock assets, malnutrition, starvation and loss of social status among the most vulnerable sections. The situation of scarcity in some cases may exacerbate social tensions and lead to erosion of social capital.

CHAPTER-2

DROUGHT MONITORING & EARLY WARNING



Objectives:

- Need
- Institutional Structure
- Key Variables for Monitoring Drought
- Drought Monitoring Checklist

2.1 MONITORING AND EARLY WARNING SYSTEMS

2.1.1 Need

Drought is a complex phenomenon characterized by slow onset. Careful monitoring of the symptoms of drought and early warning are key to effective management of the calamity. It is essential that along with a drought monitoring system, medium and long term area specific plans be prepared for drought proofing of susceptible areas. In addition, contingency and Crisis Management Plans need to be formulated with care to deal with drought in the short term. Such well conceived plans, when executed promptly, can go a long way in mitigating distress and disruption to the rural economy and society. The objectives behind an effective monitoring and early warning system are to:

- provide accurate and timely information on rainfall, crop sown area, data on soil moisture (wherever possible), stream flow, groundwater, lake and reservoir storage at the relevant spatial scale at the State / district / sub-district levels.
- detect drought conditions as early as possible in order to implement District Agriculture Contingency Plans and the Crisis Management Plan.

The development of such a system and its success depends on the coordinated efforts on the part of all affected parties viz. Government of India, State Governments, Scientific Institutions and farmers.

Institutional Mechanism for Drought Monitoring and Early Warning at the National and State Levels

The Central and State Governments should set up institutional mechanisms for drought monitoring and early warning at the National and State levels. The existing capacities of these institutions need to be enhanced and strengthened for the purposes of data collection, analysis, and derive meaningful and actionable conclusions.

The institutional arrangements for drought management at the National and State levels are described below:

2.1.2 Institutional Structures

Government of India

1. Central Drought Relief Commissioner (CDRC):

Additional Secretary in the Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW) serves as the CDRC and is assisted by the Disaster Management (DM) Division in the Department. A Drought Management Cell in the DM Division is created to help collate information for diverse sources, monitor drought conditions, issue advisories, coordinate with other Ministries of the Central Government, State Governments and relevant agencies to mitigate/ combat the effect of drought.

2. Crop Weather Watch Group

The Crop Weather Watch Group (CWWG), in the DAC&FW, can act as an Inter-Ministerial mechanism, which should meet at least once a week during June to September period to monitor drought situation in the country. The composition of the Group and the specific areas of responsibility are suggested in Table 2.1 below.

Table 2.1: Composition and Role of CWWG

Partners	Tasks
Additional Secretary, Department of Agriculture, Cooperation & Farmers Welfare & Central Drought Relief Commissioner	Chairperson of the Group: overall coordination
Economics & Statistical Advisor, DAC&FW	Report behaviour of agro-climatic and market indicators
Agriculture Commissioner	Crop conditions: Availability of Inputs; Contingency Planning
Animal Husbandry Commissioner	Livestock health; Fodder availability
India Meteorological Department	Rainfall forecast and monsoon conditions.
Central Water Commission & Central Ground Water Board	Monitoring data on Important reservoirs / groundwater.
Ministry of Power	Availability of power
Indian Council of Agricultural Research (Crop Specific Research Institutes, Central Research Institute for Dryland Agriculture, Central Arid Zone Research Institute, Indian Agricultural Research Institute etc.)	Technical input and contingency planning
National Centre for Medium Range Weather Forecasting	Provide medium-term forecasts
Remote Sensing Centres	Provide satellite based inputs
Mahalanobis National Crop Forecast Centre	Agricultural Drought Information
Indian Space Research Organisation	Technical inputs on drought parameters

The CWWG will be responsible for the evaluation of multi-source information and data from scientific and technical bodies to determine the likely impact of meteorological and other environmental parameters on agriculture. The CWWG could also consider video conferences with State Governments every week, particularly, during the June-Sept period, to keep a close watch on the developments in the agricultural scenario and forge a common plan of action with all stake-holders, should the need arise. The monitoring and information-management system of the CWWG is summarized in Table 2.2.

Table 2.2: Details of CWWG Monitoring and Information Management

Parameters	National-level	State-level	District-level	Field agencies
A. Meteorological				
Delay in the onset of monsoon	D	D	D	D
Rainfall	D	D	D	D
Dry spell during sowing Period	D	D	D	D
Dry spells during critical crop-growth periods	D	D	D	D
B. Hydrological				
Water availability in reservoirs	W	W	W	D
Water availability in tanks	F	F	F	D
Stream flow	F	F	F	D
Groundwater Level	S	S	S	S
C. Agricultural				
Delay in sowing	W	W	W	W
Sown area	W	W	W	W
Crop vigour	F	F	F	W
Soil moisture deficit	F	F	F	F
Change in cropping pattern	W	W	W	W
Supply and demand of agricultural inputs	W	W	W	W

D= Daily; W= Weekly; F= Fortnightly; M= Monthly; S= Seasonal (pre- and post-rains)

This system would provide an integrated approach to drought management covering all aspects of drought: early warning and forecast, response and mitigation. The monitoring and early warning / forecasting systems are discussed below. Response and mitigation measures will be discussed in subsequent sections.

State Government:

1. State Drought Monitoring Centres :

The State Governments to consider setting up of Drought Monitoring Centres (DMCs) staffed by a multi-disciplinary team of meteorologists, hydrologists and agriculture scientists to provide critical inputs to the State Executive Committee / State Disaster Management Departments / Other Institutional Structures established by the States. The DMCs will collect, collate and analyse information on drought parameters from National and State level agencies e.g., the IMD, NRSC/SRSCs, MNCFC, CWC, CGWB, State agricultural department etc.

The outline for setting up DMCs at the State levels is provided in **Annex 2**. The State Governments can consider introducing suitable modifications in the constitution of these centres, taking into consideration their specific needs of drought monitoring. The DMCs will process the inputs received from sources to advise the State Governments/State Executive Committees (SECs) of any critical developments on drought.

Scientific & Support Organisations:

1. India Meteorological Department (IMD)

IMD provides, inter alia, national weather based services for weather-sensitive activities like agricultural and is the principal government agency in all matters related to meteorology, seismology and allied subjects. IMD provides following weather forecasts;

- All India Weather Forecasts: It includes meteorological sub-division wise 5 day rainfall forecasts for 36 sub-divisions.
- Monsoon Forecasts: Operational forecasts for the South West Monsoon season (June – September) rainfall are issued in two stages. The first stage forecast is issued in April and the second stage forecast is issued in June. In the first stage, a forecast is made for the seasonal rainfall in the country as a whole, while in the second stage, forecasts are made for the four homogenous regions and for June-July period.
- Severe Weather Warning: Meteorological sub-division wise 5 day extreme weather warnings are issued.
- District-wise rainfall Forecasts: 3 day district-level forecasts for rainfall are made.

In addition to these forecasts, IMD also issues other forecasts such as 3 hour now-casts for severe weather, specialized forecasts for tourism, highway, mountain weather, etc.

Under Agro-Advisory Services, the Agricultural Meteorology Division of IMD (located at Pune), provides district level 5-day forecasts and crop wise agro-advisories. These advisories are prepared in collaboration with Agro-Met Field Units (AMFU), located in State Agricultural Universities (SAUs) and ICAR centres.

2. Mahalanobis National Crop Forecast Centre (MNCFC)

MNCFC was established as an attached office of DAC&FW in 2012 to use space technology for agricultural assessment. MNCFC, operationally, carries out drought assessment and monitoring under the National Agricultural Drought Assessment and Monitoring System (NADAMS) after the technology was transferred from the National Remote Sensing Centre in the Department of Space (Government of India). District/sub-district level monthly drought assessments are carried out for 14 major drought-prone agricultural States of India under the NADAMS project. The drought assessment is carried out in the MNCFC using long-term satellite data (NOAA-AVHRR, MODIS, Resourcesat 2 AWiFS) on multiple vegetation indices, Rainfall Deficiency (or SPI) using meteorological data, Soil Moisture Index (from agro-meteorological modeling and satellite data), irrigation statistics and sown area figures. The monthly reports are made available in the public domain (www.ncfc.gov.in) for use of all concerned States and National agencies.

3. Central Research Institute for Dryland Agriculture (CRIDA)

The CRIDA, Hyderabad and the All India Coordinated Research Projects on Agro-meteorology and Dryland Agriculture (AICRPAM and AICRPDA), each with 25 centres under SAUs across the country take part in drought studies pertaining to assessment, mitigation, risk transfer, and development of decision support software for drought-prone States. CRIDA has prepared comprehensive District Agriculture Contingency Plans for more than 600 districts in the country, which State Governments and district level authorities can use as guidance documents to deal with drought.

4. Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD & GR)

The Central Water Commission (CWC) and the Central Ground Water Board (CGWB) under the (MoWR, RD & GR) are the two lead organizations in the country which monitor reservoir and ground water status. The data on river flows, reservoir storage levels and groundwater status can prove to be extremely useful in making a realistic assessment of water availability for agricultural crops in the event of drought like developments.

5. Indian Space Research Organisation (ISRO):

ISRO is a premium organization of the country with the mission to harness space technology for national development. Two major centres of ISRO viz., Space Applications Centre, Ahmedabad and National Remote Sensing Centres, Hyderabad carry out applications related to remote sensing, including those in agriculture. These Centres, along with 4 Regional Remote Sensing Centres, located in Bengaluru, Kolkata, Jodhpur and Nagpur can provide R&D and technical support for drought assessment/monitoring activities through satellite data products available on Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC) and Bhuvan platforms. The satellite derived products available on Bhuvan (<http://bhuvan.nrsc.gov.in/>) can be useful for drought assessment, including the computation of Normalized Difference Vegetation Index, Soil moisture etc.

6. State Remote Sensing Application Centres (SRSACs)

Most State Governments have established state level Remote Sensing Application Centres realizing the potential of remote sensing techniques. Many of these centres have matured over a period of time with required infrastructure and human resources for carrying out remote sensing applications including those critical for agriculture. These centres have not only participated in many national level programmes but have developed valuable State level geospatial database. These centres can help the State Governments in satellite data analysis for agricultural drought assessment.

2.1.3 Key Variables for Monitoring Drought

State Governments monitor drought by obtaining information from various sources on key variables of drought which include rainfall, reservoir / lake water levels, surface water / groundwater, soil moisture and sowing / crop conditions etc.

- Meteorological Data – Rainfall and other parameters like Temperature, Wind speed and Relative Humidity (subject to availability)
- Weather forecast - Short, medium, extended range
- Soil Moisture (subject to availability)

- Sown Area / Crop Health / Stress
- Satellite based Vegetation Index
- Stream Flow - Discharge
- Groundwater Levels
- Reservoir and Lake Storage / Level
- Impacts – distress sale and migration of cattle, human migration, fodder availability, drinking water, animal health, employment opportunities in agriculture sector

Data Sources for Key Variables

Rainfall

The IMD and State Governments collect data on rainfall every day during the rainy season. The IMD maintains its network of weather stations throughout the country. Within the State Government, data are collected at the Tehsil / Taluka / Block level(s), generally by the Revenue Department which is entrusted with the responsibility of collecting rainfall data at the district and Tehsil levels. The actual rainfall is compared with the Long Period Average (LPA), which is standardized on a daily, weekly and monthly basis. Such a comparison provides information on the deficit or excess of rainfall in a particular sub-division for a certain period. Satellite derived rainfall products, such as those from INSAT 3D and INSAT 3DR can also be used to assess deviation of rainfall at spatial scales in different time scales (daily, weekly and fortnightly).

Daily rainfall information could be collected and submitted in Form No. 1, included in the Annex 1.

Storage Water Levels in Reservoirs

Reservoir storage data is an useful indicator for water availability. Since reservoir storage data is available on a regular basis, it may help provide clear indication of possible water shortages in areas dependent on the surface water storage systems. The Central Water Commission (CWC) monitors and compiles reservoir storage data for 91 major reservoirs in the country (<http://www.cwc.nic.in/rsms/index.asp>). A periodic report on available live reservoir storage for 91 major reservoirs in the country is published by CWC regularly (<http://www.cwc.nic.in/>). In addition, the water resources departments in the States monitor daily reservoir level data for important reservoirs/tanks etc. State Governments need to plan for the use of reservoir storage as per their reservoir operation rules, which ought to lay down the priority for the use of available water among competing demands, e.g. drinking, urban and industrial use, irrigation, etc.

Information on water storage in important State /Union Territory owned reservoirs by the State/ UT authorities could be provided in Form No. 2(A), included in Annex 1.

Stream Flow Data Monitoring

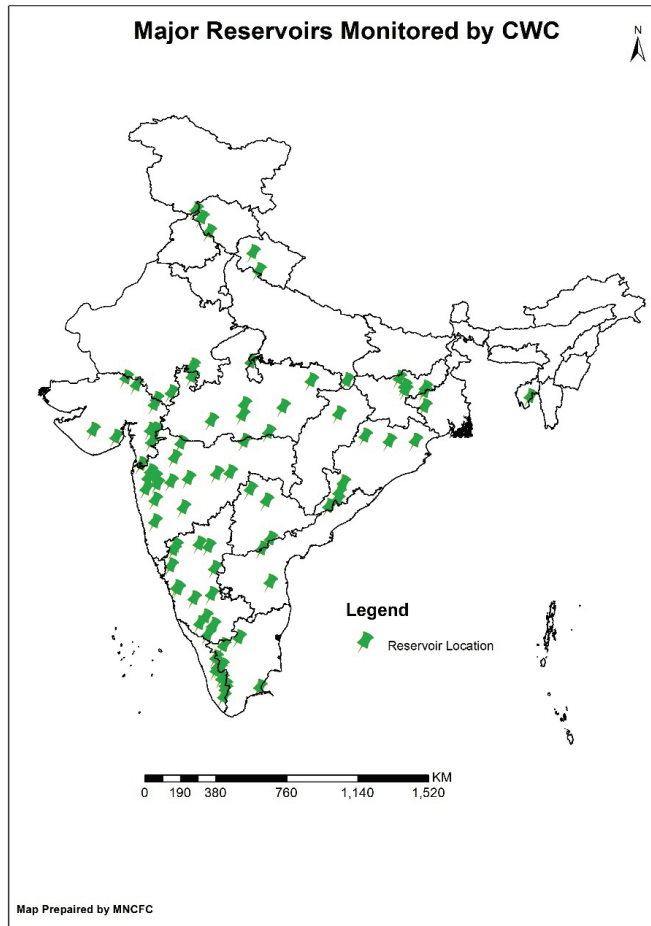
The CWC carries out extensive stream flow data monitoring in the country. The CWC has established a network of hydrological observation stations in all major river basins. Hydro-Meteorological Sites (HMS) of CWC are stations responsible for generating the stream flow data. Recently, a web based water resources information system called 'India-WRIS' has been developed

and information on the water resources in the country, including observed stream flow data for all unclassified river systems is available in the public domain (<http://www.india-wris.nrsc.gov.in/wris.html>). The stream-flow data for restricted/classified river systems can be obtained for this purpose by State Governments. Information on Stream Flow Data may be collected in Form 2(B) in Annexure-1.

Groundwater Level

The groundwater table depth below ground level is one of the important factors responsible for contribution of base flow in streams, ponds and lakes particularly during dry non rainy season. Similarly, groundwater levels are also affected due to occurrence of low recharge, either due to lack of adequate rainfall or poor water conservation practices.

The Central Ground Water Board (CGWB), and the State Groundwater Departments monitor groundwater table (GWT) depths across the country. This monitoring is usually done during pre and post monsoon seasons. In various States, GWT depth is monitored four times a year, whereas in some regions, the GWT depths are monitored on monthly time scale. Form 2(c) in Annexure-1 provides a template for collection and monitoring of information on groundwater.



Sowing and Crop Conditions

An important indicator of drought is the total area sown. The State Government agriculture departments provide information on sowing on a weekly basis. A delayed sowing indicates rainfall deficiency and is a portent for the onset of drought. Reports on crop conditions also provide an indication of the severity of the drought situation e.g. wilting of crops signifies soil moisture stress. The agriculture contingency plans and other mitigation measures are activated on the basis of reports on different crops sown during the monsoon.

Weekly Information on the area and crop-wise sowing can be provided in Form No. 3 and Form No. 4 respectively. These forms are included in the Annex 1.

Table : Key variables, indicators and sources of data for drought

S.	Key Variable	Indicator / Index(ices)	Sources of Data
1	Rainfall	Rainfall Deviation / SPI Dry Spell	IMD, State Govt.
2	Crop Sown Area	Deviation from normal	State Govt. (Department of Agriculture)
3	Satellite based crop condition	NDVI, NDWI deviation from normal VCI form of NDVI/NDWI	MNCFC, NRSC, ISRO and State Remote Sensing Centres
4	Stream Flow	SFDI	CWC / India-WRIS
5	Groundwater Levels	GWDI	CGWB
6	Reservoir Level		CWC, Irrigation Department, Water Resources Department

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is a relatively new drought index based only on precipitation. The SPI assigns a single numeric value to precipitation, which can be compared across regions and time scales with markedly different climates. This spatial and temporal flexibility allows the SPI to be useful in both short-term agricultural and long-term hydrological applications.

Reservoir Storage Index

The Surface Water Supply Index (SWSI) integrates reservoir storage, stream-flow, and two precipitation types (snow and rain) at high elevations into a single index number. SWSI is relatively easy to calculate and it gives a representative measure of water availability across a river basin or selected region/province. It is, however, unlikely that it could be successfully used for large regions with significant spatial hydrological variability since the weights may differ substantially from one part of the region to another.

Normalized Difference Vegetation Index

Normalized Difference Vegetation Index (NDVI) is based on the concept that vegetation vigour is an indicator of water availability or lack thereof. It demonstrates the effects of climate on vegetation

in terms of its absorptive capacity in visible light but little in the near-infrared spectrum. The difference of visible and near-infrared reflectance represents photosynthetically active vegetation; this information is used to construct a vegetation index. The lowering of the vegetation index indicates moisture stress in vegetation, resulting from prolonged rainfall deficiency. High NDVI values might reflect ideal growing conditions if vegetation greenness is higher than that encountered in other years.

Normalized Difference Wetness Index

Normalized Difference Wetness Index (NDWI) is expected to give the vegetation or crop turgidity and health. It is based on the use of Shortwave Infrared (SWIR) band, which is sensitive to moisture available in soil as well as in crop canopy. In the beginning of the cropping season, soil background is dominant which makes SWIR sensitive to soil moisture in the top 1-2 cm. As the crop progresses, SWIR becomes sensitive to leaf moisture content. NDWI using SWIR can complement NDVI for drought assessment particularly in the beginning of the cropping season. Higher values of NDWI signify more surface wetness.

Moisture Adequacy Index

The Moisture Adequacy Index (MAI) is obtained from weekly water balance. Drought impact is related to moisture availability at certain crop growth stages. Hence, categories of MAI (severity) at different growth stages are integrated into a single index value to identify drought impact on a particular crop. The Central Arid Zone Research Institute (CAZRI), Jodhpur monitors agricultural drought in the Indian arid regions by using MAI.

Levels of Early Warning

The early warning system should include the following:

1. Receipt of forecasts, early warning signals, and advisories from scientific institutions;
2. Monitor key drought indices at the National / State / District / Sub-district levels using composite index of various drought indicators;
3. Efficient dissemination of early warning so as to activate contingency measures.

Capacity Development for Drought Monitoring

The States are advised to undertake capacity building activities from time to time for all the stakeholders engaged in drought monitoring, response and mitigation with the support of relevant National and State Institutes.

Drought Monitoring Checklist

(For Ministry of Agriculture and Farmers Welfare, Government of India and Relief Commissioner, State Governments)

Meteorological Data:

Agencies: India Meteorological Department, National Centre for Medium Range Weather Forecasting, State Governments

Indices to be Monitored: Daily, weekly, and monthly rainfall, snow fall / fog

Hydrological Data:

Agencies: Central Water Commission, Central Ground Water Board, State Governments (irrigation departments, groundwater agencies, water resources departments/ projects)

Indices to be Monitored: Water storage in reservoirs / ponds / lakes, river flow, groundwater level, yield and draft from aquifers, water loss through evaporation, leakage, seepage.

Agricultural Data:

Agencies: National Crop Forecast Centre, Directorate of Economics & Statistics, Indian Council of Agricultural Research, Agricultural Census Data, State Government agriculture departments, agricultural universities

Indices to be Monitored: Soil moisture, area under sowing and type of crop, crop water requirement, status of growth, crop yield, alternative cropping possibilities, land holdings.

Data from Space:

Agencies: National Remote Sensing Centre, Indian Space Research Organisation.

Indices to be Monitored: Vegetation monitoring, rainfall, surface wetness and temperature.

Socio-economic Data:

Agencies: NITI Aayog, Department of Food & Public Distribution, Department of Consumer Affairs, Department of Rural Development. Ministry of Women and Child Development ,Department of Animal Husbandry, Dairying & Fisheries, Revenue Department of State etc.

Indices to be Monitored: Availability and prices of foodgrains, availability of fodder, migration of population.

Analysis of Data from Ground and Remote Sensing Sources

Prediction/ Forecasting / Declaration of Drought.

CHAPTER-3

DROUGHT DECLARATION



Objectives:

- 3.1 Rationale and Objectives
- 3.2 Broad Indices and Factors
 - 3.2.1 Key Index 1: Rainfall Indices
 - 3.2.2 Key Index 2: Remote Sensing based Vegetation Indices
 - 3.2.3 Key index 3: Crop Situation Related Indices
 - 3.2.4 Key index 4: Hydrological Indices
 - 3.2.5 Other Factors
 - 3.2.6 Ground Truthing
- 3.3 Determination of Drought
- 3.4 Declaration of Drought
- 3.5 Memorandum for Financial Assistance
- 3.6 Timelines
- 3.7 Direct Benefit Transfer

3.1 RATIONALE AND OBJECTIVES

'Drought declaration' signifies the beginning of Government response to conditions representing a drought situation. The decision to declare drought over a specified administrative unit (District/Taluka/Tehsil/ Block/Gram Panchayat level) should be guided by objective parameters and made without undue delay so that relief assistance and concessions can be provided to the drought-affected people in time.

There is substantial variance in the quality of drought monitoring and the methodology and parameters adopted in the declaration of drought among States. Many States still continue to rely on the traditional practice such as the *annewari/ paisewari/ girdawari* systems of eye estimation and crop cutting experiments to assess if the extent of damage to crops warranted a declaration of drought. In such cases, the final *annewari/ paisewari/ girdawari* estimates for *kharif* crops are generally available by December or after, whereas those for *rabi* crops are available not before March. Relief operations are mounted in drought affected areas by the State Governments after the notification of drought using, *inter alia*, funds available under the State Disaster Response Fund (SDRF). In the event of drought of a severe nature, the State Government may seek assistance from the Central Government including financial assistance from National Disaster Response Fund (NDRF).

The Central Government dispatches inter-ministerial teams to carry out assessment of drought and recommend the quantum of relief only after the State Government issues a notification of drought and submits a Memorandum for financial assistance from the NDRF. Therefore, delay on the part of State Governments in making the determination and declaration of drought on account of the preference for extensive field surveys and crop cutting experiments over other quicker means, is likely to set a train of delays in motion, making it difficult for the much needed relief to reach the affected population in time. The Government of India revised its norms in 2015 to lower the eligibility threshold from 50% loss to 33% loss to sown crops on account of drought to qualify for relief assistance. It was, however, noticed that some States still continue to recognise a minimum loss/damage of 50% to sown crops (i.e. *annewari /paisewari/ girdawari* less than 50%) for the declaration of an area as drought affected.

Technological advances have to a large extent, obviated the need for complete and sole dependence on crop loss assessment based on *annewari / paisewari / girdawari* or crop cutting assessments in the determination of drought. It is possible to arrive at an objective, timely and accurate assessment of drought through the establishment of an elaborate scientific drought monitoring system. Meteorological, remote sensing and hydrological data can be accessed by the State Governments from Central and State agencies, and processed quickly to arrive at fairly credible inferences on the emergence and intensification of drought-like conditions in any part within their territories.

It is acknowledged that a combination of carefully chosen indicators and indices derived from satellite / hydrological observations is capable of identifying areas with drought like propensities which will be discussed in the course of this Chapter. However, it needs to be conceded that drought, as opposed to most other calamities, is a highly complex phenomenon, and available technology not only has inherent limitations but the shortcomings are sometimes compounded by poor availability of reliable data.

3.2 BROAD INDICES AND FACTORS

On the basis of wide-ranging consultations with domain specialists, five categories of indices are recommended for developing a monitoring matrix for drought. The five categories of indices are Rainfall, Vegetation, Water, Crop and others. Rainfall is considered to be the most important indicator and therefore related meteorological data should be mandatorily considered in making any assessment of drought. The other indices are to be evaluated in conjunction with the rainfall related data to assess the impact of rainfall deficiency.

State Governments are expected to develop monitoring systems at the smallest administrative unit levels (e.g. Hobli/ sub-division/ Tehsil/ Taluk/ Block/Mandal/ Gram Panchayat etc.), to enable generation of sharper and credible observation data that are reflective of ground realities. In addition, agencies of Central and State Governments would be required to streamline and strengthen data collection system for drought variables. In addition, Standard Operating Procedures need to be considered for collection, updation of data related to the drought variables.

3.2.1: Rainfall Related Indices

As mentioned earlier, Rainfall is the most important indicator in the determination of drought. A departure in rainfall from its normal value in terms of magnitude and distribution i.e., from the Long Period Average (LPA) of 30 years or more is considered as fairly credible indicator of drought (Table-3.1). In addition, other indicators such as Standardized Precipitation Index (SPI) and occurrence of Dry Spells are also recommended. SPI is used as an indicator of deviation of rainfall from the normal and can serve as a more robust statistical indicator under certain conditions as compared to simple rainfall deviations. Dry spell, in contrast, is an indicator of anomalies in the distribution of rainfall.

A. Rainfall Deviation: The rainfall deviation (RFdev) which is expressed in percentage terms is calculated as below:

$$RFdev = \{(RFi - RFn)/RFn\} * 100$$

Where RFi is current rainfall for a comparable period (in mm) and RFn is the normal rainfall (at least 30 years average) for the same period (in mm). The IMD classification of rainfall deviation is given in Table-3.1.

Table 3.1: Categories of Rainfall Deviations (IMD)

Deviation from Normal Rainfall (%)	Category
+ 19 to -19	Normal
-20 to -59	Deficient
-60 to -99	Large Deficient
-100	No Rain

A major limitation is sometimes posed by the absence of long term rainfall data, especially at sub-district levels. This obstacle can be overcome to some extent by making use of data for a minimum of five normal rainfall years to calculate the average or the IMD gridded rainfall data (0.25° X 0.25°). This parameter needs to be considered with caution in extreme high and low rainfall regions.

- B. Dry Spell:** A dry spell is a short period, usually 4 weeks (upto 3 weeks in case of light soils), of low rainfall or no rainfall. Thus, consecutive 3-4 weeks after the due date for the onset of monsoon with rainfall less than 50% of the normal in each of the weeks is defined as a Dry spell. This indicator is important in that it quantifies the extent of intra-season rainfall variations which is so critical for the health of crops and maintenance of soil and hydrological regime. In regions normally associated with high rainfall (south west monsoon rainfall >1400mm), the dry spell criteria may need to be recalibrated in synch with the agro-climatic conditions.
- C. Standardized Precipitation Index (SPI)** expresses the actual rainfall as a standardized departure with respect to rainfall probability distribution function and hence, the index has gained importance in recent years as a potential drought indicator permitting comparisons across space and time. The computation of SPI requires long term data on precipitation to determine the probability distribution function (gamma distribution) which is then transformed to a normal distribution with zero as mean and standard deviation of one. The longer the reference period to calculate the distribution parameters, the greater the likelihood of obtaining more accurate results (e.g. 50 years data will be better than that for 30 years). Thus, the values of SPI are expressed in standard deviations, positive SPI indicating greater than median precipitation and negative values indicating less than median precipitation. SPI can be ideally calculated on the basis of a minimum of 30 years of historical data for a station. SPI should be computed only for the monthly time scale. Fitting appropriate statistical distribution to the time series rainfall data is critical for an accurate SPI computation and interpretation with the help of expert advice. However, sparse availability of long term Block/Taluk/Mandal level quality data in many States is a limitation in computation of SPI. The States are advised to refer to URL of IMD viz. imd pune.gov in for SPI data and related information.

Table 3.2: Standardized Precipitation Index (SPI) Categories

SPI Value	Category
<- 2	Extremely Dry
-1.99 to -1.5	Severely Dry
-1.49 to -1.0	Moderately Dry
-0.99 to 0	Mildly Dry
0 to 0.99	Mildly wet
1.0 to 1.49	Moderately wet
1.5 to 1.99	Severely wet
>2.0	Extremely Wet

- I.a. The State Government could consider declaring a drought if the total rainfall received during the months of June and July is deficient by 50% or more as compared to the normal rainfall

accompanied or otherwise with dry spell, and if there is an adverse impact on area under sowing, vegetation and soil moisture, or

- I.b. The State Government could consider the declaration of drought if the total rainfall received during the months of October and November is deficient by 50% or more as compared to the normal rainfall accompanied or otherwise with dry spell, and if there is an adverse impact on the area sowing, vegetation and soil moisture, or
- II. if the total rainfall for the entire duration of the rainy season of the State, from June to September (the South-West Monsoon) and / or from December to March (North-East Monsoon), is deficient as measured by either rainfall deviation (less than 75% of the average rainfall for the season) or SPI value less than -1.0 with or without dry spells, and there is an adverse impact on area under sowing, vegetative health and soil moisture, as expressed through the vegetation soil moisture indices.

3.2.2 Remote Sensing based Vegetation Indices

Advancements in satellite remote sensing technology has enabled regular monitoring of crop conditions/vigour over large regions. Among the various spectral vegetation indices commonly derived from remote sensing data, Normalized Difference Vegetation Index (NDVI) is most widely used for operational assessment of drought owing to the ease in calculation and interpretation and also its ability to partially compensate for the effects of atmosphere, illumination geometry etc. NDVI is derived using the formula $(NIR - Red) / (NIR + Red)$, where NIR and Red are the reflectance in visible and near infrared channels. Water, clouds and snow have higher reflectance in the visible region and consequently NDVI assumes negative values for these features. Bare soil and rocks exhibit similar reflectance in both visible and near IR regions and the index values are near zero. The NDVI values for vegetation generally range from 0.2 to 0.6, the higher index values being associated with greater green leaf area and biomass.

Shortwave Infrared (SWIR) band is sensitive to moisture available in soil as well as in crop canopy. In the beginning of the cropping season, soil background is dominant hence SWIR is sensitive to soil moisture in the top 1-2 cm. As the crop growth progresses, SWIR becomes sensitive to leaf moisture content. SWIR band provides only surface wetness information. Normalized Difference Wetness Index (NDWI), computed using SWIR data, can complement NDVI for drought assessment particularly in the beginning of the cropping season. NDWI is derived as follows: $NDWI = (NIR - SWIR) / (NIR + SWIR)$ where, NIR and SWIR are the reflected radiation in Near-Infrared and Shortwave Infrared channels. Higher values of NDWI signify more surface wetness.

Satellite based crop condition anomalies which point towards agricultural drought can be generated by computing Vegetation Condition Index (VCI) or NDVI/NDWI deviations from the normal years. Normal NDVI/NDWI is generated by averaging the NDVI/NDWI of at least 3 recent normal years. Such comparisons enable minimization of the effect on account of the differences in cropping pattern and crop calendar.

$$NDVI_{dev} = \{(NDVI_i - NDVI_n) / NDVI_n\} * 100$$

$$NDWI_{dev} = \{(NDWI_i - NDWI_n) / NDWI_n\} * 100$$

Where subscript 'n' refers to normal value and 'i' to current period.

The value so obtained for a given NDVI or NDWI ranges from -1 to +1. A negative number or a number close to zero is indicative of poor vegetation and a number close to >0.6—1.0 signifies healthy vegetation in the case of NDVI and absence of water stress in the case of NDWI.

NDVI/NDWI deviation of -20 to -30% represents moderate drought conditions and that of <-30% represents severe conditions. However, these values may be different for different agro-ecological regions and cropping patterns.

To combine the NDVI and NDWI deviation category, the poorest among the two will be used, for example, if NDVI deviation is moderate and NDWI deviation is 'Severe', then overall category will be 'severe'.

The current period values of Vegetation and Wetness index values can be compared with long-term data (at least ten years) by computing Vegetation Condition Index (VCI). The VCI compares the observed NDVI and NDWI to the range of values observed for the same period in previous years. The VCI is expressed in %age and gives an idea where the current value is placed within the extreme values (minimum and maximum) in the historical datasets normalized to a scale of 0 – 100%. Lower and higher values indicate bad and good vegetation state conditions, respectively. VCI is computed as under:

$$VCI (NDVI) = [(NDVI_{curr} - NDVI_{min}) / (NDVI_{max} - NDVI_{min})] \times 100$$

$$VCI (NDWI) = [(NDWI_{curr} - NDWI_{min}) / (NDWI_{max} - NDWI_{min})] \times 100$$

Where the subscript 'curr' refers to Current Period Value, 'min' and 'max' refer to minimum and maximum values of VI in historical dataset for the same period and same location.

For using VCI in drought assessment following threshold values can be used as given in Table 3.3.

Table 3.3: Classification of Vegetation Condition based on VCI value

VCI Value (%)	Vegetation Condition
60-100	Good
40-60	Fair
0-40	Poor

While combining VCI of NDVI and NDWI, the minimum of the two values can be taken, i.e if at least one is in 'very poor' condition, the category will be considered as severe. If both are 'poor' or at least one is 'poor', then the category will be taken to be Normal.

VCI is a promising index in that it has the advantage of being comparable over space and time on account of the normalization of differences in cropping patterns, crop calendars, atmospheric parameters. The limitation arises from the requirement of long term time series data for NDVI/NDWI (at least 10 years) and the risk of VCI values getting affected by the differences in cropping patterns, crop calendars and atmospheric parameters. The computation and interpretation of VCI is complex and require the services of experts (from SRSCs/NRSC/MNCFC).

The data for the current season and historical NDVI/NDWI may be sourced from State Remote Sensing Centres / MNCFC / NRSC / NDVI / NDWI data of moderate spatial resolution is recommended for agricultural drought assessment at sub-district level. The best possible spatial resolution should be preferred (Resourcesat AWiFS of 56m resolution or MODIS with 250m / 500m resolution). Use of coarse resolution data of 1 km is not desirable for sub-district level assessments. VCI data needs to be interpreted with caution when the crops are in maximum vegetative phase. It may be borne in mind while using satellite based vegetation indices (e.g., NDVI) that these indices may provide good indication of crop condition and bio-mass, which may not always offer close proximation of the estimate of crop yield.

The National Agricultural Drought Assessment and Monitoring System (NADAMS), developed by the National Remote Sensing Centre (NRSC), and currently being implemented by the Mahalanobis National Crop Forecast Centre (MNCFC) issues fortnightly/ monthly drought assessment reports on detailed crop condition during the kharif season for 14 agriculturally important and vulnerable States such as Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Odisha, Rajasthan, Telangana, Tamil Nadu and Uttar Pradesh at present. These reports provide values for Normalized Difference Vegetation Index (NDVI), Normalized Difference Wetness Index (NDWI), and Vegetation Condition Index (VCI).

3.2.3 Crop Situation Related Indices

3.2.3.1 Area Under Sowing

The extent of sowing is an important indicator of the spread and severity of drought. Sowing operations are linked to rainfall and availability of water during initial growth stage. Farmers in rainfed regions commence sowing operations mostly with the onset of the monsoon. If sowing fails due to water stress, farmers tend to sow a second or even a third time. Therefore, the area under sowing provides reliable information on the availability of water for agricultural operations.

Drought conditions could be said to exist if the total sown area under kharif crops was less than 33.3% of the total normal sown area by the end of July/August, depending upon the schedule for sowing in individual States due to failure of rains or very late arrival of monsoon. In such situations, even if rainfall revives in the subsequent months, there is little possibility of full recovery and the agricultural production is likely to take a substantial hit. However, the conditions will indicate portents for drought of a 'severe' nature will appear strong, if the area under crops falls to 50% of the normal by the end of July / August. State Governments should, therefore, consider the status of coverage by the end of July/August to see if the shortfall in sown area is significantly short of the total normal sown area.

In the case of Rabi crops, coverage of sowing of less than 50% of the total normal sown area during October-November is a strong indicator of a drought like development. State Agriculture Departments collect data on crop-wise progress for sowing for District/Taluks/Tehsils/Blocks.

However, data on sown area under crops may not shed any light either on the health of the crop or subsequent damage to the sown crop due to moisture stress.

3.2.3.2 Soil Moisture Based Indices

Available soil moisture is a very relevant indicator of drought, especially in rainfed regions. The soil moisture based indices could be calculated using a simple region wide soil-moisture balance methodology which entails collecting some of the base-line data related to soil properties, climatic parameters and crop growth pattern. Basically, soil moisture balance calculates the amount of rainfall available to crops depending upon crop water requirement, climatic evaporative demand and soil water holding capacity. This calculation may be carried out by involving technical experts like Agro-meteorologists / Agricultural Physicists / Agricultural Engineers working with State Departments of Agriculture or State Agricultural Universities or ICAR institutes located in the States. It is suggested that one of the two soil moisture based indices viz., (a) Percent Available Soil Moisture (PASM), or (b) Moisture Adequacy Index (MAI) is used. These indices may be calculated at weekly intervals and averaged over dominant crop growth stages such as “Early Growth Stage”, “Vegetative Growth Stage” and “Reproductive Stage”. These indices should be combined with other indicators for the determination of drought.

Though soil moisture is an important parameter governing crop growth, there is only a rudimentary network of agro-meteorological observatories which record soil moisture regularly. These agro-meteorological observatories are in many cases, located at /or operated with the assistance of State Agricultural Universities (SAUs) or Indian Council of Agricultural Research (ICAR) institutes. Satellite transmitted data from existing network of ISRO Agro-Met Stations (AMS) and those stations proposed by IMD can provide valuable insight into the soil moisture and moisture adequacy in agricultural systems. However, soil moisture is highly dynamic in space and time and is measured using soil sensors or satellite remote sensing. Agro-meteorological models have been developed for the estimation of soil moisture, yet the limitation of these parameters stem from the fact that the information is limited to the top-soil and at a very coarse resolution.

The data on the following needs to be collected at weekly intervals for computing soil moisture based indices with the aid of agro-meteorological models.

- (i) **Soil water constants:** These are static soil properties of Field Capacity (FC), Permanent Wilting Point (PWP) constants and soil depth of the dominant soil type in the region. These may be obtained from the State Departments of Agriculture or inferred from soil maps prepared by ICAR-National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) or Soil and Land Use Survey of India (SLUSI) in the DAC&FW. These constants can be calculated from soil texture data using pedo-transfer functions (i.e. relationship between soil water contents and sand/silt/day content) if the said organizations are unable to provide the requisite data.
- (ii) **Crop Calendar:** The normal growth period (sowing and harvesting time) for the one/two dominant crops in the region and durations of the “Early Growth Stage”, “Vegetative Stage” and “Reproductive Stage”.
- (iii) **Weather Parameter:** In season rainfall data.
- (iv) **Climatic data:** It relates to the climatic water demand of the atmosphere and is captured in terms of the Climatic Potential Evapo-transpiration (PET) / Reference Evapo-transpiration (RET) of the region. These are calculated by IMD / State Irrigation Departments / State Agricultural Universities/ICAR institutes using climatic data and standard methodologies.

(A) Percent Available Soil Moisture (PASM)

PASM is derived from observed moisture sensor data or sample soil-water balance model following the ‘bucket approach’ and using the following formula:

$$PASM = [(SM_w - PWP) / (FC - PWP)] * 100$$

Where SM_w is the weekly calculated volumetric soil moisture (vol/vol) for the current week, FC is the field capacity of soil (vol/vol) and PWP is the permanent wilting point of the soil (vol/vol). The PASM based classification is given in Table 3.4.

PASM is an useful indicator of agricultural drought. However, the limitations stem from the lack of representative large area soil moisture measurements or data on soil and meteorology. It is suggested that the States invest in setting up Soil Moisture Monitoring Stations and automated rain gauges as part of a drought monitoring system.

Table 3.4: Classification of Agricultural Drought based on PASM(%)

PASM (%)	Agricultural Drought Class
76 – 100	No drought
51-75	Mild drought
26-50	Moderate drought
0-25	Severe drought

** The ranges and class may be suitably modified by the State depending upon the local dominant crop types, soil properties, etc. in consultation with experts.*

(B) Moisture Adequacy Index (MAI)

Moisture Adequacy Index (MAI) is also based on a calculation of weekly soil water balance, and is equal to the ratio (expressed as a percentage) of Actual Evapo-transpiration (AET) to the Potential/Reference Evapo-transpiration (PET or RET) following a soil–water balancing approach during different phenological stages of a crop. Thus, MAI is obtained by using the following equation:

$$MAI = [AET/PET] * 100$$

The MAI values and corresponding drought classes are expressed in Table 3.5 below.

Table 3.5: Classification of Agricultural Drought based on MAI (%)

MAI (%)	Agricultural Drought Class
76 – 100	No drought
51-75	Mild drought
26-50	Moderate drought
0-25	Severe drought

Bearings and Limitations of MAI

- a. These are important indices for rainfed areas and estimated by considering rainfall, available moisture in soil, AET & PET.
- b. The computation of MAI generally does not take into account irrigation because of the non-availability of irrigation data related to roster schedules and quantum of release. Therefore, the application of MAI to irrigated areas is recommended where appropriate data on irrigation is available.
- c. The calculation of soil moisture from models due to the non-availability of information on soil profiles may lead to the estimation of soil moisture of the surface soil alone.

3.2.4 Hydrological Indices

Depletion in stream-flow, reduction in reservoir storages / water spread area and the rate of ground water table depletion can serve as useful indicators of drought. These indices are subject to availability of relevant data from Central Water Commission (CWC), the Central Ground Water Board and State agencies, etc.

3.2.4.1 Reservoir Storage Index (RSI)

The availability of water in reservoirs can act as an effective foil against drought. The reservoir storage status derived from percentage of storage deficit vis-à-vis long term averages can provide an indication of drought (Table 3.6).

Table 3.6: Category of deficit based on %age deficit in live storage volume of reservoir

Percentage deficit in live storage volume of reservoir w.r.t. Average Storage of last 10 years	Category of deficit
Less than 20%	Normal deficit
20-30%	Mild deficit
30-40 %	Moderate deficit
40 – 60%	Severe deficit
>60%	Extreme deficit

However, the CWC monitors storage data of selected major reservoirs only. Real / near real time data from minor / medium storage reservoirs, if gathered by the State Governments, can be useful in making assessments of hydrological drought and the possible impact on irrigated crops. Similarly, developing rainfall-run off relationship models will help in prognostic assessment of surface water availability. States may consider installing stream gauging stations - one for every 100 sq km to help develop prognostic tools for understanding supply availability vis a vis demand.

The storage records are maintained for select reservoirs and therefore an obvious limitation of RSI is that the application of this index can be useful only for those areas that are dependent for their agriculture on reservoir supplies.

3.2.4.2 Groundwater Drought Index (GWDI)

The rate of depletion of groundwater table is useful for making an assessment of groundwater availability for agriculture and drinking water supply purposes.

The monthly groundwater (GW) table records are required for a minimum period of 10 years for computation of mean value of monthly ground water depletion rate. When rate of depletion of groundwater table in a given month/period is more than the corresponding mean value then it is an indication of water deficit. The computation procedure for Ground Water Drought Index (GWDI) is as follows:

$$GWDI_{ij} = \frac{MGWD_j - GWD_{ij}}{GWD_{iMax}}$$

Where,

GWD_{ij} = Groundwater Drought Index for *i*th month and *j*th year.

MGWD_j = Mean depth to groundwater table below surface (in meter)

GWD_{ij} = Depth to groundwater table in *i*th month and *j*th year (in meter).

GWD_{iMax} = Maximum depth to groundwater table in *i*th month in available data set for *n* number of years (in meter).

i = 1, 2, 3, 4,, 12.

j = 1, 2, 3,, *n*.

n = total numbers of years for which monthly groundwater records are used.

Table 3.7: GWDI and GW Deficit Class

Groundwater Drought Index (GWDI)	Groundwater deficit class
> -0.15	Normal
-0.16 to -0.30	Mild
-0.31 to -0.45	Moderate
-0.46 to -0.60	Severe
< -0.60	Extreme

The limitation of this index is the non-availability of real-time periodic data (monthly scale) of ground water level observations. As of now, India-WRIS platform (<http://www.india-wris.nrsc.gov.in/GWLevelApp.html?UType=R2VuZXJhbA==?UName=>) provides ground water observations 4 times in a year. Care should be placed on prudent selection of GWD_{iMax} data so as to avoid getting misleading projections that may arise from outlier values in the historical data-set.

3.2.4.3 Stream-Flow Drought Index (SFDI)

The amount of water flows in streams and rivers can provide valuable insights on hydrological drought. The flows in streams display high seasonal variability necessitating estimation of variable truncation levels for all twelve months in a year. The truncation level is an analytical interpretation of expected availability of water flow in a river (refer Table 3.8). The truncation level is defined as 75% dependable flow (discharge) at a given time and for a given site over a month long time period. Therefore, average monthly flow records are required to be used to derive flow duration curves for determination of monthly truncation level. Water flow in a river or stream below the truncation level is indicative of a drought like scenario.

The severity of drought event would be classified using a stream flow drought index (SFDI) defined as a function of :

- i. the ratio of deficit flow volume to corresponding volume at the truncation levels; and
- ii. the ratio of duration of deficit flow to the maximum expected duration of the independent stream flow drought event.

$$SFDI = \frac{V_d}{V_{TL}} \times \frac{d_e}{d_m}$$

Where,

V_d = deficit flow volume,

V_{TL} = corresponding flow volume expected at TL flow

d_e = duration of independent drought event, and

d_m = maximum duration of an independent drought event (=365 days).

Table 3.8: Classification of Drought based on Stream Flow Index

Stream Flow Drought Index (SFDI)	Drought Severity class
< 0.01	Weak
0.01 to 0.05	Mild
0.05 to 0.2	Moderate
0.2 to 0.5	Severe

Stream flow records (Average 10- daily or monthly discharge data) are maintained by CWC which can be sourced by the States for assessment of drought. The SFDI is straightaway applicable for the river systems having perennial flow characteristics. In case of intermittent and ephemeral flow characteristics, joint probability distribution approach is required to be used for estimation of truncation level. The SFDI suffers from limitation arising from the non-availability of historical data (30 years or more) which may sometimes result in erroneous assessment of stream-flow drought characteristics, particularly with regard to non snowfed river systems.

3.2.5 Other Factors

The State Governments may further monitor socio-economic indicators such as the following factors in making a holistic evaluation of drought:-

- Extent of fodder availability and its prevailing prices compared to normal prices and information on cattle camps (see Forms 5 and 6, Annexure-1);
- Scarcity of drinking water supply (human and livestock) (see Forms 7 and 8, Annexure-1);
- Demand for employment on public works, and unusual outmigration of labour in search of employment (see Form 9, Annexure-1);
- Current agricultural and non-agricultural wages compared with normal times (see Form 9, Annexure-1);
- Supply of food grains, and price situation of essential commodities (see Form 10, Annexure-1).

These socio-economic indicators may aid State Governments in fine tuning the assessment of drought. However, State Governments will need to set up credible data bases and monitoring systems for objective evaluation of distress migration, price trends of fodder and food commodities, availability of drinking water etc.

3.2.6 Ground Truthing or Verification

It is acknowledged by experts that parameters identified for assessment of drought while useful, suffer from deficiencies on account of limitations of the available technology, unavailability of a wide network of monitoring stations, paucity and unreliability of long term data. It is, therefore, essential for a realistic and credible determination of a complex phenomenon such as drought, that the matrix based analysis (as at Table 3.10) is supplemented in the event that values in the matrix indicate a 'Moderate' or 'Severe' drought, by a quick field level sample survey. The findings of the quick sample survey shall be conclusive in the determination, intensity and spatial extent of drought.

The Ground Truthing (GT) needs to be conducted in each of the 10% of the drought affected villages, selected on a random basis. In each of the selected villages, representative locations (about 5 sites for each of the major crops), may be inspected for data collection. The GT shall preferably be conducted using a smart phone based App. The app shall record the GPS coordinates of the site and the photo of the state of crop, with the provision to upload these parameters on a computer server for archiving for post-facto analysis. Inspection of isolated and small fields (<1 acre) should be avoided to improve the quality of field data. The States may identify the relevant crop/field attribute data for the Mobile App. Appropriate inspection protocols may be developed for providing guidance in collection of data. An estimation of crop damage / loss of 33% or more on the basis of field verification will qualify for the declaration of drought. However, for the drought to qualify as one of a 'severe' nature, the estimation of damage / loss to crops should be more than 50%. Form-11 at Annexure-1 has been suggested for the compilation of village wise data on damage to sown crops.

It is desirable that declaration of drought by the State Governments is supported by the matrix based analysis and field level verification / GT.

3.3 PROCESS FOR THE DETERMINATION OF DROUGHT

The Drought Monitoring Cells (DMCs) in the States will monitor data regularly on various critical parameters referred to earlier in this chapter and apprise the SEC/Disaster Management Department in the State Government on the spread and intensity of an emerging drought like situation. As referred to earlier, the complexity of drought cannot be captured with the aid of a single indicator, but require a more comprehensive understanding of data on several parameters read in conjunction with rainfall, the most important and mandatory parameter in any determination of drought and bolstered by a field verification. Table 3.10 sub para 3.3.1 below provides a simple matrix to help make an objective assessment of drought.

3.3.1 Steps in the Determination of Drought

Following steps are suggested for the determination of drought:

Step 1: Mandatory Indicators viz. RF deviation or SPI or Dry Spell will be considered as per matrix at Table 3.9 to assess if the first drought trigger is set off.

Table 3.9: Matrix for rainfall deviations and dry spells (Trigger-1)

Rf Dev/SPI	Dry spell	Drought trigger
Deficit or scanty rf/SPI<-1	Yes	Yes
Deficit or scanty rf/SPI<-1	No	Yes if rainfall is scanty or SP<-1.5, else No
Normal rf/SPI>-1	Yes	Yes
Normal rf/SPI>-1	No	No

Step 2: In the event that the first drought trigger is set off in Step 1, the Impact Indicators will be examined as per the matrix at Table 3.10.

Table 3.10: Matrix for impact indicators (Trigger-2)

Mandatory Indicators		Impact Indicators				Category of drought
Rainfall Indices		Agriculture	Remote Sensing	Soil Moisture	Hydrology	
Rainfall Deviation (RFdev) or SPI	Dry Spell	Crop Area Sown	VCI or NDVI Deviations	PASM / MAI	SFI / RSI / SGWI	

The States may consider any three of the four types of the Impact Indicators (one from each) for assessment of drought, the intensity of the calamity and make a judgement.

Explanation :

The intensity of the drought will be contingent upon the values of at least three out of four Impact Indicators viz, Agriculture, Remote Sensing, Soil Moisture and Hydrology in the following manner:

- *Severe drought: if all the selected 3 impact indicators are in Severe category*
- *Moderate drought: if two of the selected 3 impact indicators are in 'Moderate' or 'Severe' class.*
- *Normal: for all other cases.*
- Trigger 2 will be set off in the event of a finding of 'severe' or 'moderate' drought.
- *The State has an option to reduce the drought category by one rank (i.e. Severe to Moderate) if the irrigation percentage of the administrative region (District/Taluk/Block/Mandal), for which drought is being declared is more than 75%. However, in such a situation of reduction of drought intensity from 'Moderate' to 'Normal', the State Government will still be required to conduct field verification as prescribed in Step 3 below.*

Step 3: In the event that trigger 2 is set off, States will conduct sample survey for ground truthing as described at 3.2.6 above and in order to make a final determination of drought. The finding of field verification exercise will be the final basis for judging the intensity of drought as 'severe' or 'moderate'.

3.4 DECLARATION OF DROUGHT

The State Governments will declare drought through a notification specifying clearly the geographical extent and administrative units such as Gram Panchayats, Blocks, Mandals, Taluks, Sub-division, Districts. Such notification will also indicate the level of severity of the drought (moderate or severe). The validity of such notification will not be for more than 6 months unless de-notified earlier. The declaration of Kharif drought should not be done later than 30 October and the Rabi drought by 31 March. The State Governments will declare the calamity as “drought ” and not by any other nomenclature, if the conditions referred to in 3.3.1 are fulfilled (see Annexure-3).

Drought declaration in the early season

Drought declaration during August month may be carried-out, if the seasonal conditions signify drought like situation. Deficit rainfall in June and July with prolonged dry spells leading to significant reduction in crop sown area can trigger the declaration of early drought.

Indicators for early season drought declaration

Rainfall deficiency based on rainfall deviation or SPI and the dry spell as shown in Table 3.9 continue to be mandatory for declaration.

Among the impact indicators, reduction in crop sown area or failed sowing, MAI, Ground water or Reservoir water index are important. NDVI is less effective when the canopy coverage is low. In such situation NDWI, a surface wetness indicator is preferred to NDVI.

3.5 MEMORANDUM FOR FINANCIAL ASSISTANCE

3.5.1 Submission of Memorandum for Financial assistance under NDRF

A Memorandum for assistance under the National Disaster Response Fund (NDRF) will be submitted within a week of the declaration of drought **only if the calamity is of a severe nature**. Only those items should be included in the Memorandum that are admissible as per extant guidelines of the Ministry of Home Affairs. The Memorandum for assistance will mandatorily contain a copy of the State Government notification on drought, details of assessment of drought as per Table 3.10 and details of village-wise field verification data (see Annexure-4). The State Governments will consider the overall socio-economic scenario as reflected through distress migration, fodder shortage, food and drinking water scarcities, abnormal price rise in food commodities and fodder, malnutrition among vulnerable sections for providing relief.

3.6 TIMELINES

States will notify Kharif drought by 30 October and the Rabi drought by 31 March. The memorandum for assistance will be submitted to the DAC&FW within a week of the declaration, in case the drought is of serious nature.

The DAC&FW will constitute and dispatch an Inter-Ministerial Central Team (IMCT) to the drought affected area within a week of receipt of the Memorandum from the State Government. The IMCT will submit a report for the consideration of the Central Government within 7 days of all relevant information provided by the State Government following the visit to the drought affected areas. The Central Government will take a final decision on the assistance to the State from the NDRF within a month of the receipt of the IMCT Report.

The State Governments will ensure disbursement of agriculture input subsidy to affected farmers within one month from the date of receipt of Central assistance from the NDRF. The timelines in the case of declaration of an early season drought will be suitably modified for the different activities enumerated above. Various instruments of Direct Benefit Transfer to beneficiaries will be employed to ensure efficiency and transparency in the process of fund transfer.

3.7 DIRECT BENEFIT TRANSFER (DBT)

Direct Benefit Transfer is a major reform initiative launched by Government of India to re-engineer the existing cumbersome delivery processes using modern Information and Communication Technology (ICT). This programme aims to transfer benefits directly into the bank/postal accounts, preferably Aadhaar seeded, of accurately targeted beneficiaries. In a nutshell, DBT intends to achieve:

- a) Electronic transfer of benefits, minimising levels involved in benefit flow
- b) Reduced delay in payments
- c) Accurate targeting of the beneficiary
- d) Curbing pilferage and duplication

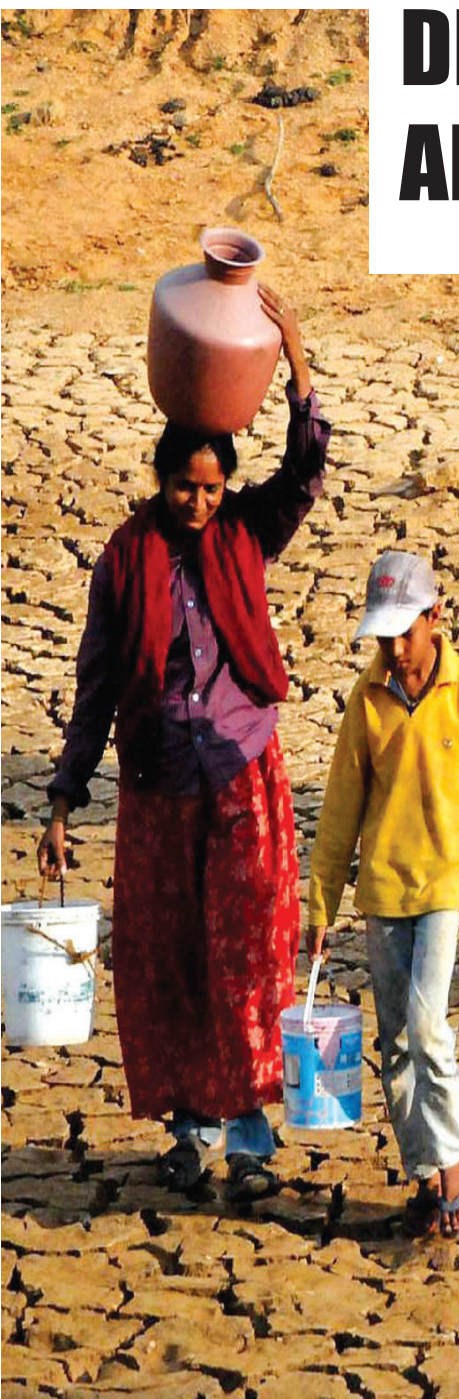
DBT is an attempt to ensure a better and more timely delivery of benefits directly into the hands of the beneficiaries, speeding up payments, removing leakages, and enhancing financial inclusion.

State Governments should invariably use DBT to provide various kinds of beneficiary oriented assistance under SDRF/NDRF like gratuitous relief, assistance to farmers for land/crop loss, assistance to small and marginal farmers for replacement of animals, assistance to fishermen, assistance to handicraft/handloom artisans and assistance for houses damaged etc.

The list of beneficiaries will be published in the website of the District Collector and the State Government for general information and transparency.

CHAPTER-4

DROUGHT RESPONSE AND RELIEF



Objectives:

- Crisis Management Plan for Drought
- Contingency crop planning: Preparedness and Near Real-time implementation
- Relief Employment
- Water Resource Management
- Food Security
- Gratuitous Assistance
- Relief through Tax Waivers and Concessions
- Cattle Camps and Fodder Supply
- Health and Hygiene
- Institutional Response
- Financing Relief Expenditure
- Information Management and Media Coordination
- Drought Preparedness and Response Checklist

Implementation of drought relief and response measures are initiated following the declaration of drought. Drought being a complex phenomenon, the response and relief measures, often require sector-specific planning and immense inter-departmental coordination. It is necessary that these measures are undertaken promptly and in a planned manner for maximum impact in the amelioration of the hardships caused by drought to the farmers and common people. In fact, it is strongly suggested that response measures in line with Crisis Management Plan and District Crop Contingency Plans ought to get activated as soon as the distress signs become visible, without waiting for a formal declaration of drought. However, such measures related to drought relief e.g., remission of land revenue and other taxes and dues, deferment and restricting of crop loans, agricultural input subsidy etc, can only be set in motion with the formal declaration of drought by the State Government. The success and sustainability of these measures depend on a continuous exchange of information between the village-levels and the decision-making levels in the State, a responsive administrative structure and careful planning.

This section discusses sector-specific drought relief and response, identifying lead and support agencies and detailing the measures that need to be taken. It also includes a section on institutional response and financing relief expenditure. A checklist for the Relief Commissioners and District Collectors has been provided at the end of this chapter.

Crisis Management Plan

The Ministry of Agriculture and Farmers Welfare prepares a Crisis Management Plan for drought (CMP) before the commencement of each Kharif season. The CMP provides a crisis management framework to identify phases of the crisis and the strategic response corresponding to each such phase. The plan also provides for a Strategic Activity Planner to act as a ready reckoner for critical steps that need to be taken in different times of the year with respect to drought preparedness, drought reporting and drought response, and the agencies responsible for the identified activities. Central Ministries and State Governments may seek guidance from the CMP to devise their own management plans for drought.

Drought Contingency Planning

District Agriculture Contingency Plans (DACPs) have been formulated for more than 600 agriculturally important districts in the country so far by the Central Research Institute for Dryland Agriculture (CRIDA) under the aegis of the Ministry of Agriculture and Farmers Welfare to suggest contingency strategies to farmers to cope with major weather related aberrations, including delay in onset of south-west monsoon, dry spells etc. CRIDA has prepared these extensive district plans covering crops, horticulture, livestock, poultry and fisheries sectors in consultation with State Agricultural Universities and State Government departments (www.crida.in; <http://agricoop.nic.in>). The State Governments are expected to have contingency plans prepared for drought management at sub-district levels (tehsil/block/mandal/taluka).

4.1. CONTINGENCY PLANNING: PREPAREDNESS AND REAL-TIME IMPLEMENTATION

Lead Agencies: State relief and disaster management department, State departments of Agriculture, Horticulture, Irrigation, Watershed management, State Seed Corporations, State electricity boards, commercial and cooperative banks.

Support Agencies: Ministry of Agriculture & Farmers Welfare, (Government of India), Indian Council of Agricultural Research (ICAR), IMD, MNCFC, Department of Land Resources, Ministry of Water Resources, River Development & Ganga Rejuvenation, State Agricultural Universities, State Remote Sensing Centres etc.

Objectives: The objective of a contingency plan is to provide cropping and other options to the farmers to help them withstand drought conditions. The recommended measures include alternate crop varieties / alternate crops suitable in the event of a delay in onset of monsoon rains or dry spell; management options tailored for initial / mid-season / end of season drought scenarios in rainfed / groundwater irrigated / tankfed areas/ canal command areas, both for field and horticultural crops.

The DACP recommends contingency measures to cope with drought for rainfed and irrigated (groundwater irrigated, tankfed and canal command areas) farming situations on account of delayed onset of monsoon (2/4/6/8 weeks delay) and (early/midseason/terminal drought) for field and horticulture crops. The contingency measures include alternate crops /crop varieties/ agronomic practices/other management options appropriate for drought scenarios.

The DACP should be updated from time to time to incorporate inputs related to new technological advancements and field experiences from scientific institutions (ICAR/SAUs), Ministry of Agriculture & Farmers Welfare and other related departments of Central and State Governments, such as Water Resources / Irrigation, Animal Husbandry, Rural Development, Drinking Water, Banking, etc, State line departments and other stakeholders. There is a need to consider the impact of climate change, the advantages to farmers from the adoption of new moisture stress tolerant crop varieties, water saving innovations, etc. while updating the plans.

Preparedness

Careful advance preparation is critical to an effective response and containment of drought. The ambit of preparedness should extend to the following:

- Establishment of a functional DMC at the State Headquarters.
- Preparation of Agriculture Contingency Plans for districts and sub-district levels, especially in vulnerable districts.
- Identification of drought prone areas, preferably at the sub district level.

- Monitoring of seasonal forecasts of IMD and other national / international agencies.
- Prepositioning of inputs like drought resilient variety seeds at strategic locations.
- Activate agricultural extension to encourage shift to crops and varieties that are not water guzzlers and recommend agronomic practices that promote conservation of water and soil moisture.
- Repair and maintenance of water bodies / tanks / wells etc. to help critical irrigation during dry spells.
- Creation of drought contingency cells at districts to monitor dry spells.
- Develop protocols for various departments to initiate contingency measures with clear allocation of responsibilities.
- Following management practices are recommended for adoption by the farming communities in susceptible areas:

Must –Do –Practices (MDPs): Initial Preparedness

In common drought prone regions of India, initial preparedness is a *sin qua non* for effective and real time implementation of contingency plan. Various components of “Must Do Practices” are as follows (Fig. 4.1):

1. Land Treatment

- Sowing across slope
- Ridge and furrow system
- Compartmental bunding
- Broad bed furrow system
- Raised / Raised Bed and sunken system, etc.

2. Rainwater harvesting and Efficient Use

- Rainwater harvesting structures
- Farm ponds
- Percolation tanks
- Micro Irrigation systems, etc

3. Suitable Crops / Varieties Cropping system

- Seed bank
- Seed treatment
- Intercropping systems, etc
- Agro-forestry

4. Need based Nutrient Management

- Rainwater availability
- Nutrient for foliar spray
- Organic recycling
- Tank silt application, etc.

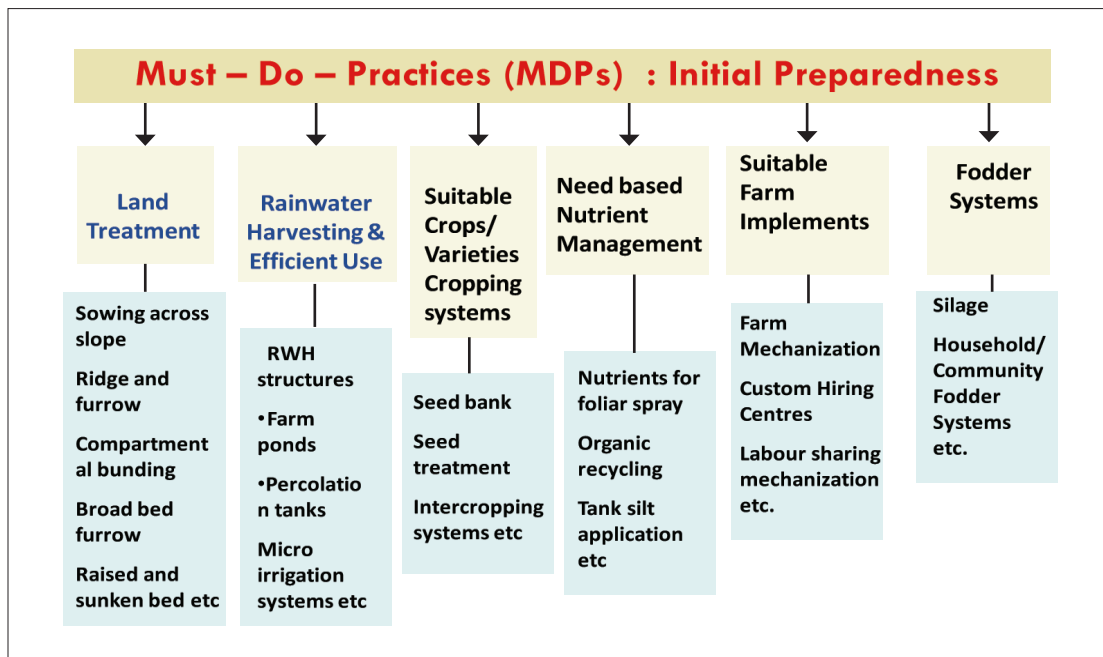
5. Farm Mechanization

- Suitable implements
- Labour sharing mechanization
- Custom hiring centres

6. Fodder Systems

- Silage
- Household / Community
- Fodder systems, etc.

Fig. 4.1



- The contingency plans are to be operationalized based on assessment of type of drought.
- Choice of short duration and less water-intensive crops, unlike paddy and sugarcane, which consume a lot of water. Alternate crops such as maize, pulses, groundnut, sunflower, soybean, fodder and millets can be considered.
- Advocacy for crop diversification, mixed / inter-cropping of main crop with drought tolerant companion crops, thinning of plant population, weed management, mulching for soil moisture conservation, supplementary / protective irrigation particularly with drip / sprinkler systems.
- Contingency plan during the kharif season is usually constrained by uncertainty of weather behaviour; and lack of lead-time causing logistical problems in organizing delivery of agricultural inputs. There is a need to utilize information on the pattern of spatial and temporal variation of monsoon to improve the efficacy of contingency crop plans.
- It is necessary that the decision-makers get information on the likely monsoon behaviour even earlier than July to put contingency measures in place. While there are certain risks and uncertainties to respond to anomalous weather conditions in July, the confidence level for crop planning increases during pre-rabi and more certainly during rabi seasons. Better information on the extent of soil moisture, reservoir water and ground water levels can help the State Governments in issuing advisories for crop planning.

4.1.1. Near Real-Time Implementation of Contingency Plans

Implementation

While some of the preparedness measures such as management practices particularly in-situ soil conservation, tank silt application, conservation tillage, conservation agriculture measures help in overcoming dry spells, a scenario may still arise on account of long dry spells or sensitiveness of crop which may warrant intervention by line departments.

The real-time contingency measures aim to (i) establish a crop with optimum plant population during the delayed onset of monsoon; (ii) ensure better performance of crops during seasonal drought (early/mid and terminal drought) and extreme events, enhance performance, improve productivity and income; (iii) minimize damage to horticultural crops/produce; (iv) minimize physical damage to livestock, poultry and fisheries sector and ensure better performance to ensure food security at village level and (v) enhance the adaptive capacity and livelihoods of the farmers.

The States are required to prepare agro-advisory bulletins in response to weather forecasts in consultation with State agricultural / horticulture / veterinary Universities and other NARS partners for the use of farmers.

States are advised to install, collect, analyze and utilize the rainfall information from sub district levels i.e., Tehsils / blocks / mandals etc. in order to address the issues of drought realistically.

To ensure successful implementation of DACPs, following support systems need to be put in place.

The States are advised to prepare agro-advisory bulletins based on crop contingency plans and widely disseminate them among farmers in drought-affected region. The district agro-

advisory bulletins issued by IMD (www.imdagrimet.gov.in; www.farmer.gov.in; www.mkisan.gov.in) under Gramin Krishi Mausam Seva project may also be consulted while preparing their agro-advisory bulletins.

Some of the methods/measures to be adopted as near real-time contingency plan implementation during various weather aberrations are given in some near-real time methods/measures to be adopted to cope with delayed onset of monsoon and seasonal drought are described below.

Delayed onset of monsoon

In rainfed areas, as a general rule early sowing of crops with the onset of monsoon is the best practice that gives higher realizable yield. Major crops affected due to monsoon delays are those crops that have a narrow sowing window and therefore cannot be taken up if the delay is beyond this cut-off date. Crops with wider sowing windows can still be taken up till the cut-off date without major yield loss and only the change warranted could be the choice of short duration cultivars. Beyond the sowing window, choice of alternate crops or cultivars depends on the farming situation, soil, rainfall and cropping pattern in the location and extent of delay in the onset of monsoon.

Early season drought

Early season drought may at times result in seedling mortality needing re-sowing or may result in poor crop stand and seedling growth. Further, the duration of water availability for crop growth gets reduced due to the delayed start, and the crops suffer from an acute shortage of water during reproductive stage due to early withdrawal of monsoon. The effect of early season drought is less on the crop, because during this period sowing is carried out. Various operations carried out are primary tillage, sowing, fertilizer application and intercultural operations. Other agronomic measures include resowing within a week to 10 days with subsequent rains for better plant stand when germination is less than 30%, thinning in small-seeded crops, interculture to break soil crust and remove weeds and create soil mulch for conserving soil moisture, avoiding top dressing of fertilizers till favourable soil moisture, opening conservation furrows at 10 to 15 m intervals, ridge and furrow across the slope for effective moisture conservation as well as in rainwater in wide spaced crops (>30 cm), pot watering may be taken up along with gap filling when the crop stand is less than 75% in crops like cotton, foliar spray of 2% urea during prolonged dry spells wherever ground/ surface water is available.

Mid-season drought

Stunted growth takes place if mid-season drought occurs at vegetative phase. If it occurs at flowering or early reproductive stage, it will have an adverse effect on the ultimate crop yield. *In-situ* soil-moisture conservation is a vital component of dryland crop management practices. During mid season drought plant protection, top-dressing of fertilizer, intercultural and supplemental irrigation are the usual practices. In case of long dry spells, crop based production system (location) related specific contingency plans are needed. Other agronomic measures include repeated interculture to remove weeds and create soil mulch to conserve soil moisture, thinning, avoiding top-dressing of fertilizers until receipt of rains, opening conservation furrows for moisture conservation, foliar spray of 2% KNO₃ or 2% urea solution or 1% water soluble fertilizers like 19-19-19, 20-20-20, 21-21-21 to supplement nutrition during dry spells, open alternate furrows, surface mulching with crop residues, providing supplemental irrigation (10 cm depth), if available.

Terminal drought

If there is a terminal drought, crop-management strategies like plant protection, soil and water conservation, interculture, supplemental irrigation and harvesting are to be adopted. Terminal droughts are more critical as the grain yield is strongly related to water availability during the reproductive stage. Further, these conditions are often associated with an increase in ambient temperatures leading to forced maturity. The agronomic measures include providing life-saving or supplemental irrigation, if available, from harvested pond water or other sources, harvesting crop at physiological maturity with some realizable yield or harvest for fodder and prepare for winter (*rabi*) sowing in double-cropped areas. Ratoon maize or pearl millet or adopt relay crops as chickpea, safflower, *rabi* sorghum and sunflower with minimum tillage after soybean in medium to deep black soils in Maharashtra or take up contingency crops (horsegram/cowpea) or dual-purpose forage crops on receipt of showers under receding soil moisture conditions.

4.1.2. Implementation of DACPs

The implementation of DACPs would require the following support systems.

Seed Banks

During drought, the availability of seeds of appropriate varieties in sufficient quantities is a major challenge.

To ensure availability of the desired seed at the time of drought, a plan for production or sourcing of desirable seed varieties needs to be implemented well in advance. A Consortium Approach for production, supply and timely availability of the seed to the farmers is advocated with sufficient guarantees from the State Government for procurement of the available contingent seed. Seed Banks can be set up at the most strategically advantageous locations for which adequate financial provisions will be called for.

Fodder Banks

Livestock component is critical for ensuring livelihoods particularly in arid regions during drought years. Fodder Banks need to be established at strategic locations using improved fodder/feed storage methods for supply of fodder to deficit areas. Community lands may be identified for fodder production.

Nutrient Banks

The concept of Nutrient Bank is being evolved wherein stocks of essential manures and fertilizers, soil amendments, foliar spray chemicals; bio-fertilizers etc. are maintained locally and made available to the local community to help timely sowing even when the sowing window is limited. These nutrient banks can be managed by SHGs in conjunction with Gram Panchayats. Farmers can approach nutrient bank to avail foliar sprays like KNO₃ spray, which enhances drought tolerance.

Custom Hiring Centre (CHC)

Custom hiring centres for farm machinery at village level are likely to enhance availability of implements at low cost, to help in zero tillage, improved seed and fertilizer application, in situ

moisture conservation practices, water lifting with energy efficient pumps and efficient application (through micro irrigation systems), foliar sprays, harvesting of crops, residue incorporation, relay cropping etc. even to small farmers on a real time contingency basis.

Support to Farmers

Farmers require prompt government support in the form of inputs, credit and extension services on a proactive basis.

- **Agriculture Input Support:** Farmers in drought-affected areas need to be provided with subsidized seeds of appropriate varieties to help with the second sowing.
- **Energy Support:** Farmers need to be provided assured quality power supply for irrigation.
- **Extension Support:** The State department of agriculture through its various bodies including ATMA (Agricultural Technology Management Agency) and agricultural universities should provide extension services related to advice on crop varieties, selection of seeds, soil and water conservation measures, contingency crops and agronomic practices. State Governments could also use the Kisan Call Centres (KCCs) and M-Kisan portal of DAC&FW for communicating audio/text messages and advisories to farmers. Audio conferencing of experts with the farmers registered with KCCs and M-kisan portal also could be considered. The State Governments could consider training the Farm Tele Advisors of KCCs so as to enable them to render proper advices and suggestions to the farmers in the Drought affected areas.

RELIEF EMPLOYMENT

Objectives: The most important relief component during the drought period is the generation of employment. Due to drought, agricultural operations are reduced substantially, restricting the scope for gaining employment. People look for alternative employment, or migrate elsewhere in search of employment. As soon as drought is declared, it is, therefore, necessary for the State Governments to immediately start relief employment programmes and provide work to those who need employment in the vicinity. Income generation through these employment works helps participating workers to meet their basic needs.

Lead Agencies: Ministry of Rural Development, Government of India, State Government departments of rural development, the district administration.

Support Agencies: State Government departments of irrigation /water resources, watershed management, forest, public works and water conservation.

Mahatma Gandhi National Rural Guarantee Scheme (MGNREGS)

Implemented by the Ministry of Rural Development, Mahatma Gandhi National Rural Employment Guarantee Act (Mahatma Gandhi NREGA), 2005 provides the legal framework for the flagship programme of the Government that directly touches lives of the poor and promotes inclusive growth. The Act aims at enhancing livelihood security of households in rural areas of the country by providing at least one hundred days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work.

Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is one of the largest and most ambitious social security and public works programmes in the world. The primary objective is augmenting wage employment. The other main objective is strengthening natural resource management through works that address causes of chronic poverty like drought, deforestation and soil erosion and so encourage sustainable development. The scheme is a significant step towards strengthening grass-root processes of democracy and infusing transparency and accountability in governance.

The Act came into force on February 2, 2006 and was implemented in a phased manner. In Phase I it was introduced in 200 of the most backward districts of the country. It was implemented in an additional 130 districts in Phase II (2007-2008). In Phase III the Act was notified in the remaining rural districts of India from April 1, 2008.

Fund sharing between Centre and States

S. No.	Costs to be met by Central Government	Costs to be met by State Government
1.	Wages for unskilled manual work	Unemployment allowances payable under the scheme
2.	Upto 3/4th of the material cost including payment of wages to skilled and semiskilled workers	1/4th of the material cost including payment of wages to skilled and semi-skilled workers
3.	6% of the total cost of the scheme towards the administrative expenses	Administrative expenses of the State Council
4.	Administrative expenses of the Central Council	–

Demand for work

1. Registering demand for work is central to the implementation of Mahatma Gandhi NREGA. The Program Officer and the Programme Implementing Agencies (PIA) must ensure that the process of submission of applications for work must be kept open on a continuous basis.
2. The implementing agencies must ensure that workers in need of employment under Mahatma Gandhi NREGA are provided work within 15 days of the receipt of the application or the date of demand, in case of advance application, whichever is later, as mandated by the Act. Program Officer and implementing agencies must ensure that work is provided on demand within 15 days.
3. The mandate of the Act is to provide at least 100 days of wage employment in a financial year to every rural household whose adult member volunteers to do unskilled manual work. The Ministry mandates the provision of additional 50 days of wage employment (beyond the stipulated 100 days) per Scheduled Tribe Household in a forest area, provided that these households have no other private property except for the land rights provided under the FRA Act 2006.
4. In exercise of the provisions under Section 3 (4) of Mahatma Gandhi NREGA, the Central Government decides to provide an additional 50 days of unskilled manual work in a financial year, over and above the 100 days assured to job card holders in such rural areas where drought or natural calamities (as defined by the Ministry of Home Affairs, Government of India from time to time) have been notified. The notification is issued by the Ministry of Rural Development based on the notification of the State Government to this effect and as recommended by the Department of Agriculture, Co-operation and Farmers Welfare.

Other Employment Generating Schemes

The State Relief Commissioners need to prepare plans, in consultation with line departments responsible for labour-intensive works, for providing relief employment to the people especially in chronically susceptible regions. The Relief Commissioner must prepare a financial plan for meeting the expenditure incurred on relief employment in close coordination with the Rural Development Department and the district administration.

In a drought situation, the volume of demand for rural employment is likely to see a significant spike and therefore it is necessary for the State Government to bring about convergence of all schemes and programmes of the Centre and States which have a potential for employment generation, such

as Pradhan Mantri Krishi Sinchayee Yojna, Local Area Development Schemes for the Members of Parliament (MPLADS) and Members of State Legislature (MLALADS) etc.

The departments responsible for the implementation of this programme need to start public works in drought-affected areas to maximize employment. The State Government may take necessary steps to encourage increased workers' participation in these programmes.

MPLADS and MLALADS have the potential to generate relief employment. Further, large-scale employment can be generated through works like canal excavation etc.

The State Governments need to issue a detailed set of guidelines and directives to the district administration for commencing relief employment programmes. The district administration needs to be given authority and flexibility within the framework of these guidelines for implementing relief employment programmes.

At the district level, Collectors of drought-affected district are required to prepare district plans for relief employment, specifying the types and number of works to be taken in different pockets of the district and the total employment these works would generate.

The district administration must provide employment to people as soon as there is a demand for employment with minimum delay. While planning, it is necessary that people get employment within 1.5–5 kilometers of their residence.

The Collector should direct all technical departments to identify feasible works (preferably as per the needs of the local community) in all the drought-affected villages and prepare estimates for these works and provide technical sanction to these works. The Collector should prepare such a plan in consultation with all the technical departments and provide administrative and financial approval for all the works included in the plan.

The district administration needs to maintain an extensive shelf of projects for execution in a drought situation. All line departments need to be in readiness for starting these works. They need to reassign their staff and keep the equipments in readiness for starting these works. Where tools and equipment are not adequate for starting these works, the line departments need to procure them, with a defined responsibility for their safe storage.

The Collector must conduct regular meetings of all the technical departments responsible for implementing relief employment programmes. The works in progress, attendance on these works, administrative and technical issues, wage payment and release of food grains to the workers are issues that need to be reviewed in these meetings.

The Collectors should be authorized to redeploy technical and administrative staff within the district for implementing and supervising these works in consultation with regional heads of these departments. In such instances, where the relief works have started on a large-scale, the Collectors can request the State Government to post additional officers on a temporary basis. Collectors can be authorized to hire vehicles, provide daily allowance and get administrative support for facilitating the implementation and supervision of relief works. The Collectors need to invoke disciplinary powers for proceeding against officers found to be in dereliction of their duties.

In the course of implementing relief employment programmes, priority needs to be given to water conservation, water harvesting works (such as check dams, gabion structures, percolation tanks),

and minor irrigation works (such as tanks and farm ponds, canal excavation, community wells, nalla bunding, afforestation). These works are useful for enhancing the availability of water and agricultural production. Desilting and cleaning of canals, which is overdue on account of non-availability of resources for many years, is also helpful in supplying of water to the tail-end users. For each State, these priorities may change as per the local situation. A discussion on the importance of these individual works for drought mitigation has been provided in the section on drought mitigation.

Along with the public works, it would be useful to undertake individual beneficiary oriented works to help as it create durable assets and enhance sources of income. These include:

- Farm ponds / percolation tanks
- New wells / deepening of wells / recharging of wells
- Horticulture / agro-forestry
- Construction of new water channels / rain harvesting structures
- Sanitation latrines

The State Government should lay down the criteria for the selection of beneficiaries for taking up these individual beneficiary works. While sanctioning these works, technical and financial norms need to be fixed. For the payment of wages, the muster roll must be maintained.

In the tribal and hilly areas, the local conditions may not be conducive for large-scale employment. In such a situation, individual beneficiary works for tribals should be taken up. It should involve land development, plantations and afforestation, water conservation programmes, grass cutting and storage, construction of new farm ponds and wells and rural houses.

It is necessary that spill-over works taken in the previous years as drought relief works be taken up first. Works that can be completed or brought to a safe stage, can be next on the priority list. New works can be taken only where the spill-over plan works are not available. Only after these works are completed, should new works be taken up. A new work can be taken up for execution only after all preliminary steps, such as preparation of plans and estimates and technical sanction and administrative approval of the appropriate authority, are completed.

Collectors must report to the State Government of the number of works, the total attendance of workers, the total wages paid and the distribution of foodgrains on a weekly basis.

In the drought-affected areas, Gram Sabhas need to be convened in all the Gram Panchayats for discussing the drought situation. In the Gram Sabha, water use management, relief employment works, payment of wages, and provision of foodgrains need to be on the agenda for deliberations. Gram Sabhas can become an effective forum for conducting a social audit of drought relief operations and need to be held once a month.

While the district administration must strive to provide employment to all the able-bodied adult, men and women and there cannot be any discrimination in the provision of relief, special attention needs to be focused on "below poverty line" families, landless labourers, Scheduled Caste and Scheduled Tribe households.

Each worker should be issued a job card, which would help in closely monitoring the attendance on works, payment of wages and amount of foodgrains to each worker. The job card should be available to the Inspecting Officers at work sites. Under the MGNREGA, all participating families are given job cards. These job cards need to be extended to other relief employment programmes also.

Wages must be paid to the workers in accordance with the norms laid down for the MGNREGS guidelines.

Information on the number of people provided with relief employment under each scheme should be provided in the form prescribed for individual schemes such as the MGNREGS. However, information on the demand and supply of the wage employment and migration etc. can be submitted in Form No. 9 included in the **Annexure 1**.

WATER RESOURCES MANAGEMENT

Objectives: Water resource management in the drought-affected areas is one of the most critical tasks of relief operations. Since water is a basic need for human and cattle population, assured supply of drinking water is the most important responsibility for the Government at all levels. It requires diverse measures such as augmentation of water supply, rationing of water use, and efficient utilization and management of water resources, in both urban and rural areas. Provision of water and its use is the most important yardstick for judging the effectiveness of relief operations.

Water scarcity is expected to manifest during events of hydrological drought. Successive years of hydrological drought will enhance the scarcity.

To assess sector-wise demand and availability of water resources, possible shortages in meeting the demand and evolving strategy to work on the shortages, if any.

Lead Agencies: State Government departments of water supply, Irrigation, rural development, public health engineering, and relief, as well as the district administration.

Support Agencies: Ministry of Drinking Water and Sanitation, Ministry of Water Resources, RD &GR; Ministry of Rural Development, Government of India; Central Water Commission, Central Ground Water Board, Railways, State Government groundwater survey and development agency, Irrigation, Drinking water and watershed development departments.

Storage levels of water in surface water bodies and in ground water reservoirs and aquifers tend to get impacted in the event of hydrological drought and as such areas with high rainfall may not be immune to severe scarcity of water. Shortage of water is one of the earliest indicators of drought and therefore, a realistic assessment of demand for water, its total availability and management of supply is extremely important in the management of drought.

Provision of Water

The first step in water resource management is estimation of the availability and demand for water from the Gram Panchayat upto the district level on the basis of the consumption needs for drinking, agriculture, industry etc. All follow up measures aimed at conservation, augmentation and sector-wise prioritization of water supply emerges from an accurate estimation of demand and availability.

Following measures are proposed for managing the water resources in a drought-affected area:

Reservoir Management

- The State Government is advised to enunciate the policy for laying down the priorities for use of reservoir storage for drinking, irrigation, industry, power plants, recreation, and other commercial uses.

- In keeping with the State policy, in a drought situation, it is the Collector who undertakes reservoir management with the help and support of the irrigation / water resources department and Zilla Panchayat. The irrigation / water resources department and / or Zilla Panchayat provide relevant information to the Collector in respect to storage of water in reservoirs and enforce his instructions regarding its distribution and use. The Collector must determine the quantity of water that is required to be reserved for drinking water purposes, and intimate the same to the concerned water supply / irrigation authorities. The Collector's order for water reservation for the purpose of drinking should be binding upon the water supply / irrigation authorities. Appropriate decision on the allocation of quantities and timing of release of the balance water for other purposes will be taken by the Collector.
- Water required to be supplied to a village or town for the purpose of drinking water should, as far as possible, be taken from the reservoir and conveyed to the village or town through a pipeline. Only in exceptional circumstances, such as where the village or town is situated within a short distance from the reservoir, the water could be released in the river.
- In case situation demands, the domestic water supply needs to be arranged through transportation by road or railway.

Repairs and Augmentation of Existing Water Supply Schemes

- The State Government should issue special orders for repairs of pipelines, electric-pumps, hand-pumps dug wells etc, and augmentation of all existing water supply schemes well before the monsoon season.
- Departments of water supply, public health engineering and rural development and Panchayat Raj will cooperate with the Collector in carrying out repair and augmentation work of drinking water supply schemes and provide all necessary information regarding water supply.
- The Collector needs to prepare a Taluka-wise list of all the water supply schemes in the district which need repairs. The Collector can accordingly prepare a contingency plan, in consultation with the technical agencies and local bodies, on the basis of availability of mechanical supervisors, mechanics and electricians and inventory of spare parts and accessories. Mobile vans with hand pump mechanics carrying spare parts, tools and tackles may be deployed in the Gram Panchayats to ensure on the spot repair of reported hand pumps and restoration without unnecessary delay. In those cases, where technically qualified people are not available with the Government agencies, they could be employed on a contractual basis at the Taluka or village level. While preparing such contingency plans, special attention should be paid to susceptible areas in the district.
- At the village level, it should be the duty of the Sarpanch or Gram Sevak, or any other functionary appointed for this purpose, to promptly report to the Tehsildar and Block Development Officer when any hand pump or power pump goes out of order. The Tehsildar and Block Development Officer, with the assistance of engineers of the relevant departments, should ensure that the hand pump or the electrical pump fitted on a bore-well is immediately repaired with the assistance of the line department. In many cases where the repairs needed are major, a mobile repairs unit can be sent for carrying out the necessary repairs.
- When drought is declared, a district-level campaign should be organized for repairing all the hand pumps and electricity / pumps fitted on bore-wells. The campaign would be more effective if it is supported by indenting in spare parts and accessories required for carrying out

necessary repairs in advance. For each hand pump and bore-well, a card can be maintained which records the visits of mechanics and electricians and the details of repairs that have been carried out.

- The village Panchayat has the overall responsibility for proper maintenance and timely repairs of the piped water supply. However, in a drought situation, village Panchayats can be given suitable grants by the district administration for meeting the expenditure on maintenance and repairs of the water supplies.
- The Collector should be provided funds for immediate repairs to water supply schemes, hand pumps, solar pumps and bore-wells through the SDRF/departmental schemes. These funds can be placed with the technical agencies for undertaking necessary repairs to these water supply schemes.
- The drinking water bore wells / tube wells need to be assessed periodically for their aquifer efficiency, well efficiency, conveyance and distribution efficiency.
- Water conservation measures to be taken up on top priority. In case of successive droughts, the ground water resources should be assessed and considered for exclusive use in the supply of drinking water. In such circumstances, the closing of sluice gates of minors / major irrigation tanks and conservation of water for human and livestock consumption ought to be given priority.

Special Measures and Schemes for Areas with Drinking Water Scarcity

- With the earliest signs of a hydrological drought, the Collector should direct the Tehsildars and Block Development Officers to visit the affected areas and draw up Taluka-wise lists of villages in which drinking water scarcity has already developed, or likely to arise. Such visits will always be undertaken with the engineers and officials of water supply, public health engineering, or rural development department, as the case may be. Such lists should be developed with maps indicating the location of villages, routes linking these villages and existing sources of water supply in these villages, such as piped water supply, bore-wells, or dug wells.
- The Collector would get the list of these problem villages counterchecked through the Sub-Divisional Officers and other district officers from the relevant departments. The Collector should also personally visit 5–10% of the villages for verifying the factual position related to availability of drinking water. The Collector should then finalize the list in consultation with the officials dealing with water supply and the State ground water survey and development agency.
- On the basis of this information, the Collector should prepare a contingency plan for provision of drinking water in all the villages that are likely to face a water scarcity. The contingency plan should lay down the priority for provision of drinking water as follows:
 - Any piped water supply scheme, which is already under execution in any of these villages, should be completed expeditiously;
 - Piped water supply, temporary piped water supply, or bore-wells already constructed in any of the villages which are non-functional should be made functional by undertaking necessary repairs or renovation;
 - The maintenance work of hand pumps or electrical pumps fitted on bore-wells in the village should be completed on top priority. If an existing bore-well can provide enough water to the village by installation of a power pump, then the district administration should take emergent

measures to get the power pump installed;

- The feasibility of a new bore-well in the village should be assessed with the help of State ground water survey and development agency. Where feasible, a programme installing new bore-wells could be taken up. Care should be taken to avoid deep bore-wells as they damage aquifers.
- If any of the above mentioned measures are not feasible, emergent measures such as desilting, deepening, or blasting of existing wells, or construction of open wells in river beds can be undertaken, as suggested in the section on Other Emergency Measures for Supply of Drinking Water.
- If the district administration assesses that these sources of water would not be sufficient to meet the drinking water needs of a village, they can arrange to provide drinking water through tankers or bullock carts, as suggested in the section on Supply of Water through Tankers and Bullock Carts.

Construction of Temporary Piped Water Supply

- The State Government should decide to construct temporary piped water supply in a village, if the following conditions are fulfilled:
 - No source of drinking water supply is available or is likely to be available within a distance of 0.5 kilometre of the village;
 - No possibility of constructing a new bore-well at the village or within a distance of one kilometre of the village or to undertake further drilling in the existing bore-well at the village, due to non-availability of groundwater source at the village;
 - Where, water supply at the rate of 40 litres per day per head would be available at the source for the projected human and livestock population of the village;
 - Where the supply is based on a private source of water, e.g. a private well, it is ensured that the source is adequate to last till the scarcity abates;
- The Collector should fix the agency for commissioning temporary water supply in consultation with the department of water supply, public health engineering, or rural development department, as the case may be. It could either be implemented by the agency responsible for water supply in the State or a local body.
- Each State Government should delegate powers of technical and administrative approval of the temporary water supply schemes to authorities.

Construction of Bore-wells

- A bore-well programme can be taken up in a village, which is facing or is likely to face drinking water scarcity, if it is technically feasible to construct bore-wells at such a village. Sites for bore-wells can be selected on the basis of recommendations made by the State ground water survey and development agency.
- Bore-wells with a hand pump fitted thereon can be set up for a population of 250.
- If the population exceeds 250, more than one bore-well can be installed to serve the village.
- The Collector can request the departments of water supply, public health engineering, or rural development department, as the case may be, to deploy drilling machines for installing

bore-wells. Where it is necessary to obtain additional drilling machines, these can be obtained on hire from private owners.

- When a village has power supply, for a population of at least 500 one or more bore-wells having high yield power pumps may be installed only on one such bore-well for solving the problem of drinking water in the village.
- When a bore-well programme is undertaken in a village, it is necessary to take into account the cattle population of the village. Along with bore-wells, it would be necessary to provide water taps and troughs for the cattle.

Other Emergency Measures for Supply of Drinking Water

- The Collector should undertake emergency measures such as de-silting or deepening of existing public wells to increase the availability of water. Other measures such as in-well drilling, blasting and revitalization can also be attempted for augmenting the capacity of these wells. These measures need to be planned with the support of departments of water supply, public health engineering, or rural development department, as the case may be,
- Where no public well is available or is likely to be successful after taking such measures, the Collector may authorize and make available a private well on rent, if the owner of the well agrees to allow public consumption with no discrimination against any caste, creed or religion. In all the cases where a private well is being brought under use, the Collector should fix the rent for drawing drinking water and make the payment to the owner of the well and also make an announcement to this effect so that the owners of private wells come forward to offer their wells for supply of drinking water at a rent fixed by the district administration.
- Old wells that have fallen into disuse should be repaired for ensuring drinking water supply to the villagers if the State ground water survey and development agency certifies that after carrying out the necessary repairs the well would provide adequate water supply. Before these old wells are used for drawing drinking water, it should be ensured that water is properly chlorinated, and a certificate obtained from the State health department stating that the water is fit for human consumption.
- Where the water in a river or stream gets scarce, holes could be dug in the beds of the stream or river. Where water has been impounded by putting a temporary bund, such holes could preferably be dug on the banks near the impounded water and the water is reserved in those holes for drinking purposes. This would provide practically filtered water to the villagers for the purpose of drinking.
- Where the water has sunk much below the bed, it may be necessary to sink concrete pipes in the holes dug in the bed so that water gets collected in the pipes and could then be used for drinking water purposes.
- When a certain area faces acute drinking water scarcity, it may become necessary to save and preserve water, particularly from small and shallow tanks, for drinking water purposes by controlling evaporation losses. Certain chemicals can be spread over surfaces of water storages, which would control evaporation. However, such a measure needs to be undertaken in consultation with the State health department. The district administration would be responsible for ensuring that chemicals used for controlling evaporation are safe and would not cause any health hazard to the people consuming such water.

- The details of expenditure on installation, augmentation and repairs to all water supply schemes and sources can be provided in Form No. 8, included in **Annex 1**.

Supply of Water through Tankers and Bullock Carts

- The Collector should take the decision to supply water through tankers or bullock carts to a village or town in the drought-affected area, where no other source of water supply is available. The Collector should decide after obtaining reports from Taluka / Block-level officials, which are counterchecked by Sub-divisional Officers. In such cases too, the Collector should decide to supply water by a tanker or bullock cart, where a permanent or temporary water supply system is under repairs, till the time these repairs are completed.
- While making the survey of villages for supply of water through tankers or bullock carts, it shall be obligatory for the departments of water supply, public health engineering or rural development department, as the case may be, to provide necessary technical, administrative and logistical help.
- The State Government should issue orders, authorizing the Collector to requisition Government tankers from all the departments for the supply of drinking water. It would be the responsibility of all the departments to provide tankers along with the services of a driver when the Collector makes a demand.
- If any of the tankers are in disrepair, it should be the responsibility of the officers of the concerned department to undertake necessary repairs to the tanker before making it available to the Collector.
- The Collector would first deploy Government tankers for the supply of drinking water.
- Private tankers can be hired only when Government tankers are not available or inadequate for ensuring uninterrupted supply of drinking water to the affected villages. The Collector should hire these vehicles by inviting tenders and fixing the rate for trips involving different distances. The Collector should issue instructions for the maintenance of logbooks of these vehicles, as payment to the owners of these tankers is to be made on the basis of entries in these logbooks. The operations of these tankers need to be regulated carefully. The Collector should discontinue the deployment of tankers immediately after local sources of water have been recharged or re-developed.
- Where water supply is being arranged through tankers or bullock carts, the Government should consider providing big storage tanks in villages or towns with a capacity of more than 5,000 litres, so that water wastage is minimized.
- In villages where roads are not motorable, it may be more convenient and economical to engage bullock carts for supplying water. The Collector should hire local bullock carts for supplying water. In all such cases, the Collector should fix the number of trips to be made by bullock carts and pay per trip to the bullock cart owner.
- In extra ordinary drought situation the drinking water requirement may also be arranged through Railways.
- Information on supply of drinking water through tankers and bullock carts can be provided in Form No. 7, included in **Annexure 1**.

FOOD SECURITY

Lead Agencies: State Government Departments of Food and Civil Supplies and the District Administration.

Support Agencies: Ministry of Consumer Affairs, Food and Public Distribution, Food Corporation of India, Indian Railways, State Government Departments of Women and Child, and School Education.

Objective: To ensure provision of adequate food and nutrition to the population in drought affected areas.

Provision of Food

1. For food security of the people, Government is implementing the National Food Security Act, 2013 (NFSA) which provides for coverage of upto 75% of the rural population and upto 50% of the urban population at the national level for receiving subsidized foodgrains under Targeted Public Distribution System (TPDS), thus covering about two-thirds of the population. Corresponding to the above coverage of the all India level, State/UT-wise coverage was determined by the then Planning Commission. Coverage for receiving highly subsidized foodgrains under the Act has been delinked from poverty estimates and is substantially above the percentage of population living below the poverty line.
2. Main responsibility for implementation of NFSA, which *inter alia* includes identification of eligible households, issuing ration cards to them, ensuring delivery of foodgrains upto door-steps of fair price shops and its timely distribution to eligible households lies with States/UTs and therefore ensuring food security in the drought-affected areas requires the following actions to be taken by the State/UT department of civil supplies:
 - Special drive should be launched to ensure that no deserving and eligible household is left out of coverage under NFSA.
 - In case ration card has not been issued to some deserving and eligible households, supply of subsidized foodgrains to that household should be started on the basis of some other identity proof prescribed by the State Government, till ration card is issued.
 - In case, names of some members of eligible households are missing from the ration card, immediate steps must be taken for rectification.
 - The State Government/UT Admn./Collector of the drought affected area must ensure that Fair Price Shops are distributing foodgrains to the people in the drought-affected areas. There should be necessary vigilance against any diversion of foodgrains or its mis-utilization.
 - In those places, where Fair Price Shops are not available, new ones for the distribution of foodgrains can be started through self-help groups or cooperatives or even village Panchayats.
 - In remote and difficult to reach areas, mobile Fair Price Shops can be arranged. The schedule of movement of these mobile shops can be fixed and publicized.

- Inspection of warehouses and Fair Price Shops should be intensified during the drought period, to ensure availability of foodgrains and its effective distribution.
 - The State Government/UT Admn./Collector of the drought affected area should exercise surveillance over prices of essential commodities. If the local prices of foodgrains increase, the Collector should bring it to the notice of the State/UT Government.
 - Wherever required, the State Government/UT Admn./Collector of the drought affected area should take steps to prevent hoarding of essential commodities, prevent manipulation in prices through creation of artificial scarcities and ensure availability of essential commodities in the market.
3. State Government/UT Administration should make assessment of requirement of additional foodgrains, if any, over and above the NFSA allocation, to deal with special situation arising due to drought, and request the Government of India for additional allocation, which shall make necessary allocation as per the then prevailing policy.

NUTRITION ASPECTS OF FOOD SECURITY

The State Government should address the nutritional aspects of food security through schemes such as the Integrated Child Development Services (ICDS) and Mid-day Meals. The ICDS is implemented for pre-school children, while mid-day meal has been introduced for school-going children.

Integrated Child Development Services (ICDS)

The ICDS scheme was initiated in 1975 to improve the health and nutritional status of children in the 0–6 age-group by providing supplementary food and coordinating with State health departments to ensure the delivery of the required health inputs. It also provides food supplements to pregnant and lactating women. The type of food supplements in the ICDS programme varies widely, from ready-to-eat food to the supply of supplements cooked in Aanganwadis.

The ICDS programme is centrally sponsored. The centre bears the cost of maintaining the infrastructure, while the State bears the expenditure on the food component.

In a drought situation, the ICDS can be used as the main instrument for ensuring nutritional security among the vulnerable sections, which constitute bulk of beneficiaries under this programme even during 'normal times'. Under this arrangement, ICDS centres / Aanganwadis register additional beneficiaries.

The Government is seeking the services of self-help groups for providing supplementary food to Aanganwadis. During a drought situation, the role of self-help groups can be increased for monitoring the health and nutritional status of women and children. Wherever it is necessary to open additional Aanganwadis temporarily, the Government should sanction them and provide finances for these Aanganwadis through the relief funds.

Mid-day Meal Programmes

With a view to enhance enrolment, retention and attendance and simultaneously improve nutritional levels among children, the National Programme of Nutritional Support to Primary Education (NP-NSPE) was launched as a Centrally Sponsored Scheme on 15th August 1995 to cover children studying in classes I-V of Government, Government aided and Local Body Schools. The scheme has been expanded both in coverage and contents since then. Now the Scheme covers the children studying in elementary classes (I-VIII) in Government, Government aided, Special Training Centres (STCs) and Madarsas/Maqtabs supported under Sarva Shiksha Abhiyan (SSA). The name of the scheme has also been changed as "Mid Day Meal Scheme in Schools". The scheme also provides for giving mid day meals during summer vacation in drought affected areas.

Community Kitchens

In drought situations where certain segments of people, such as the old, disabled, and women, are extremely distressed, the Collectors should start community kitchens, which could be run by the Government itself or through NGOs. These kitchens should be run only during the drought situation and need to be closed when the situation improves, either through provision of relief employment or improving the state of agriculture.

GRATUITOUS ASSISTANCE

Lead Agency: Relief and Rehabilitation department of State Government and district administration.

Support Agency: Ministry of Agriculture & FW, Ministry of Home Affairs, Ministry of Finance (Government of India).

Objectives: Provision of gratuitous assistance in cash or food to old, disabled and destitute persons in drought-affected areas as per SDRF/NDRF norms. The State Government should lay down clear and reasonable selection criteria for such beneficiaries. Care should be taken to ensure that only such individuals or families without any source of income, livelihood or social welfare benefits and on the verge of destitution/starvation be selected.

Survey of Eligible Persons

- As soon as drought is declared, the Collector should survey the population and prepare a list of people who are eligible for gratuitous assistance as per the selection guidelines laid down by the State Government.
- The State Government could consider having list of persons eligible for gratuitous assistance approved by the Gram Sabha.
- The list of people qualifying for gratuitous assistance would be regularly maintained and made available for inspections.
- The local district official such as the Tehsildar / Block Development Officer / Circle Officer should compile a list of all persons identified for the distribution of gratuitous assistance and forward it to the Collector. In certain cases, the district officials can test-check the list.

Distribution of Gratuitous Assistance

- In situations of acute drought instances may come to light of starvation on account of infirmity, sickness, old age or otherwise, where it may become necessary to organize community kitchens or supply cooked food.
- In remote areas, the Government may also consider setting up foodgrains bank to support the destitute, infirm, and old on a temporary basis. The Government may also take the help of the Gram Panchayats or NGOs to operate such foodgrains bank. Detailed instructions need to be issued for setting up and operating foodgrains bank.
- Collector should take all possible steps to prevent starvation deaths.

Administration of Gratuitous Relief

- To the extent possible, disbursement of gratuitous relief should be through DBT making use of Jan Dhan accounts. Only in exceptional circumstances to be recorded in writing should cash disbursement be permitted. Village-level officials would maintain a record of cash disbursement.

- The Tehsildar / Block Development Officer / Circle Officer should submit to the Collector a return form on expenditure on gratuitous relief in Form No. 12, included in **Annexure 1**.
- All expenditures incurred on granting gratuitous relief should be debited to the budget head used for natural calamities.
- The norms / guidelines for relief as applicable under the State Disaster Response Fund(SDRF) / National Disaster Response Fund(NDRF) shall be adopted.

WAIVERS AND CONCESSIONS

Lead Agency: Departments of revenue, Cooperation and Power in the district administration and Banks.

Support Agency: Finance department of the State Government

Objectives: The primary objective of such remission, deferments, restructuring, concessions and waivers is to help the affected population to tide over the immediate difficulties.

- Each State Government may take decisions on remissions, waivers, deferments, loan restructuring, concessions etc, taking into account the fiscal situation of the State and severity of the drought. Following steps can be considered by the State:
- Grant remission of land revenue as payable under the relevant Land Revenue Code for those farmers affected by drought.
- The State Government may postpone recovery of dues like Tagai / Taccavi, arrears of water, irrigation and electricity charges, or any other dues related to agriculture from farmers. If recovery is not postponed, the State Government can issue instructions for not recovering dues from the farmers and other agricultural workers by applying coercive measures.
- The State Government may consider converting short-term loans and reschedule current installment of medium-term loans for farmers in the drought-affected areas. The State Government should make necessary provision for restructuring / rescheduling of these loans and pay to the concerned banks.
- The State Government may issue instructions to all cooperative banks through the Department of Cooperation to convert or reschedule kharif loans by the end of March, when assessment of crop losses are available and final annewari / paisewari values are published.
- The Collector should furnish details of annewari / paisewari values or any other assessment of crop losses to cooperative banks to facilitate the conversion or re- scheduling of such loans. Tehsildars / Block Development Officer / Circle Officer can issue necessary certificates to the District Registrar of Cooperatives to enable the banks to grant conversion facility to the affected farmers.
- The State Government may issue instructions to the cooperative banks not to apply coercive measures for recovering their loans or dues in the drought-affected areas.
- The State Government can decide to waive education / examination fees for the students in Government schools located in drought-affected areas.

CATTLE CAMPS AND FODDER SUPPLY

Lead Agency: State Government departments of animal husbandry and the district administration.

Support Agency: Ministry of Agriculture & FW (Government of India), Indian Grassland and Forest Research Institute (IGFRI), Railways, State Agricultural Universities and Tribal / Forests produce marketing agencies.

Objectives: State Governments need to support their farmers in protecting their cattle population during a drought situation by providing necessary assistance for fodder, feed, and cattle health services. This would discourage distress selling of cattle and help farmers to maintain a very important part of their asset base.

Cattle wealth is the mainstay of the rural economy. As small and marginal farmers constitute about 80% of the total community of farmers in the country for whom, cattle often is a valuable asset to help supplement incomes from their small landholdings. Cattle ownership diversifies production and resource management options, increases total farm production and income, provides year-round employment and spreads risk. Studies shown that the more cattle heads a farmer owns, the less vulnerable the farmer is to risks. During a drought situation, every measure needs to be taken to save useful cattle from mortality or distress sale by making arrangements for drinking water, fodder and medicines etc.

Steps to provide fodder:

- On receiving information about fodder scarcity becoming imminent as a result of failure or inadequacy of rains in July–August or the failure or inadequacy in rabi rains, the Collector should have surveys done for assessment of fodder availability, the price trends and the expected demand in the light of cattle population in vulnerable areas. The cattle census figures and other data with the District Animal Husbandry Officer will be useful for this purpose.
- The Collector should submit a detailed report to the State Government, which provides information on the cattle population, the area under fodder, the estimated fodder production and the shortage of fodder in the district. The Collector can suggest measures for increasing fodder supply in the area.
- The State Government, upon the receipt of such a report, should issue detailed instructions for maintaining the supply of fodder, either through procurement of fodder, or by setting up cattle camps or fodder depots / bank, or by encouraging farmers to undertake fodder cultivation.

The State Government should authorize the Collector to ensure the availability of fodder in the drought-affected areas by taking the following steps:

- Encourage farmers to undertake fodder cultivation on the banks of canals or other areas under irrigation. Subsidy in the form of seeds should be provided for fodder cultivation;
- Request the Chief Conservator of Forests and Divisional Forest Officers to protect the available grass in the forests; and
- Consider imposing a ban on the movement of fodder from the district to another district or outside the State.

Special Measures for Increasing Fodder Supply

- The State Government should issue instructions to the Collector to take the following measures for increasing the supplying of fodder:
- Procure fodder through the Forest Department or the Forest Development Corporation at a price fixed by the State Government;
- Procure fodder through traders, private cultivators, Tribal Development Corporation etc. at a price declared by the State Government;
- Procure fodder from the neighbouring States.
- Procure feed blocks if necessary for milk-producing cattle and arrange strategic placement of feed reserves;
- Establish fodder depots in the drought-affected Talukas for selling fodder, cattle feed and concentrates at a price fixed by the State Government;
- Fix the price of fodder so that it is affordable to the farmers. Provide subsidy for the purchase of fodder supplied through fodder depots. The price should be published and displayed prominently in the fodder depot to make the farmers aware;
- Maintain accounts of sale of fodder through fodder depots. These accounts need to be open to inspection;
- Organize distribution of fodder through societies by way of Tagai / Taccavi to the needy agriculturists and particularly to small holders in the affected areas;
- Set up cattle camps or feeding centres either through district administration or the NGOs for feeding the cattle.
- Fix the quantity of fodder and feed to be provided in the cattle camp with the assistance of the State animal husbandry department. Fodder and feed should be issued for each cattle in accordance with these standards.
- Arrange water supply for all the cattle camps in accordance with the total number of cattle admitted in these camps.
- Maintain accounts of the fodder and feed provided through the cattle camps and reconcile it with the number of cattle staying in a cattle camp. Each cattle camp must maintain a register, showing the number of cattle staying there and the total stock of fodder and feed on a daily basis.
- Conduct necessary inspection of cattle camps to ensure that fodder and feed are being provided to cattle in these camps and sanitation and cleanliness measures in these camps are adequate.

- Arrange for grazing of cattle in army establishments, such as training centres or firing ranges;
- Start a special scheme for arranging the supply of nutritious cattle feed to owners of milch cattle in consultation with the State Dairy Development Department;
- Arrange with Gaushalas and other NGOs for taking care of cattle, on a per cattle head payment basis;
- In extraordinary situations, the fodder requirement may be arranged through Railways from surplus States.
- Increase awareness among farmers about the feeding requirements of cattle during drought to ensure their health and productivity; and
 - Information on cattle camps and fodder supply can be provided through Form Nos. 5 and 6, included in **Annexure 1**.
 - Based on the migration pattern of cattle, States may consider organizing cattle camps in the districts not affected by drought.
 - States may consider providing fodder to farmers who do not prefer to send their livestock to cattle camps.
 - Promote drought resilient local grasses, shrubs, tree varieties on the banks of canals, water bodies etc. for moisture conservation.

Role of the Animal Husbandry Department

- At the request of the Collector, the State Animal Husbandry Department should make available the fodder, feed, and water requirement for each cattle.
- The Animal Husbandry Department would check the quality of feed and fodder supplied through the fodder depots and cattle camps. It would ensure and certify that the feed and fodder being provided are fit for cattle consumption.
- The Animal Husbandry Department would provide minerals, vitamins, medicines and vaccines at minimum cost to the farmers. The Department would also carry out the necessary inspections and checks in drought-affected areas to ensure that cattle are maintained in good health.
- The Animal Husbandry Department would depute inspectors who would check the health of cattle in cattle camps at frequent intervals, at least once a week, and undertake all precautionary measures to avoid outbreak of any disease.
- The Animal Husbandry Department would undertake campaigns in the drought-affected areas to increase the awareness of farmers about cattle health issues related to fodder and feed, vitamin and minerals and other sanitation issues.

Role of the Forest Department

- At the request of the Collector, the Forest Department / Forest Development Corporation should maintain stocks of grass for the use of the distressed Cattle Population in the drought hit areas. The cutting of grass should be completed as early as possible and should be properly dried, converted to hay and stocked. The Forest Department should also make arrangements for the transportation of fodder to places suggested by the Collector. The Government should sanction the necessary expenditure for fodder operations to be undertaken by the Forest Department.

Role of the Agriculture Department

- The Agriculture Department through its various bodies and especially through ATMA, would encourage individual farmers to undertake cultivation of fodder, wherever possible. It would provide fodder seeds and fertilizers to the farmers for cultivating fodder, wherever possible; and extension services for undertaking short duration grasses and seasonal fodder crops.
- The Agriculture Department can also undertake cultivation of fodder on the land owned by the agricultural universities. Generally, agricultural universities have huge tracts of land, which could be used for this purpose. The Government needs to provide subsidy to the agriculture universities for cultivating fodder.
- The Agriculture Department can also grow fodder on the seed farms, wherever available or on Demo plots under ATMA. The Government should provide a grant for seeds, fertilizers and other expenditures, depending on the extent of area covered under fodder cultivation.

Role of the Irrigation Department

- The irrigation department should extend all necessary cooperation to the Collector for promoting fodder cultivation by providing water for irrigation on a priority basis. Such water could be provided to the farmers at a cheaper rate.
- The irrigation department should consider allowing reservoir and tank beds under its control to be leased out for cultivating short duration grasses or seasonal fodder crops. The Collector, with the permission of the irrigation department, could lease out the reservoir and tank bed land on short-term lease subject to the condition that the lessees should grow fodder crop therein and agree to sell the grass / fodder to needy farmers at the price to be fixed by the Collector.

HEALTH AND HYGIENE

Lead Agency: State Health Department as Health is a State Subject.

Ministry of Health & Family Welfare, Govt. of India to play supportive role.

Preamble: In drought situation, contamination of drinking water at the source or wrong storage practices may lead to waterborne diseases. Similarly water storage practices may lead to breeding of mosquitoes resulting in outbreak of vector borne diseases. Long-standing drought may affect nutritional status of local population especially that of pregnant and lactating mothers and children.

Objective: As specified in the drought manual of Ministry of Agriculture and Farmers Welfare, Govt. of India.

- In order to maintain health and hygiene standards of the drought affected population, the State Health Department should take the following steps:
- Surveillance of water borne diseases through State Integrated Disease Surveillance Programme.
- Surveillance of vector borne diseases through State National Vector Borne Disease Control Programme.
- Laboratory support for diagnosis of water borne and vector borne diseases through public health laboratories, district hospital laboratories and medical colleges.
- Provision of safe drinking water to affected population or Chlorination of drinking water sources.
- Source reduction of vectors (breeding of mosquitoes) through Integrated Vector Management as per guidelines available on the website of National Vector Borne Disease Control Programme.
- Communication of risk of waterborne and vectorborne diseases to the local population.
- IEC measures should be undertaken by State Health Department to educate affected population about steps to be taken for prevention of water borne, vector borne diseases and ways to compensate nutritional deficiency during the drought period.
- If drought is long standing, State Health authorities to undertake nutritional surveillance among vulnerable population (children, pregnant women etc.) and manage nutritional deficiencies.
- Deployment of Rapid Response Teams for managing any outbreak of waterborne or vectorborne disease.
- Health camps should be held in drought affected areas to screen local population for common ailments.
- Procurement of necessary drugs should be done by the State Health Department to prevent any outbreak of disease in the affected population.
- State Health Department should arrange for clinical management of cases due to waterborne and vectorborne diseases.

INSTITUTIONAL RESPONSE

The effectiveness of Drought management response is a reflection of the robustness of the government institutional structures .

While primary responsibility to monitor, declare, plan and manage response is of the State Government, yet a critical supportive role is contemplated under the present scheme of things for the Central Government. The district administration headed by the Collector spearheads the government institutional response to drought on the ground. Drought thus requires efficient coordination at multiple levels.

Role of the Central Government

- The Department of Agriculture, Cooperation and Farmers Welfare(DAC&FW), Ministry of Agriculture & Farmers Welfare (MoA&FW) is responsible for monitoring and coordinating the central government response to drought.
- An officer of the rank of an Additional Secretary in the DAC&FW is designated as the “Central Drought Relief Commissioner” for the purpose. SDRF and NDRF are, however, administered by the Ministry of Home Affairs and assistance under these schemes are released by the Ministry of Finance upon the recommendation of the High Level Committee (HLC).
- A Crisis Management Group functions under the Chairmanship of the Central Drought Relief Commissioner with representatives of Ministries and organizations. The Crisis Management Group meets from time to time to review the drought situation in the country and progress of relief measures.
- The CWWG, is an arrangement for monitoring and early warning of any drought like development in any part of the country on a regular basis.
- In the event of a declaration of drought, the Central Drought Relief Commissioner (CDRC) should monitor and review the progress of relief measures and apprise the National Crisis Management Committee.
- National Crisis Management Committee (NCMC) which has been set up under the Chairmanship of the Cabinet Secretary with Secretaries of Ministries and heads of agencies as members to deal with all calamities and crisis situation should be apprised of the progress of relief and other developments periodically.
- The Central Government normally constitutes a Cabinet Sub-committee or a Group of Ministers in situations of severe drought to expedite policy decisions.
- The MoA&FW is expected to coordinate closely with other Ministries and agencies in dealing with drought.

Role of the State Government

- The State Department of Disaster Management and Relief is responsible for directing drought operations in the State.
- The Department is headed by a Secretary or Relief Commissioner and assisted by a team of officers.

- The Relief Commissioner / Secretary, Disaster Management monitors the drought situation through the Drought Management Centres, the District Collectors and departments and agencies.
- The Relief Commissioner / Secretary, Disaster Management submits periodic reports to the Government and recommends the declaration of drought on the basis of situation on the ground. Once the State Government declares drought, all necessary orders for relief operations are issued.
- Relief Commissioners / Secretary, Disaster Management issue instructions to Collectors for launching relief operations for the people affected by drought.
- Relief Commissioner / Secretary, Disaster Management should take steps for timely communication of all decisions of the State Government to the district authorities.
- The Relief Commissioner / Secretary, Disaster Management administers the State Disaster Response Fund (SDRF) of the State and issues orders for release of all financial assistance to the district administration and other departments in accordance with extant guidelines.
- The Relief Commissioner / Secretary, Disaster Management shall ensure the assessment of losses and relief requirements in consultation with the district administration and line departments. On the basis of this assessment a Memorandum is submitted to Government of India by the State Relief Commissioner for seeking financial assistance from the National Disaster Response Fund (NDRF).
- States have adopted various mechanisms for managing drought like State Executive Committee in accordance with the provision of the Disaster Management Act, 2005, Cabinet Sub-committee, Secretaries' Committee under the Chairmanship of the Chief Secretary for taking policy decisions on drought.
- Drought management requires coordination with departments of agriculture, horticulture, animal husbandry, water resources, irrigation, social welfare, public distribution, rural development, school education, power, drinking water, public health, and finance.

Role of the District Administration

- The district administration under the leadership of the Collector implements all decisions related to drought management on the ground. The implementation takes place through a number of line departments and field agencies working on the ground. The effectiveness of drought management is largely dependent upon coordination among agencies working at the district level.
- As per extant revenue codes in many States, the expression "Collector" includes all subordinate officials of the Revenue Department such as Additional Collector, Deputy Collector, Sub-divisional Officer and Tehsildar. All the subordinate officers perform their tasks and exercise powers related to drought management on behalf of the Collector.
- The Collectors should ensure monitoring all the indicators of drought on the ground such as, collection of daily data on rainfall water storage position, water availability and supply and progress of sowing operations. The Collector should also monitor local information related to demand for relief employment, prices of food grains and the availability of fodder.

- The Collector shall ensure timely collection of field information and ground truthing as described in Chapter 3.
- The Collector must submit periodical reports on all the important indicators of drought to the Government.
- The State Government must ensure that delegation of administrative and financial power to the Collectors are sufficient for a prompt and meaningful response.
- The Collector must be authorized to direct all the line departments at the district level to participate in drought management, prepare contingency plans and mobilize their staff and resources e.g. in the identification of works and preparation of estimates for shelf of progress for relief employment in the drought-affected areas. The Collector should be authorized to requisition vehicles and equipments on payment basis to mount relief operation.
- The Collector needs to assess the situation related to scarcity of drinking water and fodder and issue appropriate instructions regarding reservation of drinking water, supply of drinking water through tankers, procurement and sale of fodder, and setting up of fodder depots and cattle camps as mentioned in the relevant sections of the manual. The Collector should exercise similar authority in any other area which is affected by drought.
- The role of the Collector is that of an effective coordinator of drought management. The Collector must be able to provide a sense of mission and direction to all the line departments and agencies working for drought relief. It is necessary that the Collector provides the necessary help and support to all the agencies for performing their tasks more effectively.
- At the district level, a district drought / disaster management committee should be set up under the chairmanship of the Collector with members consisting of public representatives, line departments. The SDMCs and DDMCs shall provide all relevant information to the said Committee. The Committee should meet frequently and review the progress of drought relief measures in the district. The district-level committee can become a very effective forum for addressing peoples' concerns and applying correctives in drought management.

Role of Panchayati Raj Institutions

- It is necessary to involve the Panchayati Raj institutions (PRIs) - Zilla Parishads, Panchayat Samitis, and Village Panchayats - in the implementation of drought management programmes.
- PRIs need to provide funds for water conservation and maintenance of water supply schemes.
- Efforts should be made to identify the projects related to sustainable natural resource management, water conservation etc. to support drought mitigation in the vulnerable regions.
- The PRIs need to play an important role in the regulation of water use at the individual household and village level. It should recommend using water resources for the purpose of drinking and fodder cultivation.

Role of Non-Government Organizations (NGOs) and Civil Society Organizations (CSOs)

- The State Government and district administration need to involve NGOs in organizing drought relief. NGOs and CSOs have the advantage of local presence and community outreach which could be utilized for organizing distribution of relief assistance and implementing

mitigation programs. NGOs can also be very effective in providing feedback to the Government and securing corrective actions.

- The State Government and district administration can set up a coordination forum for NGOs and CSOs at the State and district levels respectively. The coordination forum meetings can be convened to discuss the drought situation and the implementation of relief programmes.
- NGOs and CSOs can monitor various indicators of drought, particularly its impact on the people, and bring these to the attention of the State Government. The State Government can initiate necessary relief measures in drought-affected areas, based on the feedback from these organizations.
- NGOs and CSOs can convey the local demand for relief employment to the district administration. They can suggest specific works to be started so that the people are provided with employment within a short distance of their homes. These organizations can help the district administration in planning relief employment in a way that durable community assets are created. They can also coordinate with the local administration in ensuring the payment of wages and foodgrains on time.
- NGOs and CSOs can work with the local community in augmenting the sources of drinking water through repairing wells, hand-pumps, tanks, ponds and any other local water structure. They can also help the community in regulating water use within the community and ensuring equitable distribution of available water.
- NGOs and CSOs can monitor the distribution of foodgrains through Fair Price Shops and prevent hoarding and diversion of foodgrains in the open market. They can ensure that foodgrains are supplied to all the Fair Price Shops, particularly those in the remote areas and all the people in the drought-affected areas can purchase foodgrains through these shops as per their entitlements. NGOs and CSOs can also monitor that the people are paid their wages in the form of foodgrains as per the norms fixed by the government.
- NGOs and CSOs can provide assistance to the sick, elderly and disabled people in the drought situation. They can run community kitchens with Government assistance. NGOs need to bring the cases of hunger and starvation to the attention of the Government.
- In consultation with the Government, NGOs and CSOs can monitor the functioning of ICDS and mid-day meals so that the children get necessary nutrition during the period of drought. They can also bring to the attention of the Government the cases of malnutrition among infants and children.
- NGOs and CSOs can set up cattle camps and fodder depots after obtaining the necessary authorization from the Government. They can receive Government assistance as per the SDRF / NDRF norms as well as the necessary veterinary care for this purpose.
- NGOs and CSOs need to help the Government in dealing with the public health aspects of drought. They can assist the Government in disinfecting sources of water, creating awareness about public health issues and monitoring malnutrition and disease among drought-affected population.

FINANCING RELIEF EXPENDITURE

In post-independent India, financing relief expenditure has largely been arranged through the Finance Commission appointed under Article 280 of the Constitution. In the earlier phases, the role of the Commission was restricted to suggesting the pattern of financial assistance by the centre. Subsequently, the recommendations were enlarged to cover the “scheme of financing relief expenditure.”

The present arrangement of financing relief expenditure has two streams: (i) SDRF and (ii) NDRF.

The SDRF envisaged the contribution of Central and the concerned State Governments in the ratio of 3:1 for a fund to be kept outside the Government Account so that there is no cash flow constraint for initiating relief operations. The Centre’s share is normally released in two half-yearly installments, subject to the guidelines in this regard. Funds from the SDRF are to be spent on specific, pre-determined items of expenditure at predetermined scales, as specified in the SDRF guidelines. The NDRF provides funds for natural calamities of severe nature when the balances available in the SDRF are not adequate for meeting relief expenditures. It is replenished through a surcharge on certain central taxes. The Thirteenth Finance Commission had recommended the use of NDRF for “calamities of severe nature,” this fund is used to meet the expenditure on all natural calamities as recommended by Finance Commissions from time to time, where relief expenditure exceeds the amount balance in the SDRF.

The Ministry of Finance (Department of Expenditure), Government of India releases assistance from both the SDRF and NDRF. The SDRF is released to all the States in normal course, irrespective of its level of relief expenditure, while the NDRF funds are released when the States make specific requests, following a well-laid out procedure.

Administration of SDRF

The State Government needs to take following steps for the administration of SDRF:

- Check the opening balance of the SDRF in the beginning of the financial year. All money that remains unspent at the end of preceding financial year is shown as the opening balance in the next financial year.
- Submit an utilization certificate for the amount spent through the SDRF, well in time so that the SDRF allocations are released twice in year.
- Get the SDRF expenditures audited through the Office of Accountant-General. These audit reports must be submitted to the Ministry of Home Affairs, Government of India.

Release of NDRF Funds

- Whenever a State faces a calamity of severe nature and the expenditure from the SDRF exceeds its existing balance, a request is made to the Government of India for release of funds from the

NDRF. For drought, hailstorm, pest-attack and cold wave/frost, the request is made to the Ministry of Agriculture and Farmers Welfare and for other identified natural calamities, the Ministry of Home Affairs has the necessary jurisdiction.

- The State Government submits the request for release of NDRF funds through a Memorandum. A Memorandum is an important representation of the State Government, providing detailed information on the geographical extent and severity of drought, losses and damages in all the sectors, relief needs, and the request for assistance from the NDRF.
- A Memorandum needs to be a balanced document, objectively describing the drought situation, assessing the impact and estimating the relief needs. The structure and template for preparation of a Memorandum is included in **Annexure 4**.
- The State Government should submit the Memorandum to the Ministry of Agriculture and Farmers Welfare only after declaring drought.
- After the State Government declares drought and submits the Memorandum, the Ministry of Agriculture sends an Inter-Ministerial Central Team (IMCT) to the concerned State for making an assessment of the drought situation. This team consists of officials from different Central Government Ministries/Departments, such as Agriculture, Animal Husbandry, Food, Rural Development, Power, Drinking Water, NITI Aayog, Finance, Home etc.
- The team carries out extensive visits of drought-affected areas in the State during which it is expected to assess ground level situation pertaining to crop damage, drinking water, fodder shortage etc., meet local officials, farmers, PRI members, women's groups, etc.
- The team then submits a report to the Ministry of Agriculture and Farmers Welfare immediately after conclusion of its visit. The report should provide an assessment of the drought situation in terms of severity, geographical spread, impact on agriculture, availability of water, food, and fodder.
- In the report, the team makes a recommendation for NDRF assistance in accordance with the SDRF guidelines. The recommendation needs to be clear, precise and objective and in consonance with the SDRF / NDRF norms for assistance.
- The report of the team is considered by Sub Committee of the National Executive Committee (SC-NEC) which is an Inter-Ministerial Committee chaired by the Secretary, DAC&FW (Government of India) and recommendation made on the quantum of assistance from the NDRF.
- The SC-NEC recommendation is considered by a High-Level Committee (HLC), consisting of the Union Home Minister, Union Finance Minister, Union Agriculture Minister and Vice Chairman, NITI Aayog. The HLC is chaired by the senior-most Union Cabinet Minister.
- After the HLC decision on the SC-NEC recommendation, funds from the NDRF are released by the Department of Expenditure on the advice of the MHA after adjusting for the existing balance in the SDRF.

Development Programmes for Drought Relief

- In addition to the SDRF and NDRF, the Central and State Governments need to take advantage of centrally sponsored schemes etc., which permit use of 10% of the allocation as flexifunds to be used for drought mitigation.

- The MGNREGS, National Rural Drinking Water Programme, water conservation programmes can play an important role in drought relief.
- All districts covered through these programmes need to be directed about using these programmes for generating employment in the drought-affected areas and building assets, such as tanks and wells, which can reduce the impact of drought.
- At the State and district levels, water supply schemes, regular schemes for fodder cultivation and agriculture can be used for supporting various measures of drought relief.
- The State Governments need to monitor Crop Insurance Schemes effectively especially in vulnerable districts.

Monitoring Drought Expenditures

- The State Government should monitor their drought expenditures regularly. Such monitoring mechanisms should consist of monthly expenditure statements, utilization certificates and internal and external audits.

The district administration must provide monthly expenditure statements on various relief measures in a format prescribed by the Government.

The district administration and implementing departments / agencies should submit utilization certificates for the amount released for drought relief. Further releases should not be made until the utilization certificate is provided.

The State Government needs to organize concurrent audit of expenditures through its internal audit wings so that course corrections can be applied on expenditures for various relief measures.

Information on drought relief expenditures can be submitted in Form No. 12, included in **Annexure 1**.

INFORMATION MANAGEMENT AND MEDIA COORDINATION

- State Drought Monitoring Centre shall provide information on a proactive basis to the Government.
- The Central and State Governments should provide information on all aspects of drought to the people and media as and when necessary.
- The State Government should develop a Drought Management Information System (DMIS) covering different aspects of drought management.
- DMIS for drought should include information upon key indicators of drought and important interventions for relief. DMIS should be updated on a regular basis.
- Secretary, Disaster Management / Relief Commissioner should consider submitting reports on the drought situation to the State Government/SEC. Form No. 12, included in Annexure 1, can be used for preparing such a report.
- Secretary, Disaster Management / Relief Commissioner should consider documentation of the drought management efforts for guidance in dealing with future droughts.
- State Governments may set up helpline desk to provide information to all the concerned. State Governments could also make use of the Kisan Call Centres (KCCs) and M-Kisan portal of DAC&FW for communicating audio/text messages and advisories to farmers in drought affected areas. Audio conferencing of experts with the farmers registered with KCCs and M-kisan portal also could be considered. The State Governments could consider training the Farm Tele Advisors of KCCs so as to enable them to render proper advice and suggestions to the farmers in the drought affected areas.

Coordination with Media

- Sharing information with print, radio and television media, is an important aspect of drought management.

Usage of latest ICT technologies for out reach to farmers through Social Media and specially designed Apps and platforms like Facebook/Whatsapp to send recorded short videos/audio messages etc could also be considered by the State Governments, depending on the level of reach/ accessibility of the farmers in the areas.

Drought Impact Assessment and evaluation of Response System

States need to take up "Drought impact assessment and evaluation of response system". It is suggested to take up enumerative sample based house hold surveys with properly designed questionnaires and capture the impact of drought and evaluate the response system. The information available through various drought indices need to be considered in generating random sample for inventory.

The impact assessment and evaluation of response system is suggested to be taken up as a follow up for every event of drought declaration event in the State.

The studies will bring out community expectations vis a vis the interventions taken up as relief measures and help in tuning the programs to meet the local needs to the possible extent. These kind of studies shall be taken up by reputed institutions or experts with domain knowledge.

Crop Insurance

Pradhan Mantri Fasal Bima Yojana (PMFBY):

The PMFBY is a new crop insurance scheme launched by the government from the kharif season of 2016. The scheme is aimed at making crop insurance easier, more meaningful and attractive to the farmers.

The major features of PMFBY are:

- PMFBY will provide a comprehensive insurance cover against failure of the crop thus help stabilize the income of farmers and encourage them in the adoption of innovative practices.
- The Scheme can cover all food & oilseeds crops and annual commercial/ horticultural crops for which past yield data is available and for which requisite number of Crop Cutting Experiments (CCEs) will be conducted as a part of the General Crop Estimation Survey (GCES).
- The scheme is compulsory for loanee farmers obtaining Crop Loan /KCC account for notified crops, but is voluntary for Other/non loanee farmers.
- The Maximum Premium payable by the farmers will be 2% for all Kharif food & oilseeds crops, 1.5% for Rabi food & oilseeds crops and 5% for annual commercial/horticultural crops.
- The difference between premium and the rate of Insurance charges payable by farmers shall be shared equally by the Centre and State.
- The seasonality discipline shall be same for loanee and non-loanee farmers.
- The scheme will be implemented by Agriculture Insurance Company of India (AIC) and other empanelled private general insurance companies. Selection of Implementing Agency (IA) will be done by the concerned State Government through bidding.
- The existing State Level Co-ordination Committee on Crop Insurance (SLCCCI), Sub-Committee to SLCCCI, District Level Monitoring Committee (DLMC) shall be responsible for proper management of the Scheme.
- The Scheme shall be implemented on an 'Area Approach basis'. The unit of insurance shall be Village/Village Panchayat level for major crops and for other crops it may be a unit of size above the level of Village/Village Panchayat.
- The Loss assessment for crop losses due to non-preventable natural risks will be on Area approach.
- In case of majority of insured crops of a notified area are prevented from sowing/planting the insured crops due to adverse weather conditions that will be eligible for indemnity claims upto maximum of 25% of the sum-insured.
- However losses due to localised perils (Hailstorm, landslide & inundation) and Post-Harvest losses due to specified perils, (Cyclone/Cyclonic rain & Unseasonal rains) shall be assessed at the affected insured field of the individual insured farmer.

- Three levels of Indemnity, viz., 70%, 80% and 90% corresponding to crop Risk in the areas shall be available for all crops.
- The Threshold Yield (TY) shall be the benchmark yield level at which Insurance protection shall be given to all the insured farmers in an Insurance Unit Threshold of the notified crop will be moving average of yield of last seven years excluding yield upto two notified calamity years multiplied by Indemnity level.
- In case of smaller States, the whole State shall be assigned to one IA (2-3 for comparatively big States). Selection of IA may be made for at least 3 years.
- The designated / empanelled companies participating in bidding have to bid the premium rates for all the crops notified / to be notified by the State Govt. and non-compliance will lead to rejection of company's bid.
- Crop Cutting Experiments (CCE) shall be undertaken per unit area /per crop, on a sliding scale, as prescribed under the scheme outline and operational guidelines. Improved Technology like Remote sensing, Drone etc. will be utilised for estimation of yield losses.
- State governments should use Smart phone apps for video/image capturing CCEs process and transmission thereof with CCE data on a real time basis for timely, reliable and transparent estimation of yield data
- The cost of using technology etc. for conduct of CCEs etc. will be shared between Central Government and State/U.T. Governments on 50:50 basis.
- There will be a provision of on account claims in case of adverse seasonal conditions during crop season viz. floods, prolonged dry spells, severe drought, and unseasonal rains.
- On account payment upto 25% of likely claims will be provided, if the expected yield during the season is likely to be less than 50% of normal yield.
- The claim amount will be credited electronically to the individual Insured Bank Account.
- Adequate publicity needs to be given in all the villages of the notified districts/ areas.

State Governments need to participate in these PMFBY and ensure that the insurance coverage increases to 50% of farmers. Farmers need to be informed about the availability of insurance products and educated about the need for managing their yield and income risks by getting insurance coverage. As the coverage of agricultural insurance in the country increases, insurance schemes for drought protection would become more viable.

DROUGHT PREPAREDNESS AND RESPONSE CHECKLIST

for Relief Commissioner and District Collector

Activate State / district disaster management authorities: Following action points need to be checked upon the occurrence of a drought situation:

- Convene meetings of State / district disaster management authorities to review measures in line with the Crisis Management Plan.
- Review measures activated as per District Agriculture Contingency Plans.
- Operationalisation of Drought Monitoring Centre and monitoring of key indicators of drought, especially in vulnerable districts.
- Preparation for the declaration of drought.
- Revenue Relief Commissioner / District Collector in active consultation with all participating of departments strategy and contingency plan for drought management developed by
- Set up a control room for drought management.
- Review contingency plans of all departments/ agencies.
- Prepare and submit Memorandum to the Government of India for assistance from the NDRF.
- Effect early litigation of funds made available from SDRF/NDRF

Activity	Agencies	Indices to be monitored:	Drought relief measures to be organized:
Monitoring Water Sources:	Departments of revenue, irrigation, water supply and water conservation	Daily, weekly and monthly rainfall, groundwater sources, water storage levels in reservoirs/ ponds/ lakes	Reservation orders have been issued for drinking water. Water is being equitably distributed for multiple purposes: drinking, commercial, industrial and agricultural. Temporary water supply schemes have been sanctioned. Supply of drinking water is being organized through tankers/bullock carts/trains. A ban on digging deep bore-wells has been enforced
Crop Management:	State departments of agriculture and revenue, State agricultural universities	Soil moisture, area under sowing and type of crop, status of growth, crop yield, alternative cropping possibilities	Seeds for second sowing have been secured and supplied. A crop contingency plan (less-water consuming, drought-resistant crops) has been developed. Crop insurance premium has been paid by the Government. Micro-irrigation equipments (sprinkler and drip irrigation systems) are available to the farmers for using water optimally

<p>Fodder Management:</p>	<p>State departments of animal husbandry, agriculture and revenue</p>	<p>Availability of fodder, fodder prices, fodder cultivation, availability of water for fodder cultivation.</p>	<p>Supply of fodder increased through getting fodder from surplus States/ districts. Coordination mechanism set up with the forest department and agricultural university. Farms to get surplus fodder. Fodder cultivation encouraged and incentives provided through Government schemes. Ban imposed on taking fodder from the State. Fodder depots set up and the prices fixed at levels, which farmers can buy. Cattle camps set up through the Government, NGOs and cooperative societies. Water supply arranged for cattle camps. Vaccination and other health measures organized for cattle.</p>
<p>Relief Employment</p>	<p>Department/ agencies implementing the National Rural Employment Guarantee Scheme (NREGS) and other schemes such as Pradhan Mantri Gram Sadak Yojana (PMGSY) and Swaranjayanti Gram Swarozgar Yojana (SGSY):</p>	<p>Demand for relief employment, number of relief works on shelf, number of works in progress, attendance of workers, wages distributed</p>	<p>Demand for relief employment assessed. Job cards available with the people. Relief employment plan prepared in consultation with the agencies. Number of sanctioned works available on shelf. People informed of their rights and entitlements under the MGNREGS. Relief works started in response to the people's demands. All the amenities organized on the sites of relief works. Distribution of wages supervised to ensure it is timely and fair. Attendance on relief works reported on a daily/ weekly/ monthly basis.</p>
<p>Food security</p>	<p>Food and Civil Supplies Corp./ Dept. of State Govt or District Admn., Food Corporation of India (FCI)</p>	<p>Availability of foodgrains in the open market; Sufficient availability of foodgrains in FCI godown for distribution through PDS; Timely lifting of foodgrains by State Govts and its delivery to Fair Price Shops; Hassel-free and timely distribution of foodgrains to beneficiaries</p>	<p>State Government to launch drive to cover left out eligible households/members; State Government to launch drive against hoarding of foodgrains; Timely availability of foodgrains at fair price shops; Efficient and timely distribution of foodgrains for ration card holders; Efficient distribution of additional foodgrains, if any, allocated for drought relief.</p>

<p>Distribution of Relief Assistance:</p>	<p>State revenue and agriculture departments</p>	<p>Funds available through SDRF and NDRF, funds allocated for distribution of input subsidy, distribution of input subsidy and gratuitous relief</p>	<p>Seeds stock available for distribution among the farmers Enough seeds available in the open market for agricultural operations Tie-up with seeds corporations arranged. Information on the cultivable areas affected by drought collected. Information on small and marginal farmers' land holding available. Request submitted to the Government of India for NDRF assistance. Financial assistance made available to the farmers for purchasing inputs. Financial assistance made available for distribution of relief assistance Financial assistance made available through bank transfer.</p>
---	--	--	---

CHAPTER-5

DROUGHT MITIGATION



The containment and mitigation of the crippling impact of drought, and the eventual attainment of the objective of drought proofing of an area is contingent upon a proactive and relentless, but planned pursuit of a combination of structural / physical and non-structural long and short term measures. The short term measures are mostly reactive or relief centric in nature and mostly relate to in-season drought management through contingency planning and relief distribution. Long term mitigation measures are geared towards the adaptation to climate change, restoration of ecological balance through adoption of sustainable agronomic and conservation practices, sensible crop choices etc. Most of these measures are translated on the ground through soil and water conservation, watershed management, agronomic practices suited to rainfed agriculture and forestry programmes that seek to integrate soil, water and forestry management in an ecological compliant and sustainable manner.

Drought mitigation needs to be ensconced in the regular development programmes of the Centre and State Governments. Some of the most significant current national programmes that may have a decisive bearing on drought mitigation are Pradhan Mantri Krishi Sinchayee Yojna, National Rainfed Area Development Programme, National Rural Drinking Water Programme etc. Many of these programmes can be guided towards the development of a cogent drought mitigation strategy at the State level by taking advantage of the flexibility which has been in-built into the centrally sponsored schemes for the purposes of mitigation of calamities like drought.

Current Drought Mitigation Programmes

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'More crop per drop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities. The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was approved by the Central Government in 2015-16.

PMKSY has been formulated as an umbrella scheme amalgamating ongoing schemes viz. Accelerated Irrigation Benefits 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, Cooperation & Farmers Welfare (DAC&FW). The Ministry-wise activities are presented in Table 1.

The major objective of PMKSY is to achieve convergence of investments in major and medium irrigation projects with command area development to provide 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), scientific and sustainable development of watersheds, enhance recharge of aquifers and introduce sustainable water conservation practices and attract greater private investment in precision irrigation system.

District Irrigation Plans (DIPs) shall be the cornerstone for planning and implementation of PMKSY. DIPs will identify the gaps in irrigation infrastructure after taking into consideration the District Agriculture Plans (DAPs) already prepared for Rashtriya Krishi Vikas Yojana (RKVY) vis-à-vis

irrigation infrastructure currently available and resources that would be added during XII Plan from other ongoing schemes (both State and Central), like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Rashtriya Krishi Vikas Yojana (RKVY), Rural Infrastructure Development Fund (RIDF), Member of Parliament Local Area Development (MPLAD) Scheme, Member of Legislative Assembly Local Area Development (MLALAD) Scheme, Local body funds etc. The gaps identified under Strategic Research & Extension Plan (SREGP) will be made use in preparation of DIP.

DIPs will present holistic irrigation development perspective of the district outlining medium to long term development plans integrating three components viz. water sources, distribution network and water use applications incorporating all usage of water like drinking & domestic use, irrigation and industry. Preparation of DIP will be taken up as joint exercise of all participating departments. DIP will form the compendium of all existing and proposed water resource network system in the district.

The DIPs may be prepared at two levels, the block and the district. Keeping in view the convenience of map preparation and data collection, the work would be primarily done at block level. Block wise irrigation plan is to be prepared depending on the available and potential water resources and water requirement for agriculture sector prioritising the activities based on socio-economic and location specific requirement. In case planning is made based on basin/sub basin level, the comprehensive irrigation plan may cover more than one district. The activities identified in the basin/sub-basin plan can be further segregated into district/block level action plans. Use of satellite imagery, topo sheets and available database may be appropriately utilised for developing irrigation plans at least on pilot basis to begin with and subsequently may be extended to all projects.

State Level Sanctioning Committee (SLSC) chaired by the Chief Secretary of the respective States are authorized to sanction projects, oversee its implementation and monitoring. National Executive Committee (NEC) under the Chairmanship of Vice Chairman, NITI Aayog will oversee programme implementation, allocation of resources, inter-ministerial coordination, monitoring & performance assessment, addressing administrative issues. At National level, programme is to be supervised and monitored by an Inter-Ministerial National Steering Committee (NSC) under the Chairmanship of Hon'ble Prime Minister with Union Ministers of concerned Ministries as a Member.

Table 1. Components and Responsibilities of Various Ministries (Source: pmksy.gov.in)

S.N.	Components	Illustrative Activities
1	AIBP by MoWR,RD&GR	<ul style="list-style-type: none"> To focus on faster completion of ongoing Major and Medium Irrigation including National Projects

2	PMKSY (Har Khet ko Pani) by MoWR,RD&GR	<ul style="list-style-type: none"> • Creation of new water sources through Minor Irrigation (both surface and ground water) • Repair, restoration and renovation of water bodies; strengthening carrying capacity of traditional water sources, construction rain water harvesting structures (Jal Sanchay); • Command area development, strengthening and creation of distribution network from source to the farm; • Improvement in water management and distribution system for water bodies to take advantage of the available source which is not tapped to its fullest capacity (deriving benefits from low hanging fruits). At least 10% of the command area to be covered under micro/ precision irrigation. • Diversion of water from source of different location where it is plenty to nearby water scarce areas, lift irrigation from water bodies/rivers at lower elevation to supplement requirements beyond IWMP and MGNREGS irrespective of irrigation command. • Creation and rejuvenation of traditional water storage systems like Jal Mandir (Gujarat); Khatri, Kuhl (H.P.); Zabo (Nagaland); Eri, Ooranis (T.N.); Dongs (Assam); Katas, Bandhas (Odisha and M.P.) etc. at feasible locations.
3	PMKSY (Watershed) by Dept. of Land Resources, MoRD	<ul style="list-style-type: none"> • Water harvesting structures such as check dams, nala bund, farm ponds, tanks etc. • Capacity building, entry point activities, ridge area treatment, drainage line treatment, soil and moisture conservation, nursery raising, afforestation, horticulture, pasture development, livelihood activities for the asset-less persons and production system & micro enterprises for small and marginal farmers etc. • Effective rainfall management like field bunding, contour bunding/ trenching, staggered trenching, land levelling, mulching, etc.
4	PMKSY(Per drop more crop) by Dept. of Agriculture, Coop. & FW& Cooperation, MoAFW	<ul style="list-style-type: none"> • Programme management, preparation of State/District Irrigation Plan, approval of annual action plan, Monitoring etc. • Promoting efficient water conveyance and precision water application devices like drips, sprinklers, pivots, rain-guns in the farm (JalSinchan); • Topping up of input cost particularly under civil construction beyond permissible limit (40%), under MGNREGS for activities like lining inlet, outlet, silt traps, distribution system etc. • Construction of micro irrigation structures to supplement source creation activities including tube wells and dug wells (in areas where ground water is available and not under semi critical /critical /over exploited category of development) which are not supported under PMKSY (WR), PMKSY (Watershed) and MGNREGS. • Secondary storage structures 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; • Water lifting devices like diesel/ electric/ solar pumpsets including water carriage pipes.

		<ul style="list-style-type: none"> • Extension activities for promotion of scientific moisture conservation and agronomic measures including cropping alignment to maximise use of available water including rainfall and minimise irrigation requirement (Jalsarankchan); • Capacity building, training for encouraging potential use water source through technological, agronomic and management practices including community irrigation. • Awareness campaign on water saving technologies, practices, programmes etc., organisation of workshops, conferences, publication of booklets, pamphlets, success stories, documentary, advertisements etc. • Improved/innovative distribution system like pipe and box outlet system with controlled outlet and other activities of enhancing water use efficiency. • Implementation of Watershed projects with the help of dedicated institutions with multi-disciplinary professional teams (State, District and project levels) and active participation of Gram Sabha, Watershed Committee, Self Help Groups and User Groups right from planning execution and monitoring. • Use of information technology, remote sensing techniques, GIS facilities, with spatial & non-spatial data in scientific planning, implementation, monitoring and evaluation of watershed project. The Ridge to Valley approach is followed while planning rainwater harvesting structure for sustainability and efficiency. • Renovation and repair of existing water harvesting structures in the project areas.
--	--	---

Using geospatial technologies viz., satellite remote sensing, geographic information systems, global positioning systems, and mobile technology etc. many critical parameters of watersheds such as their delineation, silting and monitoring the water harvest structures, including their impact could be well addressed. At NRSC (ISRO), the monitoring of watersheds using geo-spatial technologies is being carried out as per the guidelines of the PMKSY. These products and services are helpful in decision making on the action plans towards drought mitigation.

National Rainfed Area Programme

The objective of the programme is to increase agricultural productivity in rainfed areas in a sustainable manner by adopting appropriate farming system based approaches, minimize adverse impact of possible crop failure due to drought and other calamities through diversified and composite farming system etc.

The National Rainfed Area Authority (NRAA) in the Department of Agriculture, Cooperation & Farmers Welfare an advisory body for policy and programme formulation and monitoring of schemes / programmes related to degraded land development for horticulture and integrated agricultural development in rainfed areas. The Central Government approved the involvement of NRAA for providing technical inputs in policy planning, implementation and monitoring of PMKSY especially in the areas of rain water conservation / watershed development and its management including other agricultural and allied sectors.

Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)

Considering the importance of water conservation, and given all the scientific and technological advances at their command, the Ministry of Rural Development in consultation and agreement with the Ministry of Water Resources, River Development & Ganga Rejuvenation and the Ministry of Agriculture and Farmers Welfare has developed an actionable Framework to ensure that MGNREGS funds are used in accordance with the best practices in the sector.

The need for drought proofing villages in water stressed blocks was being felt for many years. Many State Governments have started excellent initiatives for water conservation in last few years using Mahatma Gandhi NREGA funds viz. the 'Mukhyamantri Jal Swalamban Abhiyan' in Rajasthan, the 'Dobha' or Farm Ponds construction in Jharkhand, the 'Mission Kakatiya' in Telangana. 'Neeru Chettu' in Andhra Pradesh, 'Kapil Dhara' in Madhya Pradesh, bore well recharge in Karnataka, 'Jalyukt Shivar' in Maharashtra are some of the recent initiatives. The present Framework draws on many of the good practices in these States and some other initiatives.

The Framework strives to leverage the synergies between Mahatma Gandhi NREGA, Pradhan Mantri Krishi Sinchayee Yojana, IWMP and Command Area Development & Water Management programmes, given their common objectives. Types of common works undertaken under these programmes/ schemes are water conservation and management, water harvesting, soil and moisture conservation, groundwater recharge, flood protection, land development, Command Area Development & Water Management (CAD&WM). These programmes were addressing the above mentioned activities with their own set of planning tools, processes, technical expertise and financial resources which is now envisioned to be used in coordination to bring the advantages of each programmes/ schemes to strengthen a concerted action for water conservation and management.

The highlights of the Frameworks are:-

- **Paradigm shift from Relief Works approach to Integrated Natural Resource Management (INRM) approach in implementation of MGNREGS.**
 - Planned and systematic development of land and harnessing of rainwater following watershed principles to become the central focus of MGNREGS works.
 - All lands falling under the watershed will be developed on ridge to valley treatment principle.
 - Individual works (including work on private land) will be logically sequenced and packaged together on the principles of INRM, to form projects following the principles of watershed management in an integrated manner.
 - Systematic identification, planning and implementation of projects leading to creation of sustainable and productive assets for the community.
- **District as synergizing unit for convergent planning under the leadership of the District Collector.**
 - With the convergence of the ongoing schemes in the area, a comprehensive project of village/ watershed/ command area, incorporating/ integrating all the works/ activities required for the integrated development of the village/ watershed/ CAD approach is to be prepared.

- Support of institutions like IITs, NIITs, Agricultural Universities, State technical institutions, professionals sourced as part of Corporate Social Responsibility and Universities as a part of the 'Unnat Bharat Abhiyan' to be promoted.
- The DPC to ensure that the **Natural Resource Management component of Labour Budget of Mahatma Gandhi NREGS is essentially made part of the District Irrigation Plan (DIP).**
- **Technical inputs from the joint pool of IWMP in Watershed Cell cum Data Centre, Mahatma Gandhi NREGA unit, Water Resource Department, the Agriculture department, Regional Office of Central Water Commission (CWC).**
- **Consultation with National Remote Sensing Centre (NRSC), ISRO** to leverage the GIS solution for planning and monitoring for Natural Resource Management.
- **Community based participatory planning and creation of sustainable livelihoods** by involving the Self Help Groups (SHGs) under National Rural Livelihood Mission (NRLM) in the planning and implementation of watershed projects under Mahatma Gandhi NREGS.
- **Ratification by the Gram Panchayat(s) for shelf of projects.**

Under Mahatma Gandhi NREGA, 153 works are permissible of which 100 relate to NRM alone (of which 71 are water related works). Refer Annexure I

As per the list provided by Central Ground Water Board, 112 districts from 13 states are categorised as most 'Irrigation Deprived' Districts. Due to over utilisation of ground water, 1068 blocks (from 18 States) and 217 blocks (from 17 States) categorised as 'Over Exploited Blocks and Critical Blocks' respectively.

In upcoming years i.e. FY 2017-18 and onwards, focus will be given to these 'Irrigation Deprived' districts and 'Water Stressed' Blocks.

Technological support will be taken from National Remote Sensing Centre, ISRO for identification and planning of watersheds and monitoring of each and every activity undertaken and missed out. Central Ground Water Board is storehouse of information related to groundwater resource and have technical expertise available at regional/ State level on designs and structures suitable/ required for water stressed blocks based on their geomorphological and climatic zone.

Creation of sustainable livelihoods is one of the desired outputs of NRM/ IWMP works; hence, the Self Help Groups (SHGs) under NRLM will be closely involved in the planning and implementation of watershed projects under Mahatma Gandhi NREGS. The Mahila Kisan Sashaktikaran Pariyojna farmers falling under these areas shall be linked on priority basis.

Watershed management works can be taken up independently under MGNREGA where there is no IWMP project sanctioned/proposed and in convergence with IWMP- wherever IWMP project is already sanctioned and proposed (new IWMP Projects).

The comprehensive watershed plan shall be prepared in accordance with the concepts of ridge to valley treatment. It is recommended to use the satellite imagery for this planning work. For selection of the appropriate sites and preparing the above plans, the Engineers/Technical Assistants and Mates of MGNREGS at Block and GP level would be trained and supported by the State Level Nodal Agency (SLNA) of IWMP and technical personnel of WCDC, the cost of which would be met by the Administrative cost of MGNREGS. Watershed works will preferably be taken up in cluster approach.

Drought Mitigation measures

The objectives of these mitigation measures are to reduce soil erosion, augment soil moisture, restrict surface run-off of rainwater and improve the efficiency of water use. It involves a wide range of soil and water conservation measures and farm practices.

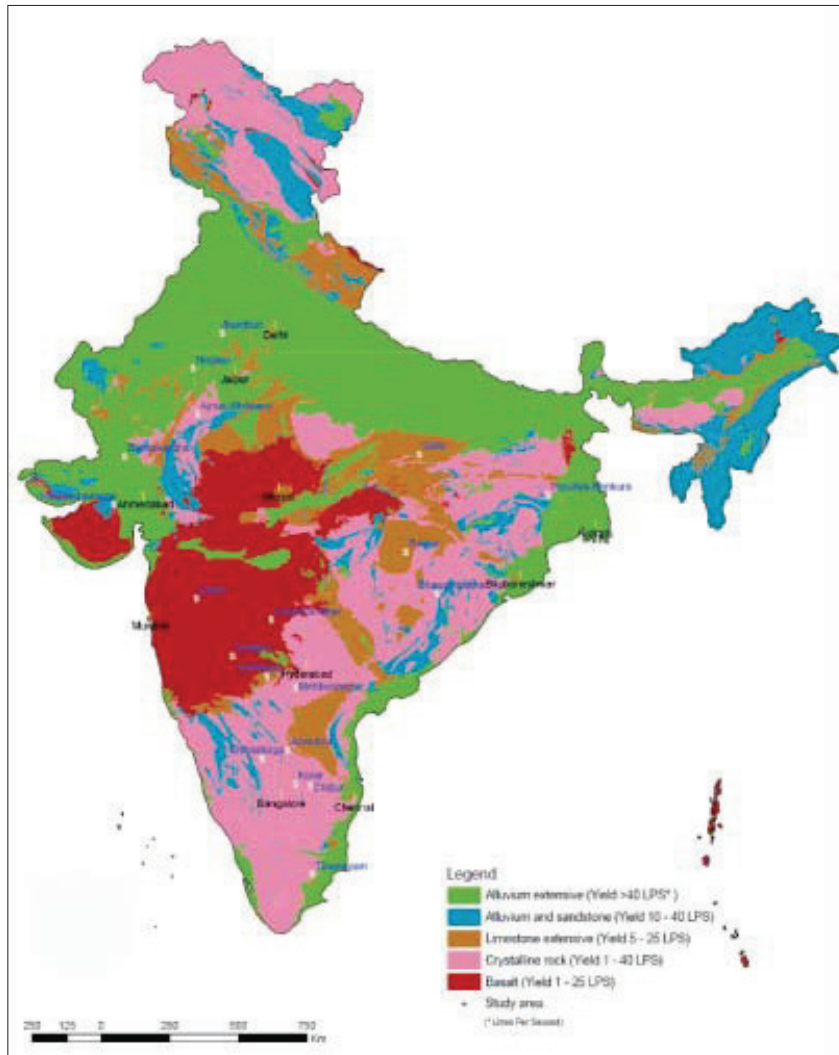
Water Harvesting and Conservation

Water harvesting and conservation refer to processes and structures of rainfall and run-off collection from large catchments area and channelling them for human consumption. In India, these processes and structures have been in existence since antiquity, but the increasing frequency and severity of droughts and population growth have focused on the revival of these practices and structures. Every household's minimum water requirements can be easily met by collecting rainwater locally from village / community ponds / large manmade containers, by diverting and storing water from local streams / springs and by tapping sub-surface water below river / stream beds.

There are two methods for water conservation: (i) artificial recharge of groundwater, and (ii) traditional methods. While the artificial recharge of groundwater is used extensively in all the watershed development programmes being implemented, traditional methods of water collection and harvesting through ponds / tanks are even more important for assuring continuous and reliable access to water. Both methods include measures which are low-cost, community-oriented and environment-friendly. It is necessary for the Government and NGOs working in the area of water conservation to promote both sets of measures, depending on the local conditions.

These methods are considered very useful for groundwater recharge both when rainfall is deficient and when there are flash floods (that result in overtopping of defined courses of rivers / streams and their spreading into flood plains). Harvesting and conservation of floodwater to rejuvenate depleted high-capacity aquifers by adopting integrated groundwater recharge techniques, such as dams, tanks, anicuts, percolation tanks, could improve water availability and create a water buffer for dealing with successive droughts.

Map 8: India's Groundwater Aquifer System



Legend

Alluvium extensive (Yield >40 LPS*) Alluvium and standstone (Yield 10-40 LPS) Limestone extensive (Yield 5-25 LPS) Crystalline rock (Yield 1-40 LPS)

Basalt (Yield 1-25 LPS)

Study area

(* Litre Per Second)

Source: Central Ground Water Board

Artificial Recharge of Ground Water

A typical watershed development programme has several components, depending on the topography (shape, configuration and slope of the land), nature and depth of soil cover, type of rocks and their pattern of formation and layout, water absorbing capacity of land, rainfall intensity and land use. These include the following:

Contour Bunding

Contour bunding is one of the most widely practised soil and water conservation measures, which controls erosion, conserves moisture, recharges groundwater and prevents silting of tanks and reservoirs in the downstream. The practice comprises constructing narrow-base bunds on contour to impound runoff water behind them, so that impounded water is absorbed gradually into the soil profile.

Contour bunding works are undertaken in shallow and medium soils. An area extending from the ridge-line (topmost line) to the valley-line (lowest line) is called a catchment. For a bunding project, a self-defended catchment (i.e. the topmost end of the catchment in the selected area is such that no water from outside the catchment drains into it) is selected. In the selected catchment, bunds are constructed on contours. The bunds are normally impounded upto a height of 30 cm. The spacing of the bund is decided based on the slope of the land and the nature of the soil. For gently sloping lands, with 2–3% slope, the bunds are nearly 200 feet apart. The section of a bund is also dependent on the value of the soil. In light soil, the section is 10 square feet, whereas in medium soil it is 24 square feet. About 25 mm of rainwater could be stored at a soil depth of 130–150 mm for growing crops. On average, contour bunds had 27% higher soil moisture and 14–180% higher yield than flat surfaces.

Contour Trenching

This consists of excavating shallow / intermittent trenches across the land slope and forming a small earthen bund on the downstream side. Plantation is done on the bund to stabilize the bund. The trenches retain the runoff and help in the establishment of plantations made on the bund.

Trenches are useful where the land surface is fairly porous. Rainwater that gets collected in the trenches can quickly percolate into the ground. The spacing of trenches and their size (i.e. length, width and depth) should be adequate to intercept about 50% of the peak rainfall in semi-arid regions (annual rainfall of about 400–550 mm). The trenches should be cleaned and desilted periodically.

Contour Cultivation

Contour operations are done across the slope by cultivating crops and trees on the contour. The contour furrows created would form a multitude of mini barriers across the flow path of the runoff. Contour cultivation remains the most effective on moderate slopes of 2–7%. The water in the furrows gets collected in the depressions. Perennial grasses can be grown in such depressions. Another practice called strip cropping involves growing parallel rows of erosion-resistant crops to control loss of surface soil, with other crops grown in between.

Bench Terracing

Bench terracing is practised on steep hilly slopes where agriculture has replaced natural forest and grasslands since a long time. Thus, further reduction in slope length would reduce the intensity of runoff water. Bench terracing involves converting the original ground into level step-like fields constructed by half cutting and half filling, which reduces the degree of the slope. This approach of bench terracing for agro-forestry models is gradually becoming popular in the hilly areas of Nilgiris, north-east India and Himachal Pradesh.

Graded Bunding

Graded bunds are constructed in relatively high rainfall areas. The excess water has to be removed out of the field to avoid water stagnation, especially in deep black soils. These bunds are outlets for safe removal of water. The channels of graded bunds are wide and shallow.

Gully plugging

Gully plug, as the name implies is a small conservation structure across small gullies and streams in hilly areas to slow the run-off of the flowing water. Gullies result from functional disorder of the land, improper land use and are the most visible result of severe soil erosion. They are small drainage channels, which cannot be easily crossed by agricultural equipment. Gully plugging measures include vegetative plantings and brushwood check dams, boulder bunds, brick masonry and earthen bunds or a combination of both and sand bag plugs.

Check Dams / Nalla Bunding Construction

Check dam / nalla bunding work consists of construction of a masonry embankment across a stream or nalla with surplussing arrangement (waste weirs, at suitable intervals).

These works are undertaken to hold maximum runoff water to create temporary flooding in the stream with arrangements to drain water at suitable intervals. Such embankments depend on the slope of the nalla or off-stream and the quantity of water expected to flow. The impounding of water facilitates percolation of water into deeper soil and makes it possible to bring under cultivation the land under the bed of the nallas. The water released from these bunds is free from silt and very low in velocity and thus unable to cause erosion. Thus, water can be utilized optimally.

Gabion Structure

This is a commonly constructed check dam across small streams to conserve stream flows with practically no submergence beyond the stream course. Locally available boulders are stored in a steel wire. This is put up across the stream's mesh to make a small dam by anchoring it to the streamside. The height of such structures is around 0.5 m and is normally used in 10–15 m wide streams. The cost of such structures is around Rs.10,000–15,000. The excess water overflows from this structure storing some water in reserve which serves as a source of recharge. The silt content of stream water in due course is deposited in the interstices of the boulders to make it more impermeable. These structures are common in Maharashtra, Madhya Pradesh and Andhra Pradesh.

Stream Bank Protection

Eroding stream banks not only damage adjoining agricultural lands but also contribute large quantities of sediment load to the river systems. Under the watershed management programme, bank protection of only small / minor streams is included. However, works of this nature should only be taken up if the benefits justify the cost of construction.

The works usually involved are that of boulder pitching on banks of about 20–30 cm thickness after dressing the bank to a stable slope. Where the flow velocity of the stream is high (1.5 m/sec or more) gabion structures should be built at the toe of the bank with the foundation firmly embedded in the streambed and bank.

Farm Ponds

In any watershed management programme farm ponds are an important component and useful in storing water for irrigation. They also retard sediment and flood flows to the downstream river system. In a relatively flat terrain with good soil cover, a farm pond has an earth section with usually 3:1 side slopes on the waterside and 2:1 side slopes on the downstream face (a uniform side slope of 2½:1 on both sides can be adopted at some sites). The sides are sodded. A natural depression nearby should be used as an earthen spillway with minimum channel section construction. A pipe drop inlet spillway and an irrigation outlet are also provided. A key trench is dug to provide good bondage between the original ground and the filled earth. Storm riprap against wave action may be required in some cases. The pond crest usually serves as a farm road (provide 4.25 m roadway for motorable roads).

A good pond site should possess the following traits:

- The site for the earthen bund should be a narrow gorge with a fan shaped valley above so that a small amount of earthwork provides large storage.
- The drainage area above the pond should be large enough to fill the pond in 2 or 3 spells of good rainfall.
- The pond location should be near where the water is to be used; e.g. for irrigation, it should be above the irrigated fields and for sediment control it should intercept the flow from the most erodible parts of the catchment.
- The junction of two drainage channels or large natural depressions should be preferred.
- The land surface should not have excessive seepage losses unless it is meant to serve as a percolation tank for groundwater recharge.

Percolation Tanks (PT) / Spreading Basin

One of the effective measures by which groundwater recharge can be achieved, is by the construction and use of percolation tanks. The efficacy and feasibility of percolation tanks is better established in hard rock formation where the rocks are highly fractured and weathered.

In Maharashtra, Andhra Pradesh, Madhya Pradesh, Karnataka and Gujarat, numerous percolation tanks are constructed in basaltic lava flows and crystalline rocks.

Percolation tanks are constructed for very small catchments up to 10–12 sq. km., where minor irrigation schemes, bandharas or other storage schemes are not technically and economically feasible. Percolation tank schemes are intended mainly for recharging aquifers and improving the groundwater supply to the wells for drinking water and irrigation. In comparison to ponds, percolation tanks conserve water to a greater extent because the filling and recharge occur mostly during the monsoons when the evaporation rate is about the half of the potential rate in summer through which ponds contain water. Selection of a suitable site for the construction of percolation tanks and subsequent maintenance is crucial for its effective functioning. Where hydro-geological conditions are favourable, percolation rates may be increased by constructing recharge (intake) wells within percolation tanks.

Important Aspects of Percolation Tanks

- A detailed analysis of the rainfall pattern, number of rainy days, dry spells, evaporation rate and detailed hydro-geological studies are required to demarcate suitable percolation tank sites.
- For India's semi arid climate, the storage capacity of the percolation tank needs to be designed so that water percolates to the groundwater reservoir by January since the evaporation losses would be high subsequently.
- Percolation tanks should normally be constructed on second-to-third order streams as the catchment as well as the submergence area would be smaller. The submergence area should be in uncultivable land as far as possible.
- Percolation tanks should be located on highly fractured and weathered rock for speedy recharge. In case of alluvium, bouldary formations are ideal for locating percolation tanks.
- The benefited area should have sufficient number of wells and cultivable land to develop the recharged water.
- Detailed hydrological studies for run off assessment should be done and design capacity should not normally be more than 50% of the total quantum of rainfall in the catchment.
- Waste weir or spillway should be suitably designed to allow the flow of surplus water based on single day maximum rainfall after the tank is filled to its maximum capacity.
- Cut off trench should be provided to minimize seepage losses both below and above the stream bed. To avoid erosion of the embankment due to ripple action, stone pitching should be provided upstream up to HFL (High Flood Line).

Anicuts

An anicut is a small water harvesting masonry dam constructed across a stream to hold sufficient water and submerge the upstream area during the rainy season. The height of the anicut above ground level is about 22 feet. Anicuts are built to serve many purposes among which, recharge of groundwater in adjacent wells, providing water for consumption for animals, for bathing and providing a reservoir of water in water- scarce years, are critical. If the submerged area is large, bed cultivation is practised using the stored soil profile moisture.

Anicuts are constructed all over the country and are considered very useful in those States where droughts are very common. Anicut construction can be undertaken on a large-scale to seek community participation in watershed development and make them self-reliant in water resource use.

Sub-surface Barriers

A sub-surface barrier is the most suitable artificial structure for promoting groundwater recharge. Since it is constructed below the riverbed on impervious subsurface strata, the structure is secure from floods, does not need elaborate overflow arrangements or periodic desilting and has limited evaporation. In addition, sub-surface structures do not require extensive areas of land for their implementation and hence have minimal ecological repercussions following their construction.

The construction of a sub-surface barrier needs a concrete or brick masonry wall, 30–60 cm wide, extending down to the impermeable / compact basement. A sub-surface barrier should also be constructed with angular rock pieces arranged in the form of a 100 cm wide dry masonry wall or with a 250-micron polyethylene sheeting, properly embedded in the soil. Some arrangement for sub-surface outflow from the dyke is often desirable to avoid water-logging.

Two sub-surface dykes of 100 m length each, within 300 m upstream and downstream of the water supply well, can capture and infiltrate enough water to service potable water requirements of a village with a population of up to 500.

Injection Wells

Injection wells are structures similar to a tube well but with the purpose of augmenting the groundwater storage of a confined aquifer by pumping in treated surface water under pressure. Injection wells are advantageous where land is scarce.

Hydraulically, the effective induction of water in an injection well is determined by the pumping rate, permeability of the aquifer, distance from the stream, natural groundwater gradient and the type of well.

In alluvial areas, an injection well for recharging a single aquifer or multiple aquifers can be constructed on a normal gravel packed pumping well. An injection pipe with an opening against the aquifer to be recharged may be sufficient. However, if there are a number of permeable zones separated by impervious rocks, a properly designed injection well with an inlet pipe against each aquifer to be recharged needs to be constructed. The injection wells as a means of artificial recharge are comparatively costlier and require specialized techniques of tube well construction supported by operation and maintenance to protect the recharge well from clogging.

Traditional Water Harvesting and Conservation

In India, water harvesting and conservation has been practised for a long time by local communities through traditional methods and structures. Different eco-regions have their own water harvesting and conservation structures, which the State Governments should aim to revive and rejuvenate through special schemes. Some of the important structures are discussed below:

Dug Well Recharge

In alluvial as well as hard rocky areas, there are thousands of dug wells either gone dry or with declining water levels. These dug wells can be used as structures to recharge. Ground water reservoirs (storm water, tank water, canal water) can be diverted into these structures to directly recharge the dried / drying aquifer. By doing so the soil moisture losses during the normal process of artificial recharge are reduced.

A dry / unused well can be recharged by installing a pipe to the bottom of the dug well or below the water level to avoid scouring of the bottom and entrapment of air bubbles in the aquifer. The quality of source water including the silt content should be such that the quality of the groundwater in the reservoir is not deteriorated. The bottom of the dug well should be cleaned and all fine deposits should be removed before recharging. The recharge water should be silt-free. The well should be cleaned regularly and periodic chlorination should be done to prevent bacteriological contamination.

In Maharashtra, a two-pit well recharging technology has been used successfully to recharge dug wells. Two percolation pits are dug next to the well, one large and one small. The smaller pit is filled with stones, gravel and coal, which acts as a filter. A cement pipe fitted with a wire mesh filter is fixed at the bottom of the smaller pit. This pipe opens into the well. Rainwater that collects in the larger pit, flows into the smaller pit and is filtered before it flows into the well through the pipe. The silt that accumulates in the pits can be used in the fields. In this way, soil is conserved as well.

Village Pond / Tank

Village ponds / tanks are the most commonly used method to collect and store rainwater. Most ponds have their own catchments, which provide requisite quantity of water during the rainy season. Where the catchments are too small to provide enough water, water from nearby streams is diverted through open channels to fill the ponds. In some places water from irrigation canals is also used to fill ponds.

Ponds are excavated in different shapes and sizes depending on the nature of the terrain, availability of land and water requirements of the village community. Pond water is available for 2 months to a year after the rains, depending on the catchment characteristics and the amount and intensity of rainfall. Ponds / tanks are known by different names in different regions (Table 15).

Table 15: Village Ponds / Tanks in India

Andhra Pradesh	Tank (Mainly for irrigation)
Assam	Dong
Bihar	Katas, Mundas, Bandhas, Ahars
Gujarat	Kunda (Sacred Ponds), Jheel
Jammu	Chhapris
Karnataka	Volakere, Katte or Kunte, Kola or Kunda, Kalyani
Kerala	Tank (Mainly for irrigation)
Ladakh	Zing
Maharashtra	SathwanTalav

Nagaland	Zabo
Rajasthan	Johad,Nadi,Talab,Dhab,Toba,or Talai
Sikkim	Khup
Uttar Pradesh	Talab,Johad or Pokhar

Tankas / Kunds / Kundis

In the desert and arid areas of Rajasthan people build unique underground structures of various shapes and sizes to collect rainwater for drinking purposes. These structures called tankas, kunds or kundis are constructed in a variety of places, such as courtyards, in front of houses and temples, in open agricultural fields, barren lands. These are built both for individual households as well as for village communities using locally available materials. While some structures are built in stone masonry with stone slab coverings, others are built with only rudimentary plastering of bare soil surfaces of the tank with cement or lime and covered with *Zizyphus numularia* thorns. Some “kuccha” structures have a convex covering of local wood with mud plaster. Inlet holes are provided in the convex side at the ground level to facilitate entry of rainwater into the tank. In “pucca” structures (e.g. tanka) the wall of the tank is projected above the ground to provide inlet holes.

Since tankas are the main source of drinking water in these areas, people zealously protect and maintain them. Just before the onset of the monsoons, the catchment area of the tanka is cleaned up to remove all possible pollutants, and human activity and grazing of cattle in the area is prohibited. Even though the average annual rainfall in these areas varies from 200 mm to 300 mm with the minimum as low as 120 mm, these structures provide enough drinking water to tide over the water scarce summer months. In many, the stored water lasts for the whole year. These simple traditional water harvesting structures are useful even during years of below-normal rainfall.

Khadin

The khadin, a runoff farming and groundwater recharging system, is popular in hyper- arid parts of Rajasthan. Its main feature is a very long (100–300 m) earthen embankment built across the lower hill slopes lying below gravel uplands. Sluices and spillways allow excess water to drain off. The khadin system is based on the principle of harvesting rainwater on farmland and subsequent use of this water-saturated land for crop production. A khadin farm is developed based on rainfall probability, available catchment area and its runoff generation potential. Apart from the submerged area, khadin beds are cultivated from top to bottom, the line of receding moisture. Ponding of water in a khadin induces continuous groundwater recharge.

Vav / Vavdi / Baoli / Bavadi / Jhalara

These are traditional stepwells in Rajasthan and northern India. Often rectangular in design, these structures have steps on three or four sides. These ancient water harvesting systems collect subterranean seepage of a talab or a lake located upstream. They were mainly set up by the nobility in cities and big towns to provide water supply to the community. They were constructed at exorbitant cost and were often monumental, with fine stone work covering large areas and were associated with religion and culture.

Hill Slope Collection

This system is common in many hilly areas with good rainfall (in Uttarakhand, Himachal Pradesh, Meghalaya, Arunachal Pradesh). It consists of lined channels that are built across the hill slopes to intercept rainwater. These channels convey water for irrigating terraced agricultural fields. The water is also used to fill small ponds for domestic use and for cattle.

Spring Water Harvesting

In the Lahaul and Spiti areas of Himachal Pradesh, water from hill streams are diverted through small excavated channels, called kuls, for domestic use and irrigation. In Jammu region these are called kuhals. This practice can also be seen in Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Sikkim and Darjeeling area of West Bengal. Where the springs are merely in the form of water trickling through layers and joints in rocks, split bamboo channels are used to trap and convey water up to the village / hamlet for drinking purposes.

Rainwater Harvesting in Urban Areas

Rainwater harvesting involves the collection, storage and distribution of rainwater from the roof, for use inside and outside the home or business. In most urban centres, rainwater harvesting has become necessary to address the acute water scarcity, which they experience and the flooding during short spells of heavy rainfall. Most of the rain falling on the surface tends to flow away rapidly leaving very little for recharge of groundwater. Capturing the runoff is therefore an important solution to the worsening urban water situation.

Rainwater harvesting has several benefits. It helps in utilizing the primary source of water, and prevents the runoff from going into sewers or storm drains, thereby reducing the load on treatment plants. It also reduces urban flooding and by recharging water into the aquifers, helps in improving the quality of existing groundwater through dilution.

Rainwater harvesting can be harvested from the following surfaces:

Rooftops: If buildings with impervious roofs are already in place, the catchment area is effectively available free of charge and can provide enough supply.

Paved and unpaved areas: Landscapes, open fields, parks, stormwater drains, roads and pavements and other open areas can be effectively used to harvest the runoff. The main advantage in using the ground as a collecting surface is that water can be collected from a larger area. This is particularly advantageous in areas with low rainfall.

Waterbodies: The potential of lakes, tanks and ponds to store rainwater is immense. The harvested rainwater not only meets the water requirements of the city, it also recharges groundwater aquifers.

Storm water drains: Most of the residential colonies have a proper network of stormwater drains. If maintained neatly, these offer a simple and cost-effective means for harvesting rainwater.

The decision on whether to store or recharge water depends on the rainfall pattern and the potential to do so, in a particular region. The sub-surface geology also plays an important role in making this decision.

For example, in Delhi, Rajasthan and Gujarat where the total annual rainfall occurs during 3 or 4 months, are examples of places where groundwater recharge is usually practised. In places such as Kerala, Mizoram, Tamil Nadu and Bengaluru where rain falls throughout the year barring a few dry periods, a small-sized tank for storing rainwater is enough, since the period between two spells of rain is short. Wherever sub-strata are impermeable, recharging would not be feasible. Hence, it would be ideal to opt for storage.

Features of Roofwater Harvesting Systems

Rainwater is clean and can usually be used for drinking and domestic purposes without filtering, depending on the cleanliness of the roof and storage system. In many cities, it is now mandatory for the residents to install roofwater harvesting systems with the following main features:

- Basic requirements: a roof (preferably rectangular), gutters, down pipe, cement base and storage system. Corrugated iron or tiled roof preferable, but closely packed thatching also works (do not use asbestos). Low cost guttering systems can be made from split bamboo.
- Storage systems range from earthenware jars to large tanks of 30,000 litres capacity.
- Below ground storage systems: generally are cheaper to construct because of the support of the sidewalls but they require a pump to lift the water and are more difficult to clean.
- Partial below ground systems: a circular hole is dug into the ground and lined with polyethylene or concrete plastering. It is covered with a roof (from thatch or iron sheets) to protect the water from sunlight, birds and animals.
- Above ground storage: constructed from curved galvanised sheets, ferro-cement or bricks to form a round tank. This system does not require a pump, cleaning is easier and leaks can be detected easily. A concrete base is desirable.

Storage systems should prevent mosquitoes entering and breeding in the water, and prevent sunlight that stimulates algae growth. Easy access to all storage systems is necessary for periodic cleaning. A first flush system can be incorporated to flush away the first rainwater which has dislodged leaves and dirt after a long dry spell.

- Amount of water collected: A house with a 7 m x 7 m roof can capture 500 litres of water from 10 mm of rainfall. An area with an annual rainfall of 750 mm and a 75% efficient well designed and constructed system, yields 28,000 litres per year. If an average family consumes 100 litres per day then there is enough water for 280 days (assuming there is sufficient storage).

Water Saving Technologies: Drip and Sprinkler Irrigation Systems

State Governments are encouraging adoption of water-saving technologies, such as sprinkler and drip irrigation systems, through provision of subsidies to the farmers on the purchase of these systems. These technologies are recommended for achieving higher irrigation efficiencies and could be used for very small-sized holdings.

While sprinklers require energized pump sets, microtube drips can work under a very low-pressure head, with as little as a bucket full of water. Sprinklers tend to irrigate more uniformly than gravity systems and therefore efficiencies typically average about 70%. But in windy and dry areas

much water can be lost due to evaporation in this system. The sprinkler system is particularly effective in sandy undulating terrain. For fruits, vegetables and orchard crops, drip irrigation (also known as trickle irrigation) is more suitable.

These systems require much less maintenance when compared with the conventional pressurized irrigation systems. The ease of maintenance is more significant in microtube drip systems. However, the adoption of these technologies by poor farmers would depend heavily on the supply of information, materials and services for installation.

Improved Water Saving Farm Practices

It is necessary to adopt farm practices which can progressively reduce the water requirement of existing crops and improve primary productivity of the cultivated land. Such practices are particularly important for semi-arid regions which have already taken to intensive farming with irrigation water, both from canals and aquifers. These practices include the increased use of organic manure with the gradual reduction of chemical fertilizers, vermin-culture and agronomic practices, such as mulching, crop rotation and the use of biopest control measures. Organic manure can help regain structure and texture of soils and enhance their moisture retention capacity along with improving soil nutrients. Use of farm management practices, such as mulching, can reduce evaporation from the soil surface, thereby increasing the efficiency of irrigation water utilization.

Long-term Irrigation Management

A long-term strategy is required for managing water resources through irrigation projects in India. It consists of several measures which would expand the area under irrigation and reduce the incidence of drought. All State Governments need to develop policies and procedures for utilization of irrigation resources. The State irrigation department should formulate long-term policies and management practices for the use of irrigation resources. The important elements of these policies and management practices are listed below:

Monitoring Reservoirs: It is necessary for the State irrigation department to set up a monitoring system for water stored in reservoirs, exercise appropriate control on releases of water from these reservoirs and plan for judicious use of water resources. The State irrigation department should prepare a water budget for every reservoir covering drinking water, kharif / rabi requirements and evaporation losses. Many details of reservoir management have been discussed in the chapter on water resource management in the previous chapter.

Setting up Water Users Association: State Governments should provide incentives for setting up Water Users Association (WUA) to involve communities in the management of irrigation resources. WUAs should be formed at the minor canal level (average command of 500 hectares). The responsibility for maintaining the minor and smaller channels can be entrusted with the WUAs. The State irrigation department should charge WUAs on the basis of the volume of water actually taken. Incentives for setting up WUAs could be provided to the farmers by relaxing designated crop restrictions and restrictions on conjunctive use of surface and groundwater, channel repairs, rebates for prompt payment of irrigation fees, volumetric fees lower than crop-area fees and maintenance grants.

Conjunctive Use of Surface and Groundwater: This concept is very essential, especially in drought areas to increase the production per unit of water. It allows flexibility in cropping patterns and multi-cropping in the canal command. For proper water management it is necessary to treat the command areas as one composite unit and the two resources managed judiciously to achieve optimal benefits. This concept use has been successfully implemented in various States. Conjunctive use of surface and groundwater supplies needs careful planning on more scientific lines to achieve full benefits.

Prevention of Evaporation Losses from Reservoirs: Shallow tanks having large surface areas located in the drought-affected regions lose nearly half the volume of stored water by evaporation during the summer months. The evaporation is quite high (250 cm or more) in West Rajasthan, Saurashtra, Deccan Plateau and Southern Coastal regions of Tamil Nadu. In these areas use of a chemical retardant to minimize evaporation losses may be economically viable. A layer of chemicals like cetyl, steary and fatty alcohol emulsions when applied on the water surface can help reduce evaporation. It has been reported that fatty alcohol emulsions can effectively retard evaporation, saving around 40% of the normal evaporation losses. However, such measures may be considered after suitable bio-degradability study and bio-hazard assessment, and after necessary approvals from pollution control and other regulatory authorities.

Increasing Storages through Expeditious Completion of Irrigation Projects: Water storage capacity in the States could be increased through expeditious completion of irrigation projects. Many States that started a large number of irrigation projects, could not complete them due to inadequate resources. States should seek resources through the Accelerated Irrigation Benefits Programme (AIBP) of the Government of India for completing these projects and increasing the area under irrigation.

Integrating Small Reservoirs with Major Reservoirs: As large dams are difficult to construct due to high costs and large-scale displacement of people, there is an increased emphasis on creating small reservoirs. A number of small reservoirs could be created to replace a single large reservoir. However, in many cases a group of small schemes may not provide the same benefits as a large project can. It is, therefore, very important that minor schemes are integrated with the canal systems of major reservoirs.

Integrated Basin Planning: This concept is aimed at coordinating water resources plans throughout a river basin, the most important example of which is the Tennessee Valley Authority in the USA. In India, the Damodar Valley Corporation covering the river Damodar and its tributaries in Bihar and West Bengal was modeled on the lines of the Tennessee Valley Authority.

The philosophy of river basin development, however, underwent significant changes during the latter half of the twentieth century. In 1950, the construction of multiple-purpose dams and other engineering works along a river's main channel was central to the concept. The region benefited through navigation, flood control, hydropower generation and distribution, and agricultural development. By the end of the century, however, the concept shifted and broadened and laid emphasis on the values of biodiversity, nonstructural means of improved water management and stakeholder participation in watershed-level initiatives. All States need to adopt integrated basin planning for addressing wide-ranging issues of natural resource management.

Inter-basin Transfer of Water: The permanent long-term solution to the drought problem may be found in the basic principles of transfer of power from surplus river basins to the areas of

deficit. Many basins in the country have surplus water resources while others face serious shortages. Creation of storages and inter-basin transfer of water from surplus to deficit regions could therefore be an option for achieving more equitable distribution and optimal utilization of water resources. It has been argued that a National Water Grid could be set up by linking resource abundant rivers such as the Brahmaputra and Ganga with other rivers. Long distance water transfer is not a new concept in India. There are a number of canals, such as the Western Yamuna Canal and Agra Canal in north India, and the Kurnool–Cuddapah Canal and the Periyar–Vaigai Canal in south India, which have carried water for long distances and irrigated water deficient areas. However, these projects would require huge commitment of resources as well as popular support across the States, and would call for extensive studies related to environment impact and benefit-cost analyses.

Afforestation

It is well-known that the development of forests in areas, which are susceptible to periodic recurrence of drought, is indeed a very effective drought-resistant measure. Areas which are devoid of tree growth suffer serious erosion and need to be covered with vegetation in the shortest possible time with a view to mitigate drought conditions.

Drought-affected areas have vast expanses devoid of vegetation, depleted of tree growth and exposed parent rocks and boulders. The accelerated run-off in these areas is so large that all the surrounding agricultural land cannot even support marginal or subsistence agriculture. To remedy this, vegetation on hill slopes, catchments and other vulnerable areas need to be undertaken, particularly where rainfall is low. Plantation and green cover may be encouraged to help check soil erosion and the use of organic compost and bio-degradable mulching will enable the absorption and retainment of minerals for long time thereby reducing the risk of leaching.

Trees and vegetation not only protect the soil, improve its water holding capacity, minimize run-off, regulate drainage (both surface and underground), but also preserve and improve the productive capacity of the soil and fertility of agricultural land in the vicinity. The foliage produced any effective vegetation, whether trees, shrubs, bushes or even well-pastured grass, forms a sheltering shield or canopy which breaks down the intensity of torrential rain and thus reduces its erosive action on the soil. Furthermore, when this water with reduced velocity reaches down, it does not flow down to the rivers but is absorbed due to the vegetation and helps recharge ground and surface water resulting in the creation of perennial rather than seasonal storage in the reservoirs. Therefore, multi-tier plantation of grasses, bushes, shrubs and trees of local multipurpose varieties should be promoted as these are more tolerant to temperature / climatic conditions.

Before the afforestation programme is taken up, a thorough inspection and classification of the areas needs to be conducted. The land identified for afforestation should be divided into three categories: (i) areas with adequate depth of soil to make afforestation feasible; (ii) areas with shallow soils fit for supporting grass and shrub growth but not fit for tree growth; (iii) badly degraded and eroded areas unfit for tree growth and shrubs and where only soil and moisture conservation operations should be carried out.

In drought-prone areas, planting of drought-resistant varieties of trees should be considered. Fruit trees, such as sitafal (*annona squamosa*) and drought-resistant fodder species, may not only be useful as an afforestation measure, but also enable the supply of fodder to the cattle. Different

species of bushes and shrubs should be planted, which not only prevent soil erosion but also provide a leaf-hedge against cattle and barrier against fire when planted like a boundary or fence.

Afforestation should be financially supported through the social forestry and watershed development programmes which normally carry budgetary provisions for this activity. Assistance from the Sub-Mission on Agro-forestry will help to promote peripheral boundary plantation, low density block plantation and high density block plantation. Panchayat Raj Institutions (PRIs) can play a critical role in the expansion and sustainability of activities.

Crop insurance

Farmers from drought risk regions may be encouraged to subscribe to the crop insurance for reducing the risk. Awareness building programmes may be undertaken to increase the farmer participation in the crop insurance.

Community Participation in Drought Mitigation

Community participation is an essential feature of drought mitigation programmes. As local water management and rainwater harvesting hold the key to drought mitigation, Government policies should emphasize community-based water resource management. Community-based institutions, such as WUAs, can play important roles in managing water resources at the micro level. The Prime Minister's Fasal Bima Yojna (PMFBY) and Pilot Unified Package Insurance Scheme may be promoted vigorously in drought affected districts

Build on Micro-level Experiences: The villages of Sukhomajri in Haryana and about 100 communities in Alwar have improved their socio-economic conditions through community-led water management. These communities used traditional water harvesting structures, such as village tanks and johads, which increased the groundwater table in the area, resulting in increased water storage and substantial increase in crop production and resultant income. Ralegan Siddhi and Hirve bazar from Ahmednagar district are the other successful examples of community-based initiatives in water resource management. These micro-level success stories need to be spread to other parts of the country for other communities to replicate.

Innovate Community-based Institutions: Several models of community-based institutions have emerged, which are effectively managing surface and groundwater. In Odisha, the 'Pani Panchayat programme' assigns various roles to the community and the local self-government in water management and is preparing community-based drought management plans. In Ozhar, Maharashtra WUAs are enabling farmers to manage irrigation water. In Banikhet, Himachal Pradesh the lift irrigation project deals with various aspects of water use, such as water charges, local maintenance. In Rajasthan, communities are participating in checks on rainwater loss and thus ensuring the enhancement of groundwater. State Governments need to build on these examples and encourage the formation of community-based organizations for effective management of water resources.

As discussed above, State Governments need to encourage the formation of WUAs for community-based management of water delivery system. Maharashtra has taken the lead in 1990 in forming WUAs, and its State Government has handed over the management of the entire irrigation systems of Niphad block, where the irrigation dam is situated, to the WUA network. WUA-like initiatives have

been launched in Tamil Nadu, Andhra Pradesh, Rajasthan, Madhya Pradesh and Odisha, which also suffer from water scarcity. Legislations dealing with transferring of water management to WUA- like groups are being formulated in all these States.

Organize Community-based Consultations through Gram Sabha: Community-based consultations refer to community decisions, collective contribution, self-regulations, and negotiations with the Government conducted through Gram Sabhas, in particular and PRIs in general. These processes can be very important for the management of water, fodder and crops at the community-level. Further, these processes can also lead to meeting the basic entitlements through provision of work and food to people affected by drought.

Strengthen Women's Self-help Groups: Self-help groups empower women and help them to access resources. Women start economic activities and generate an independent stream of income. While it has an empowering impact on women, it also increases resilience of the households in responding to drought. Those households who depend solely on agriculture for their livelihoods suffer badly due to income and consumption losses, while diversified households cope with the impact better. These self-help groups could be formed and strengthened through many interventions at the community level.

Women's self-help groups can play an important role in a large number of measures targeted at drought mitigation. They could be involved in rainwater harvesting, running PDS shops, Aanganwadis and day care centres and overseeing water distribution and utilization in their community. Since women are the most affected in a drought situation, they could plan several measures that reduce their hardships and promote greater equity and efficiency in natural resource management. Women's self-help groups could also come forward in addressing special needs of certain groups, such as pregnant women, school-going children and the old and disabled people. During a drought situation, the well being of these groups can only be ensured through the active support of women's groups.

Empower Panchayati Raj Institutions: Several drought relief and mitigation measures could be implemented through the PRIs more effectively. The necessary budget allocations and implementation support should be provided to these institutions for launching programmes in drought-affected areas. PRIs improve the delivery mechanism and reduce the impact of drought. The examples of several droughts have shown the importance of involving these institutions in drought management.

Climate Variability and Adaptation

Climate variability refers to the climatic parameter of a region varying from its long-term mean. Every year in a specific time period, the climate of a location is different. Some years have below average rainfall, some have average or above average rainfall. Due to the phenomenon of climate change affecting India, such variability would have an impact on agriculture. As a result of variability, the hydrological cycle is likely to be altered and the severity of droughts and intensity of floods in various parts of India is likely to increase. Further, a general reduction in the quantity of available run-off is predicted. Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases in different parts of India.

Incidence of pests and diseases may increase with climate variability and climate change. With long dry spells and more intense rainfall, the resulting decline in water quality will lead to greater risk of water-borne diseases. Changing temperatures and rainfall in drought-prone areas are likely to shift populations of insect pests and other vectors and change the incidence of existing vector-borne diseases in both humans and crops.

Livelihood activities that rely on sensitive agricultural systems will be more vulnerable to climate change. Trends such as population growth, pollution, increasing demand for food and water and market fluctuations can compound the impact of climate variability and climate change.

Adaptation to climate variability is a process of practising the cultivation methods to moderate, cope with or take advantage of the consequences of climatic events.

Adaptation options need to benefit the community and ensure community participation so that experiences of local-level adaptation strategies can be shared. To implement adaptation measures in the agriculture sector, it is necessary to understand the potential impacts of climate change and local perceptions. The basic understanding in the context of climate change adaptation in drought-prone areas is that the adaptation option should have the potential to improve the livelihood assets (human, natural, financial, physical and social) of rural people.

Through efforts to determine the viability of adaptation options, it is actually possible to create a menu of adaptation options for the development planning process with the potential to be integrated into the existing institutional agenda. Short-term cropping, inter-cropping, small-scale fodder cultivation, small-scale fish cultivation in mini-ponds, homestead gardens and farm ponds for rainwater harvesting are some of the examples of adaptation practices that can be adopted at the local level. These livelihood practices, which improve the adaptive capacity of the farmers, are likely to be a regular feature of the drought management programme.

Power supply in vulnerable area

States may take necessary actions to ensure quality power supply in the areas vulnerable drought. Structural measures for power distribution need to be implemented in a systematic manner.

Public Distribution System (PDS)

The Public Distribution supply chain and Fair Price Shops should be fully geared to deal with a drought situation. The State Government/District Administration should carry out regular inspections to ensure that distribution of ration is not hampered in any way.

Crop management practices

Cultivation of drought resistant crops and crop varieties followed by scientific management practices would lead to drought proofing over a period of time. The State departments should encourage farmers adopt better crop management practices from time to time.

Indigenous knowledge

Traditional knowledge and local practices need to be fully exploited and implemented to increase the drought resistance.

Documentation of best practices

The best practices in drought mitigation implemented in different parts of the State need to be documented and showcased to all the stakeholders in order to achieve large scale use of such practices.

Awareness and Capacity building

Campaigns to build awareness on drought mitigation methods and programmes to build the capacities of farmers and village level functionaries would be of immense use for efficient implementation of different measures of drought proofing.

Monitoring of Drought Mitigation

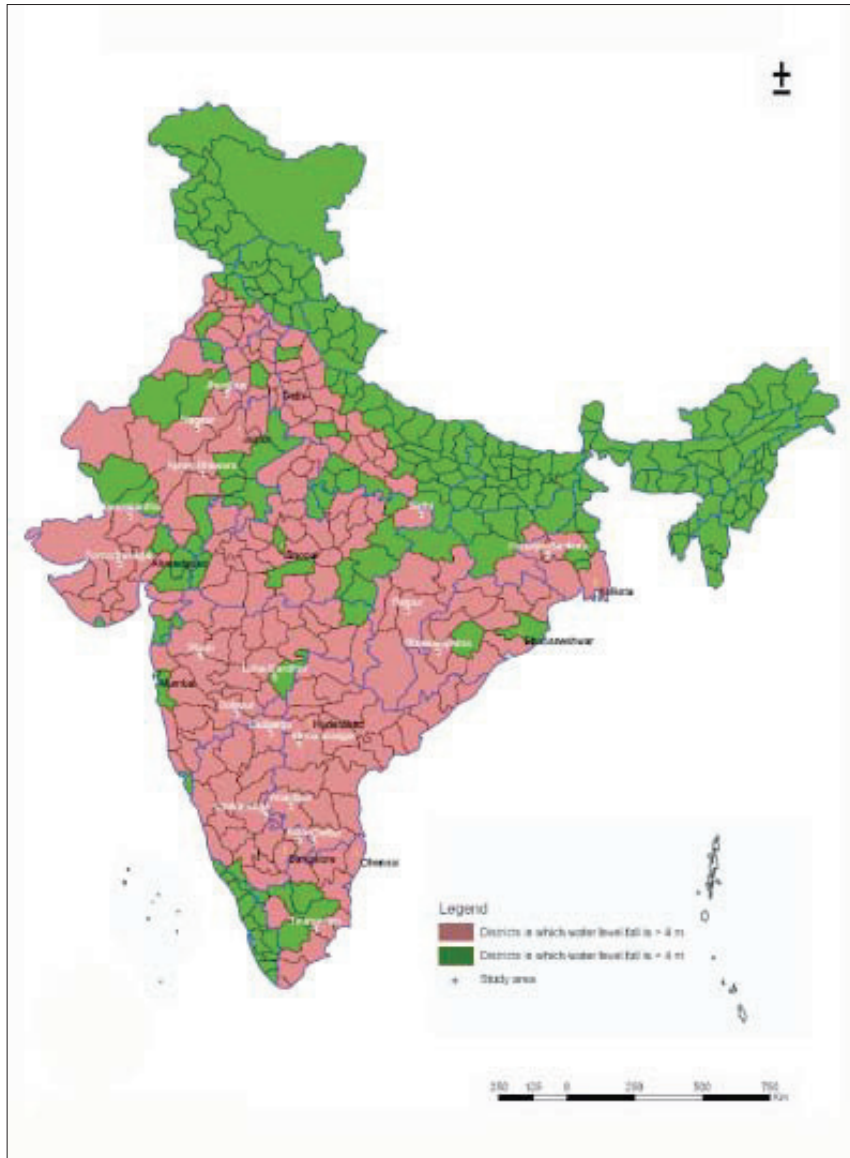
The State Government /State Executive Committee (SEC) may consider periodic review of the progress of drought mitigation activities of different departments. The SEC should cause the formulation of holistic drought mitigation plans at least for vulnerable districts, if not for sub divisions/Mandals etc. Such plans will help sharpen the focus on mitigation measures and gain from the synergies being brought in by line departments.

Drought Vulnerability and Risk mapping

Drought vulnerability and risk maps are useful to prioritize the areas for convergence of drought mitigation measures.

Vulnerability assessment studies should examine livelihood patterns, impact on income and consumption, social capital, migration and social security system, which influence the vulnerability of people. Such an assessment would be necessary to suggest measures for watershed management, irrigation efficiency, appropriate agricultural practices and cropping choices pattern, water conservation etc., new risk management measures. NRSC (ISRO) has developed agricultural drought vulnerability assessment methodology by including weather, soil, crop and socio-economic indicators and generated sub-district level vulnerability maps for Andhra Pradesh, Telangana and Haryana states. The study reports are available at www.nrsc.gov.in. The States may take the assistance of Scientific institutions in the mapping of drought vulnerability and risks. However, to begin with, the districts having encountered large number of droughts in the past 15 years can be justifiably selected for vulnerability assessment.

Map 7: Decline in Water Level during 1981–2000



Districts showing > 4m fall in water level of (@>20 cm/yr) for the period 1981-2000

Legend

Districts in which water level fall is > 4 m Districts in which water level fall is < 4 m Study area

Source: Central Ground Water Board

The mission / task force should also prioritize programmes that include the completion of unfinished irrigation and watershed development projects, ground and surface water and regulatory framework for improved use conservation of natural resources for reducing the drought risk.

Decision Support System for Drought Management

Development of a decision support system for drought management would streamline the implementation of the drought mitigation activities. Establishing automated weather stations and rain gauges to improve the collection of information, promote the use of data related to soil, vegetation and water resource obtained through remote sensing technology and actively support research on climate and natural resource management are some of the initiatives to strengthen the drought mitigation endeavours. Such information provides more analytical tools for understanding drought and making informed policy choices for drought mitigation.

States may network with all the established research institutions at the national level dealing with remote sensing satellite data, dryland agriculture and natural resource management to acquire necessary technical expertise for handling drought mitigation measures.

Impact Assessment and evaluation

Drought mitigation measures have been in existence for a long time, but the complexity and dynamics of the calamity are equally daunting.

States should therefore consider evolving mechanisms for monitoring and impact assessment of drought mitigation programmes/activities. It is suggested to take up household survey with properly designed questionnaire to capture the effectiveness of drought mitigation measures. The impact assessment and evaluation of response system is suggested to be taken up at regular intervals.

Promote Education and Awareness of Mitigation Policies and Measures

Encourage education and awareness programmes on drought mitigation issues. People must be informed of the importance of water conservation and harvesting, optimal water use and the need for increasing forest cover. A wide public awareness about the importance of natural resource management is a very important aspect of a long-term drought mitigation programme.

Bring together policymakers and scientific experts for developing feasible and practical public policies and encourage academic research on the key indicators of drought. It should be extremely helpful if academic institutions are asked to participate actively in drought mitigation programmes.

Encourage Community-level Plans for Drought Mitigation

The States should consider involving community institutions actively in drought mitigation and to build public awareness.

The States should provide necessary policy, programme, and financial support to the PRIs for drought mitigation. A large number of programmes are being implemented through the PRIs and it is necessary that these institutions are sensitive to the drought mitigation issues. Though the PRIs are generally very active in monitoring local interventions, there is a need for greater sensitization of the drought risks.

All over the country, self-help groups are being set up, seeking the participation of women in large numbers. Women bear a disproportionate share of the consequences of drought and, therefore, it would be fruitful to initiate an active dialogue with women Self Help Groups (SHGs) on drought mitigation strategy based on conservation and optimal use of water. The mission / task force should consider encouraging self-help groups to take up drought mitigation programs and for that these groups should be allowed access to resources, knowledge and information.

The States should consider involving NGOs and community-based organizations in implementing the drought mitigation strategy. Several Government programmes in soil and water conservation and water supply are being implemented through NGOs. The mission / task force should recommend implementing these programmes in a more integrated manner for effective drought mitigation.

BIBLIOGRAPHY

- ADPC and FAO.2007. Climate Variability and Change. Adaptation to Drought in Bangladesh. A Resource Book and Training Guide. Rome.
- Central Ground Water Board, Ministry of Water Resources. 2000. Guide on Artificial Recharge to Ground Water, New Delhi.
- Department of Agriculture and Cooperation, Government of India. 2004. Drought 2002: A Report, Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi
- Department of Agriculture and Cooperation, Government of India. 2009. Crisis Management Plan, 2016.
- Department of Drinking Water Supply, Ministry of Rural Development, Government of India. 2000. Guidelines for Implementation of Schemes and Projects on Sustainability under Accelerated Rural Water Supply Programme (ARWSP) & Prime Minister's Gramodaya Yojana (PMGY) - Rural Drinking Water.
- Kumar,M.Dinesh.2003. Food Security and Sustainable Agriculture in India:The Water Management Challenge. Working Paper 60. International Water Management Institute. Colombo.
- Mall R. K., Gupta Akhilesh, Singh R. and L. S. Rathore. 2006. Water Resources and Climate Change: An Indian Perspective. Current Science, Vol. 90. No. 12, 1610-1626.
- Ministry of Rural Development, Government of India. 2006. From Hariyali to Neeranchal, Report of the Technical Committee on Watershed Programmes in India
- Narain, P., M.A. Khan and G. Singh. 2005. Potential for Water Conservation and Harvesting against Drought in Rajasthan, India. Working Paper 104. Drought Series Paper 7. International Water Management Institute. Colombo.
- National Remote Sensing Centre,ISRO / Department of Space (DoS), Government of India.<http://dsc.nrsc.gov.in>. Accessed March 2009.
- Public Health Engineering Department, Government of Meghalaya. Rainwater Harvesting Manual. <http://megphed.gov.in/knowledge/RWHManual.htm>. Accessed on February 25,2008.
- Rathore, M.S. 2005. State Level Analysis of Drought Policies and Impacts in Rajasthan, India. Working Paper 93. Drought Series Paper No. 6. International Water Management Institute, Colombo.
- Sakhtivadivel,Ramaswamy.2007.The Groundwater Recharge Movement in India.In. M.Giordano and K.G.Villhloth.The Agriculture Groundwater Revolution:Opportunities and Threats to Development. CAB International.
- Samra J.S. 2004. Review and Analysis of Drought Monitoring, Declaration and Management in India. Working Paper 84. Drought Series Paper 2. International Water Management Institute, Colombo.
- Sathaye,J.,P.R.Shukla and N.H.Ravindranath.2006.Climate Change,Sustainable Development and India. Current Science,Vol. 90. No. 3, 10 February.

- Shah, M. 2006. Towards Reforms, Overhauling Watershed Programme. Economic and Political Weekly. July 8-15.
- Sharma, A. 2003. Rethinking Tanks: Opportunities for Revitalizing Irrigation Tanks, Empirical Findings from Anantapur District, Andhra Pradesh. India. Working Paper 62. International Water Management Institute. Colombo.
- Sharma, B.R. and V.U. Smakhtin. 2004. Potential of Water Harvesting as a Strategic Tool for Drought Mitigation. International Water Management Institute. Colombo.
- Sinha Ray, K.C. (Year Unspecified). Role of Drought Early Warning Systems for Sustainable Agricultural Research in India. Posted on http://drought.unl.edu/monitor/EWS/ch10_Sinha-Ray.pdf. Accessed 7 March 2009.
- Steinmann, A, M.J. Hayes, and L. Cavalcanti. Drought Indicators and Triggers. In Donald Wilhite (ed.) Drought and Water Crises: Science, Technology, and Management Issues. CRC Press, Boca Raton, FL. Also available on <http://water.washington.edu/Research/Reports/droughtindicatorsandtriggerschapter.pdf>.
- Upadhyay, Bhawana. 2004. Gender Roles and Multiple Uses of Water in North Gujarat. Working Paper 70. International Water Management Institute. Colombo.
- Wilhite, D.A., M.J. Hayes, and C.L. Knutson. 2005. Drought Preparedness Planning: Building Institutional Capacity. pp. 93-135. In D. A. Wilhite (ed.) Drought and Water Crises: Science, Technology and Management Issues. CRC Press, Boca Raton, FL.
- Vaidyanathan, A. Watershed Development: 2001. Reflections on Recent Developments. Discussion Paper No. 31. Kerala Research Programme on Local Level Development. Centre for Development Studies.
- Agha Kouchak, A., A. Farahmand, F. S. Melton, J. Teixeira, M. C. Anderson, B. D. Wardlow, and C. R. Hain (2015), Remote sensing of drought: Progress, challenges and opportunities, *Rev. Geophys.*, 53, 452–480, doi:10.1002/2014RG000456
- Boken, V. K., Cracknel, A. P., Heathcote, R. L., 2005, Monitoring and Predicting Agricultural Drought: A Global Study. Oxford University Press.
- Ch. Srinivasa Rao, B. Venkateswarlu, A.K. Sikka, Y.G. Prasad, G.R. Chary, K.V. Rao, K.A. Gopinath, M. Osman, D.B.V. Ramana, M. Maheswari and V.U.M. Rao (2015). District Agriculture Contingency Plans to Address Weather Aberrations and for Sustainable Food Security in India. ICAR-Central Research Institute for Dryland Agriculture, Natural Resource Management Division, Hyderabad -500 059, India. 22 p.
- DAC&FW, 2016, Pradhan Mantri Krish Sinchayee Yojana Guidelines. <http://pmksy.gov.in/Guidelines.aspx>
- DAC&FW, 2016, Crisis Management Plan: Drought (National), 2016. Department of Agriculture, Cooperation & Farmers Welfare, Government of India.
- DAC&FW, 2016, Operational Guidelines: Pradhan Mantri Fasal Bima Yojana. Department of Agriculture, Cooperation & Farmers Welfare, Government of India.
- DAC, 2009, Manual of Drought Management, Department of Agriculture & Cooperation, Government of India, 192p.

- DoRD, 2013. Mahatma Gandhi National Rural Employment Guarantee Act, 2005, Operational Guidelines, 2013. Department of Rural Development, Ministry of Rural Development, Government of India
- Gupta, A. K., Tyagi, P. Sehgal, V. K, 2011, Drought disaster challenges and mitigation in India: strategic appraisal , Current Science, Vol. 100, No. 12,1795-1806
- Loon, Anne F. Van, 2015, Hydrological drought explained; *WIREs Water* , 2:359–392. doi: 10.1002/wat2.1085
- Murthy, C.S. and SessaSai, M V R (2011) Agricultural Drought Monitoring and Assessment. In: 'Remote Sensing Applications' (Eds.) P. S. Roy, R. S. Dwivedi and D. Vijayan, NRSC, Hyderabad.
- Nagarajan, R., 2010, Drought Assessment. Springer, 429p.
- NDMA, 2010, National Disaster Management Guidelines: Management of Drought. A publication of the National Disaster Management Authority, Government of India. ISBN 978-93-80440-08-8, September 2010, New Delhi.
- NRAA, 2013, Contingency and Compensatory Agriculture Plans for Droughts and Floods in India-2012. Position paper No.6. National Rainfed Area Authority, NASC Complex, DPS Marg, New Delhi-110012, India : 87P
- Pai. D.S., Latha Sridhar, M. Rajeevan, O.P. Sreejith, N.S. Satbhai and B. Mukhopadhyay. 2014: Development of a very high spatial resolution (0.250 x 0.250) Long period (1901-2010) daily gridded rainfall data set over the Indian region", *Mausam*, 65, 1, PP 1-18
- Ramana Rao, B.V., Sastri, AS.R.AS., Rama Krishna, Y.S. 1981. An integrated scheme on drought classification as applicable to the Indian arid zone. *Idojaras*85 : 317-322.
- Ray, S. S., SessaSai, M. V. R. and Chattopadhyay N. (2014) Agricultural Drought Assessment: Operational Approaches in India with Special Emphasis on 2012. In: High-Impact Weather Events over the SAARC Region (Ed. K. Ray, M. Mohapatra, B.K. Bandyopadhyay, L.S. Rathore). Springer. pp. 349-364.
- WMO, 2012, Standardized Precipitation Index: User Guide, WMO-No. 1090, World Meteorological Organization.

ANNEXURES

Annex 1: Forms

FORM 1

District wise/Taluk wise/Mandal or Hobli-wise Rainfall Summary

(Rainfall in mm)

	South-West Monsoon			North-East Monsoon			Annual Rainfall		
	Normal RF	Actual RF	Dep %	Normal RF	Actual RF	Dep %	Normal RF	Actual RF	Dep %
<i>District</i>									
<i>Taluk /Tehsil</i>									
<i>Hobli / Mandal</i>									
<i>Gram Panchayat</i>									

Form No. 2(A)

Water Storage in Major Reservoirs/Irrigation Projects

1. Name of the Reservoir/ Irrigation Project:.....
2. Name of Taluk/Block/Mandal/Tehsil:
3. Name of District:
4. Tick mark (√) on category/purpose of reservoir:-

Major/Medium	Multipurpose/ hydropower/ irrigation/ Drinking water supply /other

5. Full Reservoir Level (FRL) m Dead Reservoir Level (DRL) m
6. Other site specific information (if any):

Sr. No.	Date/ Week	Full storage Capacity (Total volume at FRL) (m ³ or MCM)	Dead storage (Total volume at DRL) (m ³ or MCM)	Average Storage for the week/ date (m ³ or MCM)	Actual Reservoir storage on week/date (m ³ or MCM)	Difference in actual storage from average (m ³ or MCM)	Percentage deficit in storage volume i.e. RSI
	(a)	(b)	(c)	(d)	(e)	(e)-(d)	[(e)-(d)/ (d)]* 100

m= meter, MCM=million cubic meter, RSI = Reservoir Storage Index

Note:

- Average reservoir storage can be calculated from observed past data for at least past 10 years

Form No. 2 (B)

Stream flow data

1. Name of river/stream :
2. Location of discharge measurement site:
- (i) Latitude (ii) Longitude
- (iii) Catchment area upto discharge measurement site:
3. Name of Taluk/Block/Mandal/Tehsil:
4. Name of District:
6. Other site specific information (if any):

Sr. No.	Date/ Week/ 10-daily/ Month ('T')	Observed discharge (Cumec)	Truncation Level flow (Cumec)	Difference of Stream flow from truncation level flow (Cumec)	Volume of flow at truncation level (V_{TL}) (m^3)	Volume of deficit flow (V_d)/ surplus flow (V_s) (m^3)
	(a)	(b)	(c)	(b)-(c)	[(c)*86400*T']	[(b)-(c)* 86400*T']

Cumec= cubic meter per second, 'T' = number of days in time step (for daily/ week/10-daily/month the value of "T" is 1/7/10/30or31, respectively).

Note:

- The Truncation Level flow can be estimated from flow duration curve at 75% dependability level derived using observed past data for the given site for at least past 10 years

Form No. 2 (C)

Groundwater Level

1. Location of Well: village name: well no.
- (i) Latitude (ii) Longitude
2. Name of Taluk/Block/Mandal/Tehsil:
3. Name of District:
4. Tick mark (✓) on category of well: dug-well or tube-well
5. Depth of the well from ground surface: m
6. Other site specific information (if any):

Sr. No.	Month/ Week	Maximum observed water level depth from ground surface for given month, m	Average water level depth from ground surface for given month, m	Actual observed water level depth from ground surface, m	Difference in water level depth from average m	GWDI
(a)	(b)	(c)	(d)	(c)-(d)	$[\{(c)-(d)\}/(b)]$	

m= meter, GWDI = Groundwater Drought Index

Note:

- Average water level depth from ground surface can be calculated from observed past data for the given well for at least past 10 years
- Maximum observed water level depth from ground surface can be obtained from observed past data for the given well for at least past 10 years

Form No. 3

Agricultural area statistics at Taluk / Tehsil / Block / Mandal / District

District (1)	Taluk / Tehsil / Mandal / Block (2)	Geographical area (3)	Net Cropped area (4)	Area Sown more than once (5)	Current Fallows (6)	Total Agricultural area = (4 + 5 + 6)	Net Irrigated area (7)	Percent Irrigated area = (7 / 4)

Form No. 4

Progress of Crop-wise Sowing at Taluka / Tehsil / Block / Mandal / District

Season: Kharif / Rabi

As on date (dd/mm/yy):

Taluk/ Tehsil/ Block / Mandal/ District	Normal area sown					Actual area sown					Percent area sown = (10 / 5)
	Cereals (1)	Pulses (2)	Oil seeds (3)	Others (4)	Total (5) = (1 + 2 + 3 + 4)	Cereals (6)	Pulses (7)	Oilseeds (8)	Others (9)	Total (10) = (6 + 7 + 8 + 9)	

Form No. 5

Fodder Availability in District

S. No.	Name of Taluka	No of affected villages	No of livestock affected	Fodder demand and availability in the district (in quintal)				Price of Fodder (in Rs./quintal)							
				Dry fodder		Green fodder		Dry fodder		Green fodder					
						Source of fodder									
				Demand	Availability	Demand	Availability	Normal	Prevailing	Normal	Prevailing				

Form No. 6

Information on Cattle Camps

Taluka/Tehsil/Block:			District.....		
Sl.No.	Name of village	Name of Organization	No. of Heads of Cattle		Others
			Major	Minor	

Form No. 7

Supply of Drinking Water through Tankers and Bullock Carts

Taluka / Tehsil / Block / District:

Week-ending:

Village/Taluka/District	Current Week		Previous Week	
	Number of Tanker trips	Number of Bullock cart trips	Number of Tanker trips	Number of Bullock cart trips

Form No 8

Expenditure (in Rs) on Temporary Water Supply Schemes and Sources (as on dd/mm/yyyy)

District /Taluk or Tehsil / Mandal or Block or Hobli / Gram Panchayat / Village						
	New Installation	Augmentation	Repairs	Total Expenditure	Per capita water supply LPCD	
					Before	After
Permanent Water Supply Scheme						
Temporary Water Supply Scheme						
Bore wells with Electric Motors						
Bore wells with Diesel Pump Set						
Bore Wells with Solar Pump						
Bore Wells with Wind energy pumps						
Bore Wells with Hand Pump						
Dug wells with Electric Motors						
Dug wells with Diesel Pump Set						
Dug Wells with Solar Pump						
Dug Wells with Wind energy pumps						
Dug Wells with Hand Pump						
Tanks / Ponds						

Multi Village Water Supply Schemes						
Tankers						
Bullock carts						
Other Water Supply Sources						

LPCD: Litres Per Capita per Day

Per Capita Availability of water (in LPCD) – Normal
 – Current

Form 9

Wages, Employment and Migration

Name of District.....

Sl. No.	Name of Mandal/ Taluka/ Block/	Unskilled labour wage rate (Rs./day)		Demand for wage employment under MGNREGS (in person days)		Actual wage employment provided under MGNREGS (In person days)	Wage employment provided under other schemes (in person days)	Migration (in nos.)*	
		Normal	Prevailing	Normal	Current			Normal	Current.

* Based on credible surveys and baseline data.

Form No. 10

Taluka wise Food grains Stock in District.....

S. No.	Name of Taluka	No of affected villages	No. of population affected	Food stock position in Government Godowns in M.T.							
				(a) Wheat	(b) Rice	(c) Other food grains like ragi, jowar, millets etc.	(d) Sugar	(e) Edible oil	(f) Kerosene K.L.		

Form No. 11

Damage to Agricultural Crops due to Drought

Name of Village...../Taluka / Tehsil / Block / Mandal /..... District:

Crop	Normal sown area	Irrigated area	Actual sown area during the season	Crop Area (ha)			
				Area unsown	Total sown Area with damage to crop	Sown Area with % of damage between 33% and 50% to crops	Sown Area with Percentage of damage above 50% to crops.

Form. No.12

A Monthly Report of Expenditure on Different Relief Measures

(Amount Rs. in Lakhs)

Drought Relief	Expenditure during The Month	Progressive Total
Gratuitous Relief		
Cash		
Food		
Supply of fodder/ feed supplements		
Supply of seeds		
Supply of fertilizers		
Any other, specify		
Drinking water supply for human and livestock		
Emergency measure - water tanker / bullock cart		
Installation/Augmentation/Repair of water supply schemes		
(iii) Provision/construction of mini water tanks for livestock in villages		
(c) Input Subsidy		
Seed		
Fertilizers		
Insecticides/fungicides		
Foliar spray chemicals to cope with drought		
Supplemental irrigation to crops		
Supply farm implements for contingency agricultural operations		
Supply of water lifting pumps and microirrigation systems (drip, sprinkler/rain gun etc.) for supplemental irrigation		
Supply of sprayers for plant protection		
Any other, specify		
(d) Animal Health		
Small ruminants		
Large ruminants		
(e) Cattle camps		
(f) Fodder camps		

Annex 2 : Drought Monitoring Centres Mandate and Organization

Background

At present, the Ministries / Departments responsible for drought management at the National and State levels get inadequate technical support for drought early warning and monitoring. It has a serious impact on the timelines and scale of operations for drought management.

The Government of Karnataka set up a Drought Monitoring Cell in the year 1988. This institution has taken a lead in monitoring and managing the recurring drought situation in the State on a scientific basis. Drought Monitoring Cell is thus considered to be a success in terms of knowledge management and decision support system.

The Drought Monitoring Centre (DMC) would monitor all the indices and indicators of drought on a scientific basis and provide technical advice to the Government. It would interact with multiple National and State-level scientific institutions, Ministries and Departments, obtain relevant information related to different aspects of drought, and assist the Government in the management of drought relief and mitigation.

Objectives

The objectives of DMC at the National and State levels are as follows:

- a. To act as the scientific and technical advisor to the Government on all aspects of drought management;
- b. To undertake studies and research on various scientific and technical issues related to drought management;
- c. To develop a database on various drought related indices and indicators; precipitation, evapotranspiration, groundwater levels, surface water bodies, land use, soils and forest cover;
- d. To provide drought early warning information to the Government and other stakeholders;
- e. To develop short-term and long-term drought mitigation measures and recommend them to the various institutions and farmers;
- f. To develop a network of various resources and user agencies so that the information and database management could be strengthened through collective inputs of these agencies; and
- g. To initiate, support and coordinate applied research programs in universities and other institutions related to drought monitoring and mitigation.

Activities

DMC would conduct a number of core activities in relation to drought management. These core activities are as follows:

- (i) Build and Maintain a Database on Drought Indices and Indicators: DMC would regularly collect and analyze data of various indicators of drought such as rainfall, land use patterns, agricultural conditions, groundwater and surface water levels, and socio-economic conditions

such as migration, distress sale of assets, etc. Such a database would be maintained on GIS platforms, and be accessible to all the users.

- (ii) Preparation and Issuance of Periodical Reports on Drought: DMC would prepare and disseminate reports prepared on daily, weekly, monthly, seasonally, and annual basis on different aspects of drought management. It would include reports on rainfall, various stages of agricultural operations, crop conditions, reservoir levels, fodder, and drinking water situations.
- (iii) Inter-disciplinary Studies on Drought Management: DMC would support inter-disciplinary studies on drought management to develop a knowledge-based public policy on drought management. It would combine aspects of climate change, meteorology, agriculture, irrigation, water conservation, and coping strategies adopted by the people. Such studies would provide insights into natural resource management, and suggest feasible mitigation measures.
- (iv) Maintenance and Operation of a Weather Stations Network: DMC may consider setting up telemetric rain gauges / weather stations in the state, maintaining the network, and improving the database on climate and rainfall.

DMC's subsidiary activities are described as follows:

- (i) Satellite-based drought monitoring in collaboration with National Remote Sensing Centre (NRSC), Hyderabad through obtaining vegetation index
- (ii) Crop yield estimation in collaboration with Space Applications Centre (SAC), Ahmedabad and other agriculture-related institutions
- (iii) Water balance studies and preparation of Moisture Adequacy Index (MAI)
- (iv) Crop water budgeting studies for the districts and Talukas / Tehsils / blocks, crop-wise
- (v) Impact assessment of watershed development programs
- (vi) Standardization of average rainfall for all the Talukas / Tehsils / blocks and districts
- (vii) Assist the Government in the processes leading to the declaration of drought
- (viii) Assist the Government in preparation of loss estimates due to drought and preparation of Memorandum for submission to the Government of India
- (ix) Documentation of drought management efforts
- (x) Advise the Government on different aspects of water and soil management

Organizational Set up

The State DMC should be headed by the Relief Commissioner and have a complement of technical experts related to agriculture, meteorology, remote sensing, hydrology and related fields on a permanent or deputation/ contractual basis. It should have a well defined office with appropriate staff and equipment.

Annex 3 : Drought Declaration Certificates

Annexure 3

Sample CERTIFICATE

Declaration of Drought

Date:

Place:

Having taken into account the conditions as arising from rainfall deficiency, decline in the availability of ground and surface water, poor crop conditions, and parameters related to remote sensing & socio-economic parameters etc. ascertained the distress situation that is likely to develop in the area affected by these conditions through sample field verification, and, on the basis of reports available from the Collectors / Deputy Commissioners of concerned districts, the State Government has decided to declare drought of a severe/Moderate nature in the following mandals/tehsils/blocks/villages etc. in the State:

1.
2.
3.

The declaration of drought would come into effect on _____ and would continue to be in effect for six months from this date unless revoked earlier by an order of the State Government.

The State Government hereby authorizes the Collectors / Deputy Commissioners of the concerned districts to undertake relief measures in the notified area.

By the Order and in the name of Honorable Governor

Relief Commissioner/ Secretary, Disaster Management
State Government

Annex 4: Preparation of Memorandum to Government of India for Assistance from the NDRF (National Disaster Response Fund)

State Governments submit Memorandum to the Central Government, in Ministry of Agriculture and Farmers Welfare, seeking assistance for drought relief from the National Disaster Response Fund (NDRF). The Memorandum is submitted after the State Government formally declares drought.

It is recommended that the Memorandum is precise containing all relevant details related to intra-seasonal variation in rainfall, crop condition, food-grain prices, availability of fodder, water crisis, fire incidences, migration, sale of assets, withdrawal of children from schools, etc. and details of relief employment, provision and distribution of foodgrains, supply of drinking water, cattle camps and fodder depots, and any other relief measure organized by the State Government and other organizations, along with expenditures incurred by the State Government.

The Memorandum will clearly specify if the drought is of the 'Severe' category and for assistance shall mandatorily be accompanied by details of the key indicators of drought as specified in Table 3.11 and village-wise field verification data table as referred to in 3.5.1 in Chapter 3 in the National Drought Management Manual.

The second part of Memorandum may provide details. The section may also provide information on other indicators of drought:

The Memorandum should provide the details of assistance requested from the NDRF. Such a request needs to be framed necessarily in accordance with the guidelines prescribed for the NDRF and supported by necessary details. Information on the expenditures incurred through the SDRF, and the balances available with the SDRF should also be mentioned. Request should not be made for items not covered under the extant norms.

STRUCTURE AND CONTENTS OF MEMORANDUM

Table of Contents

Executive Summary

Basic Information regarding the Drought, Magnitude of Relief Efforts, and the Total Demand for Assistance through the NDRF

1. Introduction

- a. Area
- b. Population (Proportion of Scheduled Caste / Tribe Population)
- c. Cultivable Area Crop-wise
- d. Area under Irrigation and Dryland Farming
- f. Total number of farmers in the State (District-wise)
- g. Number of small and marginal farmers
- h. Number of landless agricultural labourers
- i. Agriculture: Its contribution to State GDP

2. Incidence and Spread of Drought

- a. Declaration of Drought (Notification to be attached) the intensity and grounds for such a declaration (Mandatory and Impact indicators and Field Verification Matrix/Tables)
- b. Report on socio-economic indicators (where available)

3. Drought Relief and Mitigation Measures

- a. Relief Employment under the NREGS (District-wise Number of works and total number of workers attending)
- b. Availability and Distribution of Foodgrains
- c. Availability and supply of drinking water: Number of Tanker/Trains / Bullock Carts
- d. Implementation of Temporary Water Supply Schemes
- e. Information on Cattle Camps and Fodder Depots
- f. Information on any other relief measures
- g. Expenditure on Drought Relief and Mitigation Measures

4. Request for Central for Assistance

- a. Agriculture (Assistance to small, marginal and other farmers under irrigated and rainfed cultivation)
- b. Horticulture (Assistance to small, marginal and other farmers)
- c. Water Supply (Temporary Water Supply Schemes)
- d. Water Supply (Deployment of Tankers / Bullock Carts/ Trains)
- e. Cattle camps and fodder depots
- f. Medical care for cattle against epidemics
- g. Relief Employment (Estimated Demand for work)
- h. Supplementary Nutrition
- i. Total funds available under the SDRF
- j. Total Requirement of assistance under the NDRF

ABBREVIATIONS AND ACRONYMS

AET	Actual Evapo-Transpiration
AIBP	Accelerated Irrigation Benefits Programme
AIC	Agriculture Insurance Company of India Ltd
AICRPAM	All India Coordinated Research Project on Agri-Meteorology
AICRPDA	All India Coordinated Research Project on Dryland Agriculture
AISMR	All India Summer Monsoon Rainfall
ATMA	Agricultural Technology Management Agency
AVHRR	Advanced Very High Resolution Radiometer
AWiFS	Advanced Wide Field Sensor
BPL	Below Poverty Line
BRGF	Backward Regions Grant Fund
CAZRI	Central Arid Zone Research Institute
CCEs	Crop Cutting Experiments
CCIS	Comprehensive Crop Insurance Scheme
CDRC	Central Drought Relief Commissioner
CGWB	Central Ground Water Board
CHC	Custom Hiring Centre
CMI	Crop Moisture Index
CMP	Crisis Management Plan
CRF	Calamity Relief Fund
CRIDA	Central Research Institute for Dryland Agriculture
CSOs	Civil Society Organizations
CWC	Central Water Commission
CWWG	Crop Weather Watch Group
CYF	Crop Yield Forecast
DACFW	Department of Agriculture, Cooperation and Farmers Welfare
DACPs	District Agriculture Contingency Plans
DAPs	District Agriculture Plans
DDMC	District Disaster Management Committee
DDP	Desert Development Programme
DEWS	Drought Early Warning System
DIPs	District Irrigation Plans
DLMC	District Level Monitoring Committee
DMC	Drought Monitoring Centre / Disaster Management Centre
DoLR	Department of Land Resources
DPAP	Drought Prone Areas Programme

DRC	District Relief Committee
DRDA	District Rural Development Agency
DST	Department of Science & Technology
EDI	Effective Drought Index
ENSO	El Nino Southern Oscillation
EP	Effective Precipitation
EWS	Early Warning System
FAO	Food and Agriculture Organization
FC	Field Capacity
FCI	Food Corporation of India
FPS	Fair Price Shops
FRL	Full Reservoir Level
GCES	General Crop Estimation Survey
GDP	Gross Domestic Product
GIS	Geographic Information System
Gol	Government of India
GWT	Ground Water Table
GWDI	Ground Water Drought Index
HFL	High Flood Line
HLC	High Level Committee
IA	Implementing Agency
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICDS	Integrated Child Development Services
ICT	Information and Communication Technology
IMCT	Inter-Ministerial Central Team
IMD	India Meteorological Department
IMG	Inter-Ministerial Group
IRS	Indian Remote Sensing Satellite
IWDP	Integrated Watershed Development Programme
IWMP	Integrated Watershed Management Programme
JFMC	Joint Forest Management Committee
KCCs	Kisan Call Centres
LAD	Local Area Development
LPA	Long Period Average
LPS	Litre Per Second
LTA	Long Term Average
MAI	Moisture Adequacy Index

MDPs	Must –Do –Practices
MGNREGS	Mahatama Gandhi National Rural Employment Guarantee Scheme
MLALADS	Local Area Development Schemes for the Members of Legislative Assembly
MNCFC	Mahalanobis National Crop Forecast Centre
MODIS	Moderate-resolution Imaging Spectroradiometer
MoAFW	Ministry of Agriculture and Farmers Welfare
MoES	Ministry of Earth Sciences
MoRD	Ministry of Rural Development
MoWR,RD&GR	Ministry of Water Resources, River Development & Ganga Rejuvenation
MPLADS	Local Area Development Schemes for the Members of Parliament
NADAMS	National Agricultural Drought Assessment and Monitoring System
NAIS	National Agricultural Insurance Scheme
NBSS&LUP	National Bureau of Soil Survey and Land Use Planning
NCCF	National Calamity Contingency Fund
NCCM	National Centre for Calamity Management
NCMC	National Crisis Management Committee
NCMRWF	National Centre for Medium Range Weather Forecasting
NDRF	National Disaster Response Fund
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Wetness Index
NEC	National Executive Committee
NGO	Non Governmental Organization
NIC	National Informatics Centre
NIDM	National Institute of Disaster Management
NOAA	National Oceanic and Atmospheric Administration
NRAA	National Rainfed Area Authority
NRSC	National Remote Sensing Centre
NSC	National Steering Committee
NWDPRA	National Watershed Development Programme for Rainfed Areas
NWP	Numerical Weather Prediction
OFWM	On Farm Water Management
PASM	Percent Available Soil Moisture
PDS	Public Distribution System
PDSI	Palmer Drought Severity Index
PET	Potential Evapo-Transpiration
PMFBY	Pradhan Mantri Fasal Bima Yojana
PMGSY	Pradhan Mantri Gram Sadak Yojana

PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PRI	Panchayati Raj Institutions
PRN	Precipitation needed to Return to Normal conditions
PT	Percolation Tanks
PWP	Permanent Wilting Point
RET	Reference crop Evapotranspiration
RF dev	Rainfall Deviation
RFi	Current Rainfall
RFn	Normal Rainfall
RIDF	Rural Infrastructure Development Fund
RKVY	Rashtriya Krishi Vikas Yojana
RMC	Regional Meteorological Centre
RSI	Reservoir Storage Index
SAC	Space Applications Centre
SAUs	State Agricultural Universities
SDRF	State Disaster Response Fund
SEC	State Executive Committee
SFDI	Stream Flow Drought Index
SG	State Government
SGRY	Sampoorna Grameen Rozgar Yojana
SGSY	Swarnjayanti Gram Swarozgar Yojana
SLCCCI	State Level Co-ordination Committee on Crop Insurance
SLSC	State Level Sanctioning Committee
SLUSI	Soil and Land Use Survey of India
SMC	State Meteorological Centre
SPI	Standardized Precipitation Index
SREGP	Strategic Research & Extension Plan
SRSC	State Remote Sensing Centre
SWSI	Surface Water Supply Index
TY	Threshold Yield
VCI	Vegetation Condition Index
VSAT	Very Small Aperture Terminal
VWC	Village Watershed Committee
WBCIS	Weather Based Crop Insurance Scheme
WiFS	Wide Field Sensor
WRIS	Water Resources Information System
WUA	Water Users Association

GLOSSARY OF TERMS

The glossary defines certain terms as they need to be explained to the uninitiated and understood in the context of this Manual. Some of these terms have been defined in more precise terms in relevant laws and administrative orders, for which those documents could be referred. This glossary conveys a general sense of these terms. Many technical terms, which are already defined in the Manual, are not included in the Glossary

Aanganwadi

A Government-sponsored child-care and mother-care centre in India.

Adaptation

Adjustment in natural or human systems in response to changing climate and policies to minimize the predicted impacts of climate change.

Annewari / Paisewari / Girdawari

An estimate of crop production on the basis of crop-cutting experiment. It is expressed in varying units across the States.

Area Sown more than once

The areas on which crops are cultivated more than once during the agricultural year. This, when added to Net Cropped Area, Gross Cropped Area is obtained.

Block

An Administrative unit, which comprises several Village Panchayats. Several blocks constitute a district.

Block Development Officer

The officer in-charge of development at the block level.

Central Drought Relief Commissioner

An officer of the rank of Additional Secretary to the Government of India in the Ministry of Agriculture & Farmers Welfare, responsible for management and coordination of drought relief at the national level.

Collector

The administrative head of a district.

Crop Rotation

Crop rotation is the practice of growing a series of dissimilar types of crops in the same area in

sequential seasons for various benefits such as to avoid the buildup of pathogens and pests that often occurs when one species is continuously cropped.

Current Fallows

The cropped area which is kept fallow during the current year. It is different from the crop area which remains unsown due to drought.

Finance Commission

A Constitution of India-mandated expert body to deliberate and decide upon the distribution of tax revenues between the Centre and States.

Gaushala

A protective centre for the cows, including those which are neglected.

Geographical Area

The latest figures of geographical area of the district / territory are as provided by the Office of the Surveyor General of India / State Government.

Gram Panchayat

An elected local government at the village level. All the development functions at the village level are vested in Gram Panchayat.

Gram Sabha

All men and women in the village who are above 18 years of age form the Gram Sabha. The Gram Sabha meets twice a year. Meetings of the Gram Sabha are convened to ensure the development of the people through their participation and mutual co-operation.

Gram Sevak

A Government functionary assigned to the Village Panchayat for carrying out administrative and development functions. In some States, Village Administrative officer supported by staff carry out the functions.

Gross Cropped Area

The total area sown once and/or more than once in a particular year, i.e. the area is counted as many times as there are sowings in a year. This total area is also known as total cropped area or total area sown.

High-level Committee

A Committee of Central Ministers which decides upon the quantum of assistance from the National Disaster Response Fund (NDRF) on the basis of recommendations from the Sub Committee of National Executive Committee (SC-NEC).

Hobli

A hobli, nad or mágani is defined as a cluster of adjoining villages administered together for tax and land tenure purposes in the States of Karnataka and Andhra Pradesh, India

Kharif

Kharif crops are usually sown with the beginning of the first rains in June-July, during the South-West Monsoon season, and harvested in autumn.

Mandal

A mandal (like taluka or tehsil) is an administrative division, used in some southern States, like Andhra Pradesh and Telangana.

Minimum wage

Minimum wage ensures basic subsistence. It is fixed and enforced as per the provisions of the Minimum Wages Act, 1948.

Mitigation

Drought mitigation implies taking actions in advance of drought to reduce its long-term risk. It would include policies, activities, plans, and programs, which reduce drought risks.

Mulching

Mulching refers to placing materials on the soil surface to improve soil structure, oxygen levels, temperature, and moisture availability.

Net Cropped Area

This represents the total area sown with crops and orchards. Area sown more than once in the same year is counted only once. Also referred to as "Net Sown Area".

Net Irrigated Area

It is the area irrigated through any source once in a year for a particular crop.

Patwari / Talathi

A revenue department functionary at the village level, entrusted with the responsibility of maintaining land records and land revenue administration.

Panchayat Samiti

Co-terminus with Block. A group of Gram Panchayats constitute a Panchayat Samiti / Block.

Rabi

Refers to the winter crop, which is sown in November-December and harvested in February-April.

Sarpanch / Mukhia

The elected head of the Gram Panchayat

Secretary, Disaster Management / Relief Commissioner

An officer of the rank of Secretary to the State Government, responsible for relief administration and disaster management of the entire state.

Self-Help Group

A group of men / women formed with a common development objective. Self-help groups are useful for securing small loans without collateral security. Members of self-help group collectively monitor loan repayment and income-generation activities.

Sub-divisional Officer

Administrative head of the Sub-division, a constituent unit of the district. A district is divided into sub-division, and sub-division consists of two or three Talukas / Tehsils.

Tagai / Taccavi

A short-term agricultural loan advanced to the farmers for making improvements on their land at a moderate interest. During the British period, farmers availed of Tagai / Taccavi loans on a large-scale during the period of famine.

Tehsil / Taluka

An administrative unit, at times co-terminus with Block, which comprises several Revenue villages. Several Talukas constitute a district.

Tehsildar

A Revenue Officer, who is head of the administrative set up of a Tehsil / Taluka.

Weather Insurance

Weather insurance is provided by insurance companies against weather variations. Insurance payoff is linked to a well-defined threshold, for example, when the actual rainfall is deficient compared to the average seasonal rainfall. Weather variations could be of many kinds.

Wetland Banks

A wetland bank is a wetland stream, or other water body that has been restored, established, or enhanced for the purpose of providing compensation for unavoidable impacts to water bodies elsewhere.

Zila Parishad / Panchayats

An elected local Government, representing village and block Panchayats, at the district level. Supported by a Constitutional provision, the structure.