Extension Approaches for Water Management

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CONTENTS

Sustainable Irrigation Water Management: Context of National Water Policy

Introduction

Although water is the most widely occurring substance on Earth, only 2.53% (35 million km^3) of it is fresh water. The remaining 97.47% (1,365 million km^3) is salt water. Of the small amount of freshwater, only one third is easily available for human consumption, the large majority being locked up in glaciers and snow cover.

Imbalances between availability and demand, the degradation of groundwater and surface water quality, intersectoral competition, interregional and international conflicts, all bring water issues to the fore. Most countries in the Near East and North Africa suffer from acute water scarcity, as do countries such as Mexico, Pakistan, South Africa, and large parts of China and India. Irrigated agriculture, which represents the bulk of the demand for water in these countries, is also usually the first sector affected by water shortage and increased scarcity, resulting in a decreased capacity to maintain per capita food production while meeting water needs for domestic, industrial and environmental purposes. In order to sustain their needs, these countries need to focus on the efficient use of all water sources (groundwater, surface water and rainfall) and on water allocation strategies that maximize the economic and social returns to limited water resources, and at the same time enhance the water productivity of all sectors.

Sustainable Development

The World Commission on Development (known as Brundtland Commission) in 1987 coined a term 'Sustainable Development' and defined as 'Development that meets the need of the present without compromising the ability of the future generations to meet their own needs'. For example, if sustainable water development is considered, it has been known for more than a century that irrigation without appropriate drainage would result in water-logging and salinity, which would, in turn, progressively reduce agricultural yields over a period of time. Since, main objective of introducing irrigation is to increase agricultural yields, clearly any system that does not fulfill this purpose over the long term cannot be considered sustainable.

Worldwide, after a remarkable period of growth, the pace of irrigation's spread slowed substantially toward the end of the twentieth century. Between 1982 and 1994, global irrigated area grew at an average of 1.3 percent a year, down from an annual rate of 2 percent between 1970 and 1982. Irrigation expansion began to reach

diminishing returns. In most of the areas, the best and easiest sites were already developed; bringing irrigation water to new sites was more difficult and costlier.

International Conference on Water and Environment (ICWE) held in Ireland in 1990 indicating the importance of water for sustainable development has made the following recommendations (Dublin Principles)

1. Freshwater is a finite vulnerable resource, essential to sustain life, development and environment
2. Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels
3. Women play a central part in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognized as an economic good.

Water Resources Development in India

India is endowed with water as a precious natural resource; however, its variability in different regions and over time limits its use for different purposes. Central Water Commission (CWC) has assessed India's surface water potential at 1869 billion cubic meters (BCM), of which 690 BCM is considered utilizable; Central Ground Water Board (CGWB) has assessed additional replenish able groundwater resource as 433 BCM. The National Commission on Irrigation and Water Resources Development (NCIWRD) projected both low and high water use requirements for three scenarios of 2010, 2025 and 2050 as given in Table II.1 and concluded that India would fully utilize its water resources by 2050.

Table1. Gross water availability and requirements of all water use in India under different scenarios

Source	Average Annual Utilizable Water Availability* (BCM)	Requirements** (BCM)						
		1997	2010		2025		2050	
		Last Assessed	Low	High	Low	High	Low	High
Surface Water	690	399	447	456	497	545	641	752
Ground Water	433	230	247	252	287	298	332	428
Total	**1123**	**629**	**694**	**710**	**784**	**843**	**973**	**1180**
Return Flows (SW+GW)		96	116	110	107	125	123	169
Unutilized Surface Water		334	295	284	263	219	140	42
Unutilized Ground Water		219	203	202	146	149	96	33
Unutilized Total		553	498	486	409	368	236	75

*Source: * - CWC & CGWB; ** - NCIWRD*

Studies by the International Water Management Institute (Amarasinghe et al, 2007) found that as a result of rising water demand many river basins will be physically water scarce by 2050. According to Amarasinghe of the 19 river basins in India, 8 already have a potentially utilizable water resource of less than 1,000 m^3/capita, with a further 7 currently with less than 1,500 m^3/ha. Only the Narmada (2,448 m^3/capita) and the Mahanadi (2,341 m^3/capita) river basins have adequate water resources available into the foreseeable future. By 2050 10 river basins, with 75 percent of the total population, will have developed all of the potentially utilizable water resources with the consequence that water reallocation between sectors will be a necessary and common occurrence in these basins. It is predicted that in many basins groundwater, with the current levels of recharge and groundwater use patterns, will be in severe crisis; some already are at catchment and sub-basin level.

Currently over 80 percent of the available water is used by the irrigation sector. In some states, such as Punjab, Rajasthan and Uttar Pradesh, the development of irrigation has resulted in the full development of the water resource, leading to critical water scarcity and shortages of water for other uses. As highlighted in the 12th Five Year Plan, where a large proportion of the ultimate irrigation potential has been realized the focus needs to change from construction of new schemes to more efficient and productive management of already constructed schemes.

Improving service delivery becomes important in the context of the National Irrigation Management Fund (NIMF), established under the 12th FYP. By improving service delivery (which will include measures to improve participation by water users in scheme MOM) the level of water charges collected can be increased, leading to an increase in the funds available to the ID from central government for improvements in the management, operation and maintenance of I&D systems.

The relative quantities of water being lost at the different levels need to be looked at carefully. The largest volume of water being lost is usually at the field level where the wetted surface area is high and percolation below the root zone is also high. This is particularly the case where rice is grown with ponded water. The next largest volume of water lost is at the on-farm level, where water is distributed field-to-field or through field channels. The management losses are high at this level, as are the seepage losses as the ratio of discharge to wetted perimeter is low. Relative to these losses the seepage losses in the main canal network are relatively small, but the management losses can be high if the irrigation scheduling or the level of control and management is poor.

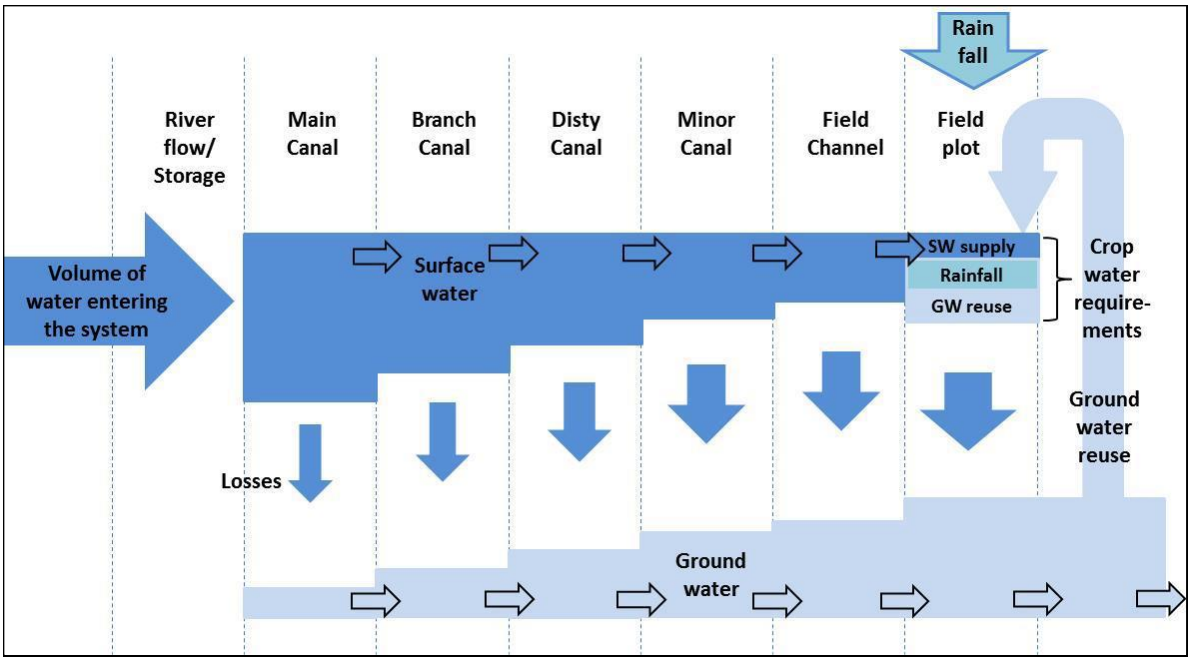

Fig.1. Linkage between different water sources in an irrigation system

Additional area where significant water savings can be made is in active management of rainwater, either by rainwater harvesting on field plots or by allowing for rainfall events in scheduling of irrigation water supplies. Rainwater harvesting can be particularly relevant where paddy is being grown, increasing bund heights to retain larger portions of rainfall events during Kharif can make a significant contribution to conserving water in reservoir-fed systems, leaving more water available for a subsequent Rabi crop.

Benchmarking

Benchmarking can be defined as "A systematic process for securing continual improvement through comparison with relevant and achievable internal or external norms and standards" (Malano and Burton, 2001). Benchmarking can be used to compare the performance of one irrigation schemes with another. By identifying best practice irrigation schemes which form the benchmark for other schemes senior irrigation managers have a valuable tools for raising the performance of all schemes.

A number of benchmarking activities have been carried out since the concept was promoted in the irrigation and drainage sector in the late 1990s/early 2000s (ANCID, 2000; Malano and Burton, 2001; Malano et al; 2004). The ICID formed a Task Force to develop the concept, with early contributions from India and institutionalizing of the process in Maharashtra (GoM, 2008). The Indian chapter of INPIM has suggested indicators for benchmarking and the World Bank is

currently supporting the development of a web site for benchmarking the performance of Water Users' Associations (http://wua-india.org/about.html).

Benchmarking relies on identifying the key processes which transform the inputs into the desired outputs and impacts (Figure 2).

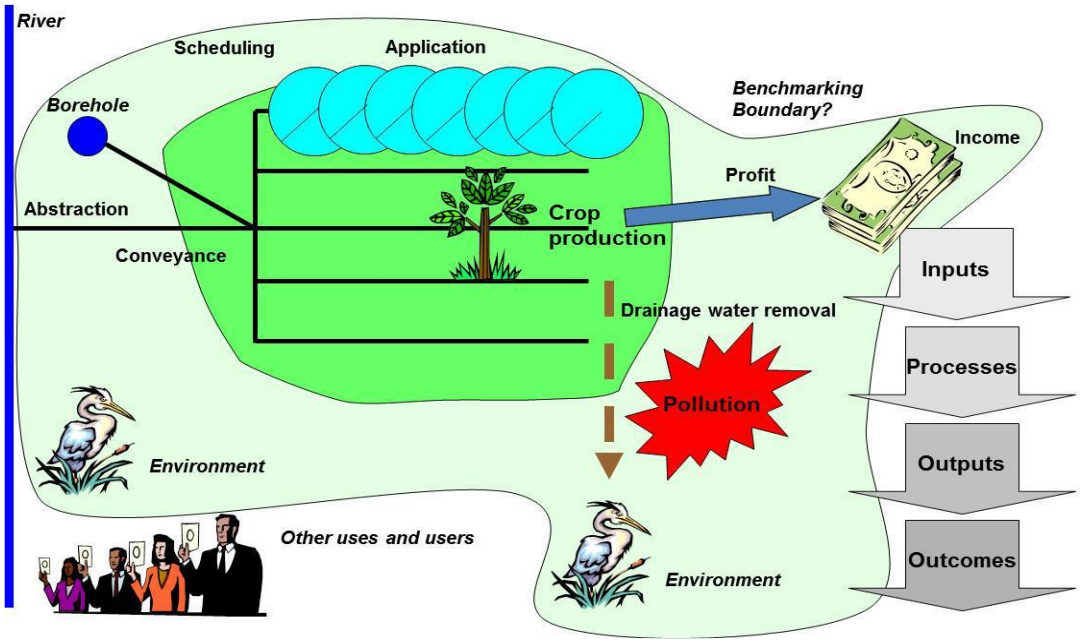

Fig. 2. Identification of key processes in an irrigation and drainage Scheme

The objective a CAD&WM project is to bridge the gap between irrigation potential creation (at canal outlet) and its utilization (in the farmer's fields) through systematically improved land, water and crop management for sustainable optimum agricultural production & productivity of irrigated commands of major and medium irrigation projects and to improve socio-economic condition of the farmers though integration of various activities related to irrigated agriculture. Organized scientific planning and development of each outlet command is envisaged under the programme through systematic topographical and soil surveys, adopting soil & climate reliant cropping patterns, consolidating land holdings for economical farming practices; levelling and shaping each farm to suit crops grown and easing extension services; linking each farm with canal outlet through field channels; streamlining farm inputs such as seeds, fertilizers, pesticides etc.; provide research and extension services to support advanced high yielding agriculture with due emphasis in providing drains and roads to each farm, market, storage and other infrastructure. The approach adopted at inception of the programme was integrated management of on-farm practices assuming that sufficient water would be available for the designed cropping patterns at the farm outlet. Coordinated efforts of all multi-disciplinary departments were planned in an integrated manner to ensure

equitable and efficient delivery of water under irrigation Acts. All Irrigation Acts provide recording of water requirements and deliveries at each control and outlet.

Performance of MMI schemes

The CWC carried out WUE studies for 30 MMI schemes which were analyzed and reviewed by the DSDAP team. Improving the performance of completed MMI schemes has been the main focus of the NWM and the 12th FYP and set a target of increasing the WUE by 20%. The 12th FYP quotes figures from WUE studies carried out by the CWC on 30 MMI schemes in which the WUE on nine schemes was found to be less than 30 percent and the average 38 percent. With the NWM and 12th FYP target the average figure would need to rise to 46%. The assessment concluded that:

i) Nearly all the schemes are integrated in nature, with functions other that for irrigation;

ii) The current hydrological pattern of supply to the schemes varies from the original design conditions;

iii) There are concerns over dam safety due to lack of adequate maintenance;

iv) Excessive siltation of reservoirs has reduced their capacity and ability to supply the required volumes of water;

v) Many of the medium and low storage volume reservoirs have a large surface area relative to their depth, resulting in high seepage and evaporation losses;

vi) In many cases the irrigation system is not able to supply the intended demands. This is due to a number of reasons, including non-availability of flows, inadequate capacity at the head-works, excessive losses (including unauthorized abstractions), inadequate capacity of canals, inadequate operating practices;

vii) In many cases there are problems with cross drainage – either due to the inadequate provision of cross-drainage infrastructure, or damaged or broken infrastructure;

viii) Control and regulation of irrigation flows is hampered by a lack of functioning control structures, including cross and head regulators;

ix) Discharge measurement is limited;

x) Implementation of participatory irrigation management is often limited or non-existent;

xi) Rotation of water supplies or Warabandi is mainly limited to Punjab and Haryana, though Andhra Pradesh is re-introducing such practices;

xii) Actual cropping patterns vary from the design cropping patterns, resulting in a number of issues. These include head-enders growing more water intensive crops (than designed) resulting in inadequate availability at the tail-ends of schemes, and irrigation schedules based on design cropping patterns which fail to match actual needs;

xiii) Irrigation from groundwater, ponds and tanks co-exists with the surface water irrigation system, and forms an important part of the farmers decision-making on which crops to grow;

xiv) In some cases where water scarcity exists scheme authorities have proposed diversification away from paddy to irrigated dry crops without assessing the impact on farmers' livelihood;

As a result of analysis of these case studies, and other reports the DSDAP study concluded that there were six core areas requiring priority attention (Table 2) for improving water use efficiency. These were:-

Table 2. Core areas wise priority attention

Core area	**Required action**
Storage	Consistent and continuous efforts are required to improve the performance of storage facilities in order to enhance the availability of supplies to the irrigation schemes.
Conveyance	Improvements are required in the design and the management of the conveyance systems
On-farm application	On-farm and field irrigation practices need to be improved in order to increase crop production and water use efficiency
Participatory efforts	Beneficiaries need to play an increasing role in the management of the I&D systems
Crop management	A variety of actions are required to improve WUE, including crop diversification, low water use crops, better farm management, micro-irrigation systems and provision of quality inputs
Research and development (R&D)	Further R&D is required into water auditing, scheme monitoring and evaluation and benchmarking

In the CWC summary report (CWC, 2010) the results of the studies for each scheme are summarized and an overall summary provided of the common reasons for low water use efficiency and common recommendations for improvement (Table 3).

Table 3. Common reasons and recommendations for low WUE from studies of 30 irrigation systems (CWC, 2010)

Common reasons for low WUE	**Common recommendations for improvement of WUE**
Damaged structures Silting in the canal system Poor maintenance Weed growth in the canal system Seepage in the system Over-irrigation Illiterate farmers Changing the cropping pattern	Rehabilitation and restoration of damaged/silted canal system Proper and timely maintenance of the system Selective lining of the canal and distribution system Realistic and scientific system operation Revision of cropping pattern, if needed Restoration/provision of appropriate control structures Efficient and reliable communication system Reliable and accurate water measuring system Conjunctive use of ground and surface water Regular revision of water rate Encouragement for formation of Water Users' Association Training to farmers Micro-credit facilities Agricultural extension services Encouragement to farmers for raising livestock

Table 4. Broad constraints to the implementation of WUE improvement solutions

Constraint	Explanation
Political	Politics and the I&D sector are closely intertwined. Political vested interests can be a significant constraint on attempts to modernise the ID or to improve the efficiency and equity of water allocation and distribution.
Institutional (including legal)	Many states have outdated Irrigation and Drainage Acts, only one state, Gujarat, has enacted a separate Water Resources Act. The Irrigation Department's focus on construction of new schemes is not appropriate in states where the ultimate

Organisational	The Irrigation Department was established to plan, design, construct, operate and maintain I&D schemes. Due to the pressure to create new irrigation areas to support a growing population the focus has been on planning, design and construction, not management. The ID is not currently equipped with the right cadres of staff, modern skills and expertise required to efficiently and effectively manage I&D systems.
Technical	Again, in the government sector, the focus has been on construction of new schemes, rather than better management of existing schemes. There is not the knowledge and understanding within the ID which enables it to modernize its processes and procedures for efficient management, operation and maintenance of I&D systems.
Financial	Finance will be a constraint as long as adequate funds are not provided to sustain the built infrastructure. Lack of adequate finance for sustainable MOM of I&D schemes is a major constraint to adequate levels of service provision and scheme performance.
Economic	Small landholdings and subsistence cropping result in many farmers living in poverty. Their economic condition influences their options and decision-making, which may sometimes be optimal for them but sub-optimal for the scheme. Payment of even small sums for the ISF is an issue for many smallholders and/or tenant farmers who lack financial resources.
Social	The large number of smallholder farmers on I&D schemes makes it difficult to implement some measures (such as laser landlevelling) and to change on-farm practices.

Framework for NWUEI support programme assumes vulnerable constrains to be taken up on priority. The guidelines on modernization (ERM) of projects thus requires identification of deficiencies in existing irrigation systems considering suggested mechanism or tools to identify the deficiencies and considering the available options to the reforms. Vulnerable constrains to be taken up on priority. Present guidelines consider extension, restoration/renovation and modernization of the project in one go, which may not be a cost effective solution. Fiscal constraints limit this objective.

Measures to achieve the target of increasing WUE by 20% are set out in the NWM Comprehensive Mission Document (CMD) and the12th FYP. The measures proposed include an integrated mix of reform of the Irrigation Department (ID), physical works, improved maintenance, improved management information systems, conjunctive use of surface and groundwater and greater participation by water users in the management, operation and maintenance (MOM) of I&D schemes. In order to incentivize IDs to reform and address service delivery and

maintenance issues the 12th FYP has introduced the National Irrigation Management Fund (NIMF) which provides funds from central government to states in a 1:1 proportion to the water charges collected, with additional funding where these funds are collected by Water Users Associations (WUAs) and a rebate given to the WUAs. Further funds will be provided where water allocation is made by volumetric measurement.

National Water Policy (2012)

India recognizes water as a scarce national resource fundamental to life, livelihood, food security and sustainable development. Recognizing that the availability of utilizable water under further constraints is leading to competition among different users, there is a growing concern on spreading scarcity due to its life sustaining characteristics and its economic value, mismanagement, poor governance, minimum ecological needs, inefficient use and rising pollution. The National water Policy (NWP) thus takes cognizance of the situation and has sketched a framework of creation of a system of laws and institutions and has drawn a plan of action considering water as a unified resource.

a) Priority on use of water

NWP recognized the need for different use and suggests optimized utilisations for diverse use for which awareness on water as a scarce resource should be fostered. Governance institutions must ensure access to a minimum quantity of potable water for essential health and hygiene to all its citizens at their household. Ecological needs should be determined through scientific studies and a portion of water in rivers should be kept aside to meet ecological requirements. Regulated use of ground water should also consider contribution of base-flow to the river during lean seasons through regulated ground water use.

b) NWP on impact of climate change

NWP recognizes the importance of adaptation to the impacts of climate change by the community through resilient technologies and endorses adaptation to strategies on increasing storages, demand management, stake holder's participation, and paradigm shift in design of river valley projects in coping with strategies to mitigate the impacts of climate change.

c) Enhancing water availability for different use

The availability of water should be periodically and scientifically reviewed and reassessed in various basins every five years considering changing trends in climate change and accounted for in the planning process. Integrated watershed development activities with groundwater perspectives need be adopted to enhance

soil moisture, reduce sediment yield, and increase overall land use productivity of rural development schemes.

d) Demand management

The policy recommends evolution of a system of benchmarks for water uses for different uses, water footprints, and water auditing to promote and incentivize efficient use of water with clear emphasis on improving 'project' and 'basin' water use efficiencies through appropriate water balance and water accounting studies. Institutional arrangements for promotion, regulation and evolving mechanisms for efficient use of water at basin/sub-basin level need be established.

Project appraisal and environmental impact assessment for water uses to inter-alia include:

(i) analysis of water foot prints,
(ii) recycle and reuse including return flows to be a general norm,
(iii) incentivizing economic use of water to facilitate competition,
(iv) adaptation to water saving means in agriculture such as controlled cropping patterns in endowment with climate, micro irrigation, recycling canal seepage through planned conjunctive use,
(v) monitoring a performance and
(vi) Reclamation of commands from water logging, salinity and alkalinity.

e) Regulation of water prices

A water regulatory authority should be established in each state to fix and periodically review and regulate the water tariff system and charges according to the principles of NWP. Volumetric assessment and allocation, entitlement and distribution should be the criteria to ensure equity, efficiency and economic principles. WUAs need be given statutory powers to collect and retain a portion of water charges and reuse of recycled water should be incentivized.

f) Project planning & implementation

The policy document recognizes the need for planning the water resources projects as per efficiency benchmarks to address the challenge of impeding climate change factors. The projects should incorporate social and environmental aspects in addition to the techno-economic aspects through consultative processes with governments, local bodies, project affected people, beneficiaries and stakeholders.

g) Data base and information needs

` The policy stresses the need for establishing a 'national water informatics centre' to collect, collate and process all hydrologic and water related information and maintain all information in an open and transparent manner on a GIS platform.

h) Capacity building, research and training needs

The NWP emphasizes on the need for continuous research and advancement of technology, implementing newer research findings, importance of water balance in spatial and temporal context, water auditing for projects and hydrological systems, bench marking and performance evaluation. Need for regular training of the manpower for skill in water management is also recognized.

The provisions of the new NWP are clearly endorsing the principles of IWRM and suggesting that the framework for water planning, development and management should be clearly governed by these principles.

Conclusions and Recommendations

There are wide ranges of issues constraining the performance of MMI schemes throughout the water supply chain from the watershed to the crop root zone. These issues cover several domains - technical, social, economic, legal, political and environmental – with solutions to specific issues requiring action in a mix of these domains.

Better management lies at the heart of any endeavors to improve the situation. Hitherto the government and the Irrigation Department have focused on the construction of new irrigation systems to increase much needed agricultural production and livelihood security for the rural community. With increasing pressure on available water supplies, as emphasized in the 12th FYP, there is a need to focus on better management of constructed irrigation and drainage schemes, making them more efficient and productive, particularly in relation to their water use.

Good management requires good information based on reliable and accurate data - the 12th FYP has highlighted the need for improved data collection, processing and analysis. These data need to be used by management to understand the performance of irrigation and drainage schemes and to improve such performance where it is found to be inadequate, with benchmarking being used to identify gaps between best practice and less well performing schemes. Emphasis shall be the importance of performance assessment and benchmarking as a basic management tool, it provides understanding of current performance ("where we are now") with identification of desirable and achievable performance ("where we want to be") and, through gap analysis, with actions required to achieve these desired levels of performance ("how we plan to get there"). Every project management shall consider the following points for sustainability of irrigation management.

1. **Water Management under Scarce Conditions.**

The valuable management practices of each project during scarce water conditions need to be recorded. Lessons can be learnt from such experiences for dealing water scarce situations. The state of Andhra Pradesh has managed scarce water situations in Godavari and Krishna delta successfully and also improved productivity. Rotational irrigation and reuses of drainage water were some of the initiatives.

2. **Large Scale Implementation of Water Saving Technologies**

Any measures made towards promotion/execution of methods towards improvement of land and water productivity need to be mapped and accounted. In Krishna Delta presently more than 1 lakh acre area is put under direct seeded rice cultivation annually. Showing is done at the onset of monsoon and once canal water comes it is converted to wet cultivation. It is saving cost of cultivation of about Rs 5000 /- per acre apart from early harvest etc.

3. **Promotion of Micro Irrigation (MI) in large scale**

National task force committee on MI identified 69 million ha areas is suitable for micro irrigation in India. Now time has come to expand micro irrigation into command areas to improve water use efficiency substantially and increase productivity.

4. **Incentivizing Water Saving**

Concepts like virtual water and water credits are to be introduced to create awareness on saving of water and encourage the farmers or agencies for contribution towards improved water use efficiency through some incentives.

5. **Gross Productivity**

Accurate estimation of productivity achieved in each irrigation project is to be recorded accurately and also to be analyzed in terms of economic parameters. The economic value of the crop yields need to be worked out. Comparison with other projects will help in understanding the contribution made.

6. **Multiple Uses of Water and Economic Value**

Irrigation projects are serving important sectors apart from irrigation. It needs to accurately mapped and estimated the water utilized in various sectors and their economic contribution for economy. FAO has developed a tool called MASSMUS Application for evaluating Multiple Uses of Irrigation Projects.

Source: K. Yella Reddy, Director, WALAMTRI, Rajendranagar, Hyderabad
L. Narayan Reddy, Director General, WALAMTRI, Rajendranagar, Hyderabad

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VIRTUAL WATER APPROACH FOR IMPROVED WATER AWARENESS

Introduction

Next to air, the other important requirement for human life to exist is water. It is the Nature's free gift to human race. The use of water by man, plants and animals is universal. As a matter of fact every living soul requires water for its survival. The water plays important role in the agriculture, manufacture of essential commodities, generation of electricity, transportation, recreation, industrial activities, etc. The water can certainly inexhaustible gift of nature. But to ensure their services for all the time to come, it becomes necessary to maintain, conserve and use these resources very carefully in every sphere of life. When you know that nothing on Earth can live without freshwater, that a human can't survive after three days without it, you see how precious this resource is – and how much we need to protect it.

Limited Fresh Water

Although water is the most widely occurring substance on Earth, only 2.53% of it is fresh water. The remaining 97.47% is saltwater. Of the small amount of freshwater, only one third is easily available for human consumption, the large majority being locked up in glaciers and snow cover

Water Crisis

Of all the social and national crises we face today, the water crisis is the one that lies at the heart of our survival, and that of our planet earth. As all different modes of water use have continued to increase, many countries, especially those located in arid and semi-arid regions have started to face crises, although the magnitude, intensity and extent of the crisis could vary from country to another or even within the same country, and also over time. Not surprisingly, the responses of individual countries, or even states or provinces within a large country, to reduce the impacts of that crisis could vary as well. There are many, often interrelated, factors that could make the water crisis more pervasive in different parts of the world in the coming years.

Increasing population and higher levels of human activities, including effluent disposals to surface and groundwater sources, have made sustainable management of water resources a very complex task throughout the world. In addition, per capita demand for water in most countries is steadily increasing as more and more people achieve higher standards of living and as lifestyles are changing rapidly. Table 1 shows the population growth, annual renewable freshwater available and per capita availability for selected countries (Biswas, 1998).

Table.1. Population and per capita water availability for selected countries

Country	**Population, Millions**			**Fresh water, km^3**	**Per capita fresh water, 1000 m^3**		
	1994	2025	2050		1994	2025	2050
Brazil	150.1	230.3	264.3	6950	46.30	30.18	26.30
Canada	29.1	38.3	39.9	2901	99.69	75.74	72.70
China	1190.9	1526.1	1606.0	2800	2.35	1.83	1.74
Indonesia	189.9	275.6	318.8	2530	13.32	9.17	7.94
USA	260.6	331.2	349.0	2478	9.51	7.48	7.10
Bangladesh	117.8	196.1	238.5	2357	20.00	12.02	9.88
India	**913.6**	**1392.1**	**1639.1**	**2085**	**2.28**	**1.50**	**1.27**
Argentina	34.2	46.1	53.1	994	29.06	21.56	18.71
Japan	124.8	121.6	110.0	547	4.38	4.50	4.97
Turkey	60.8	90.9	106.3	203	3.34	2.23	1.91
UK	58.1	61.5	61.6	120	2.07	1.95	1.95
Egypt	57.6	97.3	117.4	59	1.02	0.60	0.50

India, with 2085 km^3 of renewable water resources stands 7^{th} in the world, but due to its huge population over 1 billion, it attained 133^{rd} position in terms of per capita availability of water.

Water Scarcity

UNESCO has defined water scarcity based on the per capita availability of usable water as

Below 1700 m^3 per capita/year : **Water scarce**

Less than 1000 m^3 per capita/year : **Severely water scarce**

When country's renewable water supplies drop below about 1700 cubic meters per capita, it becomes difficult for that country to mobilize enough water to satisfy all the food, household, and industrial needs of its population. Countries in this situation typically begin to import grain, reserving their water for household and

industrial uses. At present, 34 countries in Asia, Africa, and Middle East are classified as water stressed, and all but two of them-South Africa and Syria are net importers of grain. Collectively, these water stressed countries import nearly 50 million tons of grain a year. By 2025, the number of people living in water stressed countries is projected to climb from 470 million to 3 billion- more than six fold increase.

Water Usage

Water is intrinsic to our lives and to the ecosystems on which we all depend. Water is essential to life in every way, we need clean water for drinking, adequate water for sanitation and hygiene, sufficient water for food and industrial production, and much of our energy generation relies on or affects water supplies. Demographic and urban growth over the next century will mean a far greater demand for water for industrial production. Competition between users, and sectors, is therefore becoming increasingly important (Table 3). World's water usage pattern in the previous century, which is growing at alarming rate, is shown in Fig 1.

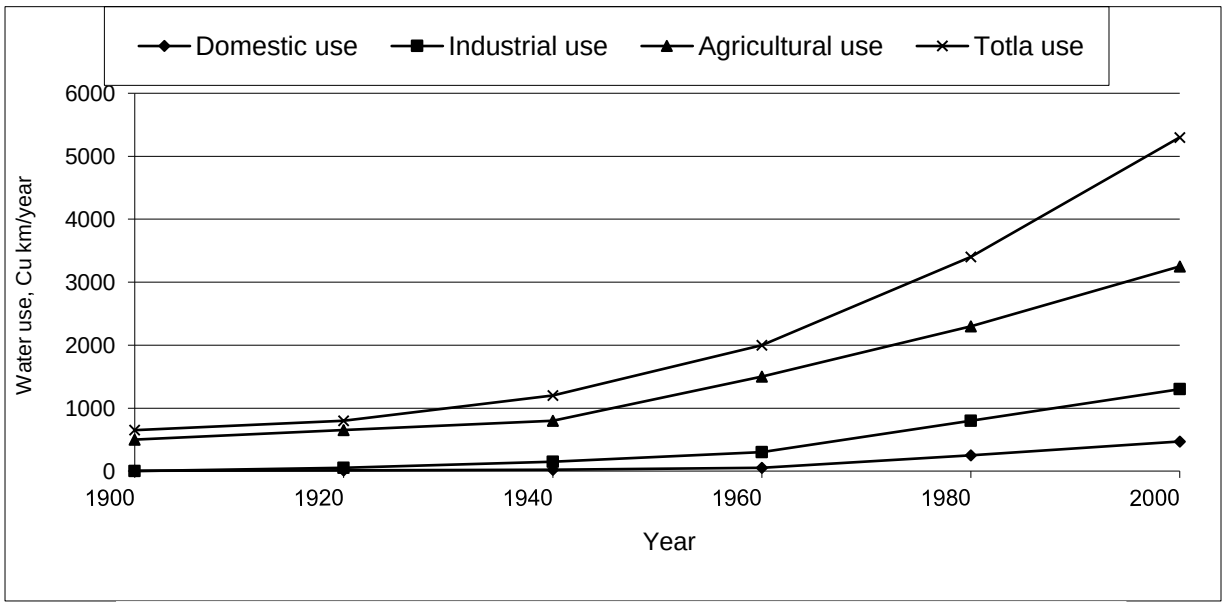

Fig.1 World's water use pattern in 20th century

Table 2. Comparison of water usage in different sectors

Usage in (%)	World	Europe	Africa	India
Agriculture	69	33	88	82
Industry & others	23	54	5	12
Domestic use	8	13	7	6

Water for Agriculture

Almost 70% of all available freshwater is used for agriculture (Table 3). Over pumping of groundwater by the world's farmers exceeds natural replenishment by at least 160 billion cubic meters a year. It takes an enormous amount of water to produce crops: three cubic meters to yield just one kilo of rice, and 1,000 tons of water to produce just one ton of grain. Land in agricultural use has increased by 12% since the 1960s to about 1.5 billion hectares. Current global water withdrawals for irrigation are estimated at about 2,000 to 2,555 km^3 per year.

For the last half-century, agriculture's principal challenge has been raising land productivity- getting more crops out of each hectare of land. As we have stepped into the twenty first century, the new frontier is boosting water productivity **getting more from every litre of water devoted to crop production.** More than half of the water removed from rivers and aquifers for irrigated agriculture never benefits a crop. Because water performs many functions as it travels through the landscape toward the sea, however, it is important to think systematically about where water goes once it comes under human management

There is long and growing list of measures that can increase agricultural water productivity. The key is to custom design strategies to fit the farming culture, climate, hydrology, crop choice, water use pattern, environmental conditions, and other characteristics of each particular area.

Drip irrigation ranks near the top of measures with substantial untapped potential. In contrast to a flooded field, which allows a large share of water to evaporate without benefiting a crop, drip irrigation results in negligible evaporation losses. When combined with soil moisture monitoring or other ways of assessing crop's water needs accurately, drip irrigation can achieve efficiencies as high as 95

percent, compared with 50-70 percent for more conventional flood or furrow irrigation.

Water Footprint

Water Footprint is quite simply the volume of water used. At the individual level, this is expressed in litres. But at the national level, this becomes complex - The water footprint of a nation is equal to the use of domestic water resources, minus the virtual water export flows, plus the virtual water import flows.

The total 'water footprint' of a nation is a useful indicator of a nation's call on the global water resources. The water footprint of a nation is related to dietary habits of people. High consumption of meat brings along a large water footprint. Also the more food originates from irrigated land, the larger is the water footprint. Finally, nations in warm climate zones have relatively high water consumption for their domestic food production resulting in a larger water footprint. At an individual level, it is useful to show the footprint as a function of food diet and consumption patterns.

Virtual Water

The concept of virtual water links a large range of sectors and issues that revolve around relieving pressures on water resources, ensuring food security, developing global and regional water markets.

The concept of virtual water emerged in the early 1990s and was first defined by Professor J.A. Allan as the water embedded in commodities. Producing goods and services requires water; the water used to produce agricultural or industrial products is called the virtual water of the product.

Virtual water is an essential tool in calculating the real water use of a country, or its **water footprint**, which is equal to the total domestic use, plus the virtual water import, minus the virtual water export of a country. A nation's water footprint is a useful indicator of the demand it places on global water resources. By importing virtual water, water poor countries can relieve the pressure on their domestic water resources.

At the individual level, the water footprint is equal to the total virtual water content of all products consumed. A meat diet implies a much larger water footprint than a vegetarian one, at an average of 4,000 liters of water per day versus 1,500.

Being aware of our individual water footprint can help us use water more carefully. Virtual water of some of the important products is shown in the Table 3.

Table 3. Virtual water of some important products

Commodity	Virtual water
1 cup of coffee	140 liters
1 liter of milk	800 liters
1 kg maize	900 liters
1 kg of wheat	1100 liters
1 kg of rice	3000 liters
1 kg sugar	3200 liters
1 kg chicken	6000 liters
1kg beef	16000 liters

Adopting a virtual water strategy: a solution for water-poor countries?

Some experts argue that the importing of virtual water (via food or industrial products) can be a valuable solution to water scarcity, especially for arid countries that depend on irrigation to grow low-value food with high water needs.

For example, growing one tonne of grain or wheat requires about 1,000 m^3 of water; growing the same amount of rice requires up to thrice as much. The value of the water used for producing these food staples in water-poor countries turns out to be many times higher than the value of the product. Thus, instead of using their scarce water resources for water-intensive products, such countries can import cheap food, and relieve the pressure on their own water resources. Already a number of countries, such as Israel and Jordan, have formulated policies to reduce export of water-intensive products. Currently, 60 to 90% of Jordan's domestic water is imported through virtual water. Still, some countries are afraid of becoming dependent on global trade – those with large populations, for example, such as China or India. What would happen if, for some reason, their food demands could not be met? This explains why they are trying, as far as possible, to fill their own food needs.

Threatened water resources in countries with net water export

In a world experiencing great population growth and ever increasing water use, our concern about the future is very understandable. Global trends are not optimistic, and show increasing environmental, social, and economic difficulties as a result of the many competing pressures on our natural resources.

The main pressures

During the past century, the world population has tripled, and water use has increased six-fold. These changes have come at great environmental cost: half the wetlands have disappeared during the 20th century, some rivers don't reach the sea anymore, and 20% of freshwater fish are endangered.

The main reasons affecting availability of water are

a) Geopolitical changes, b) Population growth, c) Agricultural demand, d) Energy requirements, e) Urbanization, f) Economic growth and industry, g) Globalization, h) Technological changes i) Lifestyle, j) Recreation and tourism, k) Climate change.

International Conference on Water and Environment (ICWE) held in Ireland in 1992 has made the following recommendations (Dublin Principles) indicating the importance of water for sustainable development.

- Freshwater is a finite vulnerable resource, essential to sustain life, development and environment
- Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels
- Women play a central part in the provision, management and safeguarding of water.
- Water has an economic value in all its competing uses and should be recognized as an economic good.

Conclusions

The world and more importantly the developing countries are heading towards water stress and scarcity. They are left with no alternative but to adopt modern irrigation technologies, which save water, double the area under irrigation, improve yields and quality as well as save on labour, energy and crop production costs. In India more than 82% of the total water is used for agriculture with very low irrigation efficiencies. It is expected that in the next 7-8 years, there will be cut of about 10% irrigation water for meeting ever-increasing demand from domestic,

industrial and other sectors. Hence, there is necessity to adopt water saving production technologies and also undertake large-scale micro irrigation projects like Andhra Pradesh Micro Irrigation Project (APMIP) to bring more areas under micro irrigation systems improving water use efficiencies to as high as 95%.

Source: K. Yella Reddy, Director, WALAMTRI, Rajendranagar, Hyderabad

MICRO IRRIGATION IN PARTICIPATORY MODE – APMIP EXPERIENCES

Dr K Yella Reddy[1]

ABSTRACT

Almost 70% of all available freshwater is used for agriculture across the world. In India more than 80 % of the renewable water resources are consumed in agriculture alone. Many of the world's most important grain lands are consuming groundwater at unsustainable rates. As we have stepped into the twenty first century, the new frontier is boosting water productivity, getting more from lesser amount of water devoted to crop production.

Government of Andhra Pradesh has launched the Andhra Pradesh Micro Irrigation Project (APMIP) in 2003 to promote this water saving irrigation technology in large scale for sustainable development of agriculture. The major thrust was on to put the 3 million electrified pump sets in the state of Andhra Pradesh into micro irrigation. The project has so far covered more than 1.042 m ha area under micro irrigation systems in 9 years period with capital investment of Rs 31,970 million (US $ 533 million @ Rs 60 per 1 US$), benefiting 0.66 million farmers.

The project has helped in improving the crop productivity, saving in water and energy and creating employment opportunities. The project is contributing to an additional productivity of worth Rs 15,260 million (US $ 254 million) per annum. On annual basis the project is indirectly helping in saving of 155.7 TMC of water (1 TMC = 2800 ha m), 593 million kWh of energy. On annual basis every rupee invested in micro irrigation pays Rs 2.4 through additional productivity. The attractive payback period of less than 3 years has influenced the bankers to provide loans to farmers to procure micro irrigation systems. The success of APMIP has led to the introduction of micro irrigation into canal commands under various lift irrigation projects in Andhra Pradesh.

Key words: APMIP, Micro Irrigation, Payback period, Participatory Approach

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INTRODUCTION

Although water is apparently abundant on Earth, only 2.53% (35 million km^3) of it is fresh water. The remaining 97.47 % (1,365 million km^3) is salt water. Of the small amount of freshwater, only one third is easily available for human consumption, the large majority being locked up in glaciers and snow cover.

Imbalances between availability and demand, the degradation of groundwater and surface water quality, inter-sectoral competition, inter-regional and international conflicts, all bring water issues to the fore. Most countries in the Near East and North Africa suffer from acute water scarcity, as do countries such as Mexico, Pakistan, South Africa, and large parts of China and India (Anonymous, 2006). Irrigated agriculture, which demands bulk of the water in these countries, is also usually the first sector affected by water shortage, resulting in a decreased capacity to maintain per capita food production while meeting water needs for domestic, industrial and environmental purposes. In order to sustain their needs, these countries need to focus on the efficient use of all water sources (groundwater, surface water and rainfall) and on water allocation strategies that maximize the economic and social returns to limited water resources, and at the same time enhance the water productivity of all sectors. Importing of virtual water (via food or industrial products) can be a valuable solution to water scarcity, especially for arid countries that depend on irrigation to grow low-value food with high water needs.

Water for Agriculture

Almost 70% of all available freshwater is used for agriculture. Over pumping of groundwater to meet agricultural water demand worldwide exceeds natural replenishment by at least 160 billion cubic meters a year. It takes an enormous amount of water to produce crops: three cubic meters to yield just one kilogram of rice, and 1,000 tons of water to produce just one ton of grain (Biswas, 1998). Land in agricultural use has increased by 12% since the 1960s to about 1.5 billion hectares. Current global water withdrawals for irrigation are estimated at about 2,000 to 2,555 km^3 per year.

Agriculture is responsible for most of the depletion of groundwater, along with up to 70% of the pollution. For the last half-century, agriculture's principal challenge has been raising land productivity- getting more crops out of each hectare of land. As we have stepped into the twenty first century, the new frontier is boosting water productivity getting more from every liter of water devoted to crop production. There is long and growing list of measures that can increase agricultural productivity.

Micro Irrigation

Micro irrigation ranks near the top of measures with substantial untapped potential. In contrast to a flooded field where much of the applied water is lost in evaporation without benefiting a crop, drip irrigation results in negligible evaporation losses. When combined with soil moisture monitoring or other ways of assessing crop water needs accurately, drip irrigation can achieve efficiencies as high as 95 percent, compared with 50-70 percent for more conventional surface irrigation. In Micro Irrigation water is carried through small tubing and delivered to the plant near its stem to gradually seep towards the root zone.

Micro Irrigation technologies adopted at 6 different location in Kullu district of Himachal Pradesh under Farmers Participatory Action Research Program (Dhanbir Singh and Vinod Sharma, 2013), resulted in yield increase of 20-90 percent and water saving of 30-80 per cent over surface methods of irrigation and helped improving the economy of the farmers.

François Brelle and Etienne Dressayre (2014) have discussed the issues involved in financing irrigation with an aim to take up the challenge of a sustainable increase in production of more and better food while better preserving ecosystems and natural resources. Questions, and thus answers, differ for funding infrastructures and for paying for water service. Financing setting up, rehabilitation or modernization, operation and maintenance of systems for collective irrigation are considered.

Cost-effectiveness analysis of four water-saving irrigation techniques that are widely implemented in China (Xiaoxia Zou et al, 2013) finds that water-saving irrigation is cost-effective in coping with climate change, and has benefits for climate change mitigation and adaptation, and for sustainable economic development. Micro-irrigation has the highest incremental cost for adaptation followed by sprinkler irrigation and low-pressure pipe irrigation, but when considering the revenues from improved adaptation, all of the measures assessed are economically feasible. The results suggest that for mitigation and adaptation objectives, micro-irrigation performs best.

Drip irrigation has long been promoted as a promising way to meet today's world water, food and poverty challenges. In most scientific and policy documents, drip irrigation is framed as a technological innovation with definitive intrinsic characteristics—that of efficiency, productivity and modernity. Based on evidence from North and West Africa as well as South Asia, Jean-Philippe Venot et al (2014) showed that there are multiple actors involved in shaping this imagery, the legitimacy of which largely stems from an engineering perspective that treats technology and potential as ‘truths’ that exist independently of the context of use.

Kevin M. Andrezejewski (2014) reported that iDEal's Global Supply serves as the distribution enterprise for these micro-irrigation technologies, providing sample products, bulk shipments, and technical support for both iDE Country Programs and other individuals and organizations worldwide. To provide widespread access to the affordable, simple, and appropriate micro-irrigation products, iDEal has established a reliable network of international and local supply chain sources. The key components of this network are *product support, order fulfillment, marketing and technical assistance*.

A National Task Force Committee, appointed by the Government of India (GOI) in 2003, has recommended that 69 million ha area is suitable for micro irrigation in India. A target of 14 M ha has been suggested for the 11th five-year plan. In view of the various advantages the technology offers, today the GOI and state governments are keen to promote micro irrigation in a large scale.

AP MICRO IRRIGATION PROJECT

Realizing the importance for economic use of precious ground water for irrigation, Government of Andhra Pradesh (AP) has launched the Andhra Pradesh Micro irrigation Project (APMIP), first of its kind in the world on 3rd November 2003. The project was aimed at bringing 0.25 million hectares (Mha) area under micro irrigation in 22 districts of AP, with financial outlay of Rs. 11763 million for 5 years.

Initiatives of the Government

Govt of AP has taken up number of measures for promoting micro irrigation, like i) Providing subsidy of the system cost, ii) Creation of separate project cells in the districts iii) Positioning of qualified technical persons, iv) Organizing exposure visits and capacity building training programs, v) Guarantee of the MI equipment against manufacturing defects, vi) Quality check of equipment through CIPET, vii) Monitoring and Evaluation through third party agencies and viii) Providing agronomic and extension services. These measures have helped in confidence building and lead to greater demand for micro irrigation in the state.

The state has about 3 million tube wells fitted with pump sets owned by the farmers. Any farmer having land, water source and suitable pump set is eligible for obtaining benefits of MI system under the project.

Project Implementation

Implementing agencies have been setup at state level and district level for discussing policy issues and for implementation of the project. At the state level a committee called 'State Micro Irrigation Committee (SMIC)' is created involving various line departments of government and institutions under the chairmanship of Agricultural Production Commissioner (APC) & Principal Secretary. All policy

decisions are taken by SMIC, including annual plan approvals. The Commissioner of Horticulture of Government of AP implements the program. Technical committee examines all issues and recommends to the standing committee. The project has designed various micro irrigation systems for different crops by considering the field requirements, adaptability by the farmers and also hydraulics and economic parameters (Reddy and Tiwari, 2006). The MI systems provided in the project were i) on line and in line drip irrigation systems, ii) micro sprinklers and micro jets, iii) portable and semi-permanent sprinkler systems. A state level senior official heads the project as Project Officer supported by five senior officers of different disciplines. The state level organizational setup is shown in Fig 1.

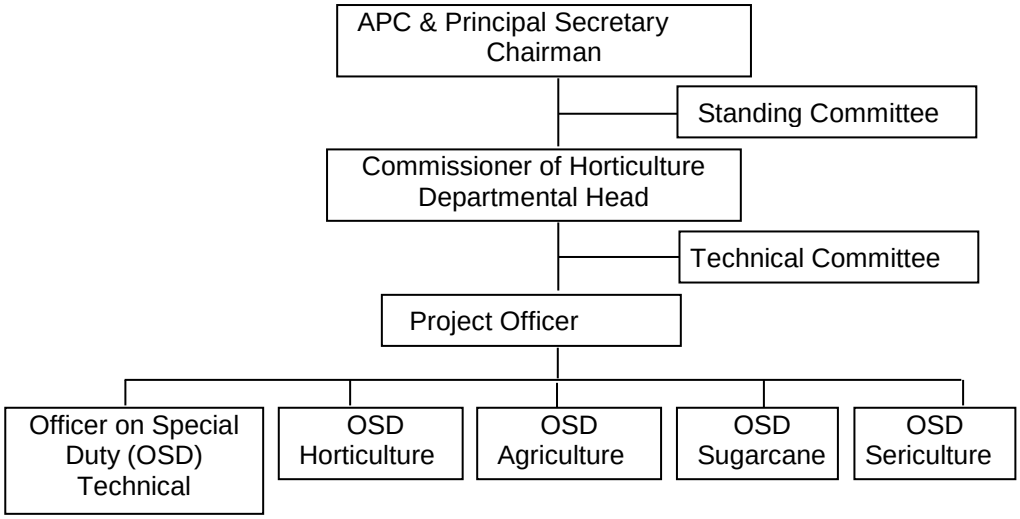

Fig 1. State level organizational setup of APMIP

At district level the District Collector acts as the chairman of the project. The Project Director, APMIP heads the project. One Assistant Project Director, a senior officer from Agriculture/Horticulture/Sericulture departments, acts as the Nodal Officer. For technical support two Micro Irrigation Engineers are placed in each district to examine the survey reports, designs, Bill of Quantities (BoQs) and they also carryout field inspections. For providing agri-extension services and capacity building a core team comprising two Agronomist/Horticulturist are provided. At Mandal level (cluster of villages of 5-6 Gram Panchayats) Micro Irrigation Area Officers (MIAO) are placed for providing services to the farmers. In the districts where the work load is more due to more demand for micro irrigation, more number of technical staff is placed.

Progress of APMIP

The project prepares annual plans for coverage of Micro Irrigation in the state based on the requirements and demands. After obtaining necessary approvals from the government it is executed in the districts. The annual coverage in various crops

is shown in Table 1 (Anonymous, 2012, 2013). The project has created national record by bringing the highest area under micro irrigation in the country (Table 2).

Table 1. Crop wise area covered since inception to March 2014

Sl.No.	Name of the Crop	2003-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
1	2	3	4	5	6	7	8	9	10	11	12
	Drip										
1	Banana	5132	5187	4896	5863	8718	4712	5361	2516	2605	44990
2	Cotton	897	35	65	143	2789	3094	2293	2811	1894	14021
3	Flowers	28	95	228	293	288	142	248	228	257	1807
4	Grapes	793	262	149	102	86	36	24	19	9	1480
5	Medicinal & Aromatic Plant	10	434	75	95	76	59	49	17	5	820
6	Sericulture	228	0	75	91	396	333	389	319	395	2225
7	Spices	1112	2	2113	3034	9575	5818	16974	18724	12170	69521
8	Sugarcane	8439	4013	1251	1727	3351	3485	5506	3768	5188	36728
9	Tobacco	9	0	268	675	151	29	227	123	2	1484
10	Vegetables	502	5665	3268	4363	14939	10299	18491	25215	27042	109783
11	Pappya	3486	1943	2585	1750	1574	1526	1254	932	2215	17265
12	Cashew	168	311	51	15	133	257	237	123	124	1420
13	Citrus	2236	31679	34853	29464	18077	14522	6500	4350	3372	145052
14	Coconut	306	479	697	781	1726	1720	1468	594	780	8551
15	Jatropha	3166	0	0	0	0	0	0	0	0	3166
16	Mango	11449	10947	23453	30945	28105	32278	13727	14598	7010	172512
17	Oilpalm	7235	0	5078	8072	8048	6594	5429	4703		45159
18	Pomegranate	1705	504	493	530	254	416	244	137	376	4659
19	Sapota	2854	612	1142	1305	1037	1088	288	72	148	8546

20	Others (watermelon, Anjura, Custard Apple, etc)	30742	4090	9260	6393	8988	4937	3149	1280	3629	72469
Total		**80497**	**66258**	**90000**	**95641**	**108311**	**91345**	**81857**	**80529**	**67221**	**761658**
21	**Sprinkler** (Ground nut, pulses, etc.)	85790	23750	30000	36202	38472	38340	28206	237	4	281001
Grand Total		**166287**	**90008**	**120000**	**131843**	**146783**	**129685**	**110063**	**80766**	**67225**	**1042660**

Table 2. Coverage of MI systems since inception of APMIP

Year	Area covered under micro irrigation, ha		
	Sprinkler	Drip	Total
2003-04	20,770	3,780	24,550
2004-05	40,020	24,905	64,925
2005-06	25,000	51,811	76,811
2006-07	23,750	66,258	90,008
2007-08	30,000	90,000	1,20,000
2008-09	36,202	95,641	1,31,843
2009-10	38,472	1,08,311	1,46,783
2010-11	38,340	91,345	1,29,685
2011-12	28,206	81,857	1,10,063
2012-13	237	80,529	80,766
2013-14	4	67,221	67,225
Total	**2,81,001**	**7,61,658**	**10,42,659**

Micro Irrigation Pays

Implementation of APMIP has created large awareness among the farmers in the state about various advantages of micro irrigation. Many farmers have realized the benefits of micro irrigation in terms of improvement in yields, water saving, fertilizer saving and reduction of labor requirement. In order to assess the impact of the project more than 500 case studies of various crops have been collected from the districts across the state. Data on various parameters were collected in a structured format and were systematically analyzed to quantify the benefits.

Effect of MI in sugarcane

A sample economic analysis was carried out on 12 cases of drip irrigated sugarcane crop. Actual cost of cultivation, cost of drip irrigation system, yield obtained, and energy used for pumping and volume of water pumped was used for conducting economic analysis. The analysis has revealed that additional income of about Rs 1,07,800 per ha was obtained due to higher cane yield by using drip irrigation. By considering average cost of MI system as Rs 95,000 per ha the payback period worked out as 0.88.

The project (APMIP) has covered 36,728 ha of sugarcane crop under drip systems till March 2014. Based on the inputs received from the field studies, the projected benefits are worked out and presented in Table 3.

Table 3. Additional monetary benefits due to drip irrigation for sugarcane

Item	Surface method	Drip method	Saving/ Increase	Unit value	Amount, Rs. million
Water required	80,802 ha m	36,728 ha-m	44,074 ha-m	Rs. 2000/- per ha-m	88.15
Energy required	92.74 m kwh	42.60 m kwh	50.14 m kwh	Rs. 2/- per kwh	100.28
Yield	3.0117 m ton	4.8114 m ton	1.7997 m ton	Rs. 2200/- per ton	3959.34
				Total	4147.77

With certain assumptions, the energy requirement for pumping is estimated at 2,525 kWh and 1,160 kwh respectively for surface and drip irrigation methods for irrigating one ha area. This indicates that for every hectare of sugarcane crop with drip system there would be a saving of 1.2 ha m of precious ground water and 1,365 kWh energy in comparison to surface method of irrigation.

The projected benefits due to drip irrigation in sugarcane crop in 36,728 ha indicates that there would be a saving of 44,074 ha m of precious ground water, and 50.14 million units of electricity every year apart from 1.80 million tons of additional cane. These additional benefits converted into monetary terms are equivalent to Rs. 4148 million (US$ 69.13 million).

Additional income generated through drip for sugarcane divided by the annual cost gives the net benefit derived per every rupee investment in sugarcane. It shows that every rupee spent on drip system for sugarcane results in additional benefit of Rs. 5.8.

Overall impact of APMIP

The project by covering 1.042 M ha has contributed significantly in improving the gross productivity of fruits, vegetables, flowers, spices and other agricultural products. The overall impact of APMIP has been summarized to present impact of implementation as presented in Table 4. Capital Recovery Factor was used to calculate annual costs and to carry out economic analysis.

Annual costs of MI systems can be obtained by multiplying their costs with capital recovery factor (CRF) (James and Lee, 1971).

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1} \quad \text{... (1)}$$

Where, i = yearly interest rate, and n= average life of the system

Table 4. Summary of Economic Analysis

S.No	Paremeter	Value
1.	Total Area Covered	1.0427 M ha
2.		
	a) Drip	0.7617 M ha
	b) Sprinkler	0.2810 M ha
3.	MI system cost	4147.77
	a) Total cost	Rs 41, 708 Million
	b) Farmers contribution	Rs 10,427 Million
4.	Annual Cost (CRF 0.2055) based on	
	a) Total cost	Rs 8,571 Million
	b) Farmers contribution	Rs2,143 Million
5.	Value of Additional yield (@Rs 15,000/ha minimum)	Rs15,640 million
5.	Payback period based (2/4)	
	a) Total cost	2.7 years
	b) Farmers contribution	0.7years
6	Every rupee spent on MI yields (4/3) based on	
	a) Total Annual Cost	Rs 1.8
	b) Annual cost of Farmers contribution	Rs 7.3

In the economic analysis of the entire project, the contribution of the farmer and also by the government (as subsidy) towards the cost of micro irrigation system was considered. The additional income due to increased productivity was considered at the rate of Rs 15,000 (US$250) per ha. The annual cost of owning the system was worked out by considering the average life of the system as 7 years and interest rate of 10%. It is seen from the above table that the payback period comes to less than 3 years based on the total cost of MI system and it is less than 1 year by considering farmers own contribution. It reveals that the government support makes it very attractive to the farmers to adapt this technology. A payback period of 3 years is considered to be very encouraging factor for the bankers to finance such projects.

In addition to the direct benefit of yield increase, the project also helped indirectly a) water saving of 149 TMC (1 TMC = 2800 ha m), b) energy saving of 417 million kwh, c) large labor saving and d) employment generation.

Micro irrigation in canal commands

In order to extend the benefits of micro irrigation to the farmers of canal commands of major lift projects, the Govt of AP has commenced a new project called LIMIP to bring 0.8 Mha area under micro irrigation. Guidelines and designs are finalized and the pilot projects are under execution in Nalgonda and Kadapa districts.

In LIMIP the water from the canal will be drawn to a sump and from there it will be delivered to the individual farm with required pressure and discharge. The operating time of the system will depend upon the power availability at farm level, which is 7 hrs a day.

Reasons for success of APMIP

The success of MI in Andhra Pradesh is mainly due to the way the program has been executed by the government in a Project Mode and from supply driven now it has been converted to demand driven program. In many of the districts of Andhra Pradesh, the farmers say 'No Drip-No Plantation' indicating how much they want drip systems for their plantations. Some of the reasons for the success of the project are listed below.

i) The project has strong structural arrangement at state level and district level. Each district has separate APMIP cell headed by Project Director.

ii) Special focus given by the Government. Frequent reviews by Hon'ble Chief Minister, Minister of Agriculture and other officials.

iii) Number of measures taken up for creation of awareness among the farmers. Exposure visits, Kalajatara Programs, Television and Radio programs, Live-demonstrations at State level, district level and divisional level were conducted regularly for five years.

iv) The project has been supported with strong technical team. Officer on Special Duty (Technical) at state level provides technical support. In each district 2 to 5 MI Engineers are placed (Preference to Agril. Engineers).

v) Establishments of demonstration plots for different crops in all mandalas of Andhra Pradesh

vi) Appointment of diploma and degree graduates of agricultural/horticultural and science graduates to support the project at district/Mandal level. About 600 people are placed in the entire state.

vii) Labor saving in irrigation is one important reason the farmers attribute for going for micro irrigation.

viii) The project is successful due to the fact that large public money has been spent as subsidy to make the system cost affordable to the farmers

SUMMARY AND CONCLUSIONS

The world and more importantly the developing countries are heading towards water stress and scarcity. They are left with no alternative but to adopt modern irrigation technologies, which save water, double the area under irrigation, improve yields and quality as well as save on labor, energy and crop production costs. In India more than 82% of the total water is used for agriculture with very low irrigation efficiencies. It is expected that in the next 7-8 years, there will be cut of about 10%

irrigation water for meeting ever-increasing demand from domestic, industrial and other sectors. Hence, there is necessity to undertake large-scale micro irrigation projects like Andhra Pradesh Micro Irrigation Project (APMIP) to bring more areas under drip irrigation systems improving water use efficiencies to as high as 95%. The following conclusions can be drawn

1. The beneficiaries have realized the benefits of micro irrigation in terms of water saving, higher yields and reduction in labor requirement.
2. Many state governments are showing interest to implement such projects in their states. Gujarat government is one, which has got benefited from the experience of APMIP and has already implementing a project on micro irrigation on similar lines of APMIP.
3. Large-scale implementation of such projects will lead to saving of precious water resources, saving energy and improving the productivity.
4. The average pay back period comes to 2.7 years with overall system cost as the basis and by considering only the farmers contribution it comes to 0.7 years.
5. Every rupee invested in micro irrigation on annual basis yields additional income of Rs 1.8 due to additional crop yield.

Acknowledgement: The project acknowledges the financial support received from the Government of India and Government of Andhra Pradesh for extending subsidy to the farmers, to make the system costs affordable and the micro irrigation technologies reach all needy farmers.

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Participatory Development Model

INTRODUCTION

For many decades and in many sectors, government had a 'monopolistic' role in providing services. This is no surprise since ours is a 'welfare state' and the state has the moral responsibility of providing welfare oriented services to the people.

However, the 'monopolistic' role has in many cases, resulted in the government agencies becoming a) Autocratic, b) Harassing, c) Threatening, d) Insensitive, e) Corrupt and f) not accountable to the clients i.e., the people. Situation has reached a point where the 'poor and vulnerable' would have thought that they are 'better off not getting any closer' to the government agencies.

Some examples are: The BSNL before liberalization when if one had to get a land line connection one had to really move 'heaven and earth'. The Doordarshan before private channels came up and the Indian Airlines before private carriers were permitted are also examples of the 'monopolistic' attitude of government agencies.

The 'monopolistic attitude breeds "inefficiency" caused due to lack of competition. This, in the long run, is not only bad for the clients / people but also to the agency itself. Eg: The Water Use Efficiency in AP, on an average, is just about 30-35%. There is no pressure to improve it.

Why Monopolistic Approach fails:

In monopolistic approach, the agency provides services at its own speed (supply based) rather than at the speed of service requirement (demand based).

Many a time, the agency is not staffed adequately to be able to fulfill the requirements of development. With the result, the 'connection' between the service provider and the recipient is lost. This brings up the whole issue of 'targeting'. Only those who can 'approach' the agency stands a chance to get benefits. A 'middle man' system develops and takes away the benefits from the most deserving.

Thus, an agency, over a period of time, loses 'connection' with its basic constituency. Eg: Involvement of farmers, right from, project survey till release of water develops connection between department and farmers.

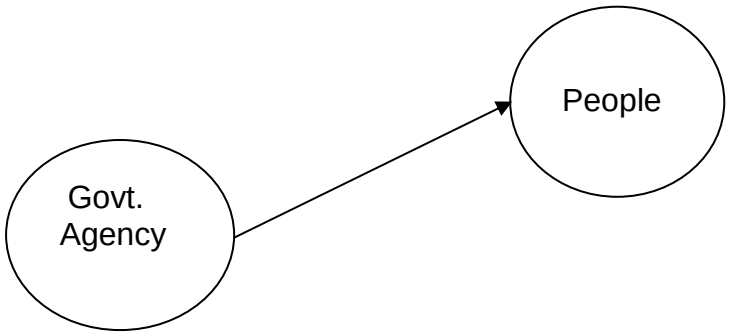
PARTICIPATORY DEVELOPMENT MODEL

This model pre-supposes that the clients must be put 'in the front' and the agencies only 'support' them. This brings in a) a need for the clients to 'organize' themselves and b) be responsible for taking initiative and thereby ownership of the decisions.

The government agency has to take up a totally different role i.e., "facilitator" wherein the agency has to have 'patience' and 'perseverance' to 'empower' the clients.

A typical representation of the development model with and without participatory approach is given below:

a) Monopolistic Approach

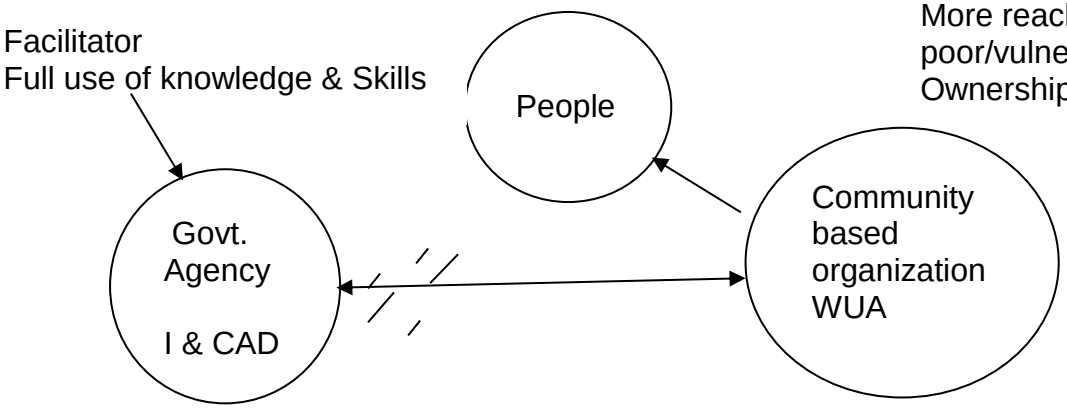


Un-organized, vulnerable
Feel Threatened by agency
Un-reached Knowledgeable
/powerful corner benefits
Not empowered
No ownership

Powerful / Dominant
High Discretion
High Scope for corruption
Lack of Transparency
Keep away from reality
Work at own speed
Show of authority

b) Participatory Development Approach

Better informed
Transparency
More reach to poor/vulnerable
Ownership



- Elected/ selected from People
- Empowered
- Enable continuity of

Though APFMIS Act is brought in 1997, its understanding and implementation leaves much to be improved in terms of the level of 'conviction' of the approach among the Irrigation Engineer as well as Farmers' Organizations.

Challenges in Participatory Approach

The facilitating Agency/Agent is likely to face the following challenges:

- Knowledge	What you know may be outdated or not relevant to the users. So, there is a need to unlearn and also update knowledge. More important, be prepared to 'understand' that users have a vast reservoir of knowledge and you can support it. Don't prescribe. Listen to understand.
- Skills	You may find that users have better skills. Be prepared to 'upgrade' your skills continuously.
- Attitude	Users are usually hard working since it is the source of their livelihood. You need to show 'sincerity and commitment' to work.

THE BIG ROLE CHANGE

The AEE is used to 'Do' the work. Being the last line of the I & CAD Department, this is natural. However, in a participatory model, one needs to 'facilitate or get done' from others. This calls for a big role change. It also tests you in the areas of patience and perseverance. It is easy to 'do' but very difficult to 'get things done'. The AEE has to learn to exercise patience and perseverance and provide 'scope' for user groups to develop knowledge, skills and attitude to take over 'Doing' role. By this approach, the role of the AEE, is raised by one level of doing to supervising.

THE TECHNIQUE OF TRANSFER OF SKILLS

Knowledge can be transferred rather easily by way of awareness (neo-literates), reading material (literate), etc. Transfer of attitude is best done by 'self-example'.

Transfer of skills is a rather difficult task. However, it can be surely done through a 'three-step process' as follows:

Step – 1	I do, you watch – Demonstrate
Step – 2	I do, you also do – Do together
Step – 3	You do, I watch - Supervise

Eg: If 'water measurement' is to be implemented, then the knowledge part is to explain the need for measurement, the benefits of measuring (accountability). The

skills part is ‘how’ to actually measure. The AEE should install necessary device, actually carryout measurement and ‘demonstrate’ the skills.

Lesson: You can’t expect others (farmers)
To do something (like measurements)
Which you yourself cannot do.

REMEMBER:

The success of participatory development model depends on how well the AEE facilitates. In many areas, the performance of the facilitator is based on the performance of the users (Eg.: The performance of AEE could be judged by the efficiency of WUAs in his/her jurisdiction).Thus, the model shifts the accountability to/from department to that of ‘Accountability to the user/client’.

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OPERATIONAL GUIDELINES OF PRADHAN MANTRI KRISHI SINCHAYEE YOJANA (PMKSY)

1.0 Introduction:

Hon'ble President in his address to the joint Session of the Parliament of 16th Lok Sabha indicated that "Each drop of water is precious. Government is committed to giving high priority to water security. It will complete the long pending irrigation projects on priority and launch the 'Pradhan Mantri Krishi Sinchayee Yojana' with the motto of 'Har Khet Ko Paani'. There is a need for seriously considering all options including linking of rivers, where feasible; for ensuring optimal use of our water resources to prevent the recurrence of floods and drought. By harnessing rain water through 'Jal Sanchay' and 'Jal Sinchan', we will nurture water conservation and ground water recharge. Micro irrigation will be popularised to ensure 'Per drop-More crop'.

Out of about 141 m.Ha of net area sown in the country, about 65 million hectare (or 45%) is presently covered under irrigation. Substantial dependency on rainfall makes cultivation in unirrigated areas a high risk, less productive profession. Empirical evidences suggest that assured or protective irrigation encourages farmers to invest more in farming technology and inputs leading to productivity enhancement and increased farm income.

The overreaching vision of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) will be to ensure access to some means of protective irrigation to all agricultural farms in the country, to produce 'per drop more crop', thus bringing much desired rural prosperity.

2.0 Objectives:

The broad objectives of PMKSY will be:-

a) Achieve convergence of investments in irrigation at the field level (preparation of district level and, if required, sub district level water use plans).
b) Enhance the physical access of water on the farm and expand cultivable area under assured irrigation (Har Khet ko pani),
c) Integration of water source, distribution and its efficient use, to make best use of water through appropriate technologies and practices.
d) Improve on-farm water use efficiency to reduce wastage and increase availability both in duration and extent,
e) Enhance the adoption of precision-irrigation and other water saving technologies (More crop per drop).
f) Enhance recharge of aquifers and introduce sustainable water conservation practices

g) Ensure the integrated development of rainfed areas using the watershed approach towards soil and water conservation, regeneration of ground water, arresting runoff, providing livelihood options and other NRM activities.
h) Promote extension activities relating to water harvesting, water management and crop alignment for farmers and grass root level field functionaries.
i) Explore the feasibility of reusing treated municipal waste water for peri-urban agriculture, and
j) Attract greater private investments in irrigation.

This will in turn increase agricultural production and productivity and enhance farm income.

3.0 Strategy & Focus Areas:

To achieve above objectives, PMKSY will strategize by focussing on end-to end solution in irrigation supply chain, viz. water sources, distribution network, efficient farm level applications, extension services on new technologies & information etc. Broadly, PMKSY will focus on:-

a) Creation of new water sources; repair, restoration and renovation of defunct water sources; construction of water harvesting structures, secondary & micro storage, groundwater development, enhancing potentials of traditional water bodies at village level like Jal Mandir (Gujarat); Khatri, Kuhl (H.P.); Zabo (Nagaland); Eri, Ooranis (T.N.); Dongs (Assam); Katas, Bandhas (Odisha and M.P.) etc.
b) Developing/augmenting distribution network where irrigation sources (both assured and protective) are available or created;
c) Promotion of scientific moisture conservation and run off control measures to improve ground water recharge so as to create opportunities for farmer to access recharged water through shallow tube/dug wells;
d) Promoting efficient water conveyance and field application devices within the farm viz, underground piping system, Drip & Sprinklers, pivots, rain-guns and other application devices etc.;
e) Encouraging community irrigation through registered user groups/farmer producers' organisations/NGOs; and
f) Farmer oriented activities like capacity building, training and exposure visits, demonstrations, farm schools, skill development in efficient water and crop management practices (crop alignment) including large scale awareness on More crop per drop of water through mass media campaign, exhibitions, field days, and extension activities through short animation films etc.

The aforesaid areas only outline the broad contours of PMKSY; combination of interventions may be required depending on location specific conditions and

requirements, which will be identified through District and State Irrigation Plans. More focus on irrigation development will be given to deficient states in terms of irrigation coverage. The state wise matrix showing State wise rain fed and irrigated area is given at **Appendix-a.**

5.0 Programme Components

PMKSY will have following programme components:

A. Accelerated Irrigation Benefit Programme(AIBP)

a) To focus on faster completion of ongoing Major and Medium Irrigation including National Projects.

B. PMKSY (Har Khet ko Pani)

a) Creation of new water sources through Minor Irrigation (both surface and ground water)
b) Repair, restoration and renovation of water bodies; strengthening carrying capacity of traditional water sources, construction rain water harvesting structures (Jal Sanchay);
c) Command area development, strengthening and creation of distribution network from source to the farm;
d) Ground water development in the areas where it is abundant, so that sink is created to store runoff/ flood water during peak rainy season.
e) 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.
f) 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.
g) Creating and rejuvenating 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.

C. PMKSY (Per Drop More Crop)

a) Programme management, preparation of State/District Irrigation Plan, Approval of annual action plan, Monitoring etc.

b) Promoting efficient water conveyance and precision water application devices like drips, sprinklers, pivots, rain-guns in the farm (Jal Sinchan);

c) 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.

d) 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 AIBP, PMKSY (Har Khet ko Pani), PMKSY (Watershed) and MGNREGS as per block/district irrigation plan.

e) 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;

f) Water lifting devices like diesel/ electric/ solar pump sets including water carriage pipes, underground piping system.

g) Extension activities for promotion of scientific moisture conservation and Agronomic measures including cropping alignment to maximize use of available water including rainfall and minimize irrigation requirement (Jal sarankchan).

h) Capacity building, training and awareness campaign including low cost publications, use of Pico projectors and low cost films for encouraging
Potential use water source through technological, agronomic and management practices including community irrigation.

i) The extension workers will be empowered to disseminate relevant technologies under PMKSY only after requisite training is provided to them especially in the area of promotion of scientific moisture conservation and agronomic measures, improved/ innovative distribution system like pipe and box outlet system, etc. Appropriate Domain Experts will act as Master Trainers.

j) Information Communication Technology (ICT) interventions through NeGP-A to be made use in the field of water use efficiency, precision irrigation technologies, on farm water management, crop alignment etc. and also to do intensive monitoring of the Scheme.

D. PMKSY (Watershed Development)

a) Effective management of runoff water and improved soil & moisture conservation activities such as ridge area treatment, drainage line

Treatment, rain water harvesting, in-situ moisture conservation and other allied activities on watershed basis.

b) Converging with MGNREGS for creation of water source to full potential in identified backward rain fed blocks including renovation of traditional water bodies
Eligible activities under these components are at **Appendix-b**.

5.0 District and State Irrigation Plans

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 Vikash 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 prioritizing the activities based on socio-economic and location specific requirement. In case of 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 utilized for developing irrigation plans at least on pilot basis to begin with and subsequently may be extended to all projects. DPRs of watershed projects should be taken into account while preparation of DIPs.

The 5 block wise master plan is to be approved by inter-mediate level block panchayat and to be forwarded to the district planning committee for inclusion in the district master plan i.e., DIP. Agriculture Universities in the State May also be closely involved with the formulation and implementation of the Detailed Project Report and the District Level Plans. Technical, financial and human resources available for this

sector with departments of rural development, urban development, drinking water, environment & forest, science & technology, Industrial policy etc. to be leveraged for comprehensive development of water sector. The DIPs are to be vetted by the Governing body of Zilla Panchayat and subsequently be incorporated in the State Irrigation Plan (SIP).

Creating access to water source either assured or protective to each farm will require a demand and supply assessment of crop water requirement, effective rainfall and potential source of existing & new water sources considering geo-hydrological and agro ecological scenario of the block. The master plan will include information on all sources of available water, distribution network, defunct water bodies, new potential water sources both surface and sub- surface systems, application & conveyance provisions, crops and cropping system aligned to Available/designed quantity of water and suitable to local agro ecology. All activities pertaining water harvesting, water augmentation from surface/sub surface sources, distribution and application of water including repair renovation and restoration of water bodies, major medium and minor irrigation works, command area development etc. are to be taken up within the frame work of this master plan. Emphasis is to be given for deriving potential benefit from low hanging fruits like extending the reach/coverage of water source through effective distribution and application mechanism, reducing the gap between potential created and utilized through more focus on command area development and precision irrigation. Proper integration of creation of source like dams and water harvesting structures, distribution system like canals and command area development works and precision farming to be made for deriving best possible use of water resources. Steps may also be taken for use of urban treated waste water for irrigation purpose. For respective cities a command area may be identified for this purpose in and around the adjoining agricultural land of urban habitation. However, the recommended norms (given Appendix-c) of treated sewage quality for specified activities at point of use be ensured during use of recycled water.

SIP will not only consolidate the DIPs and correlate with State Agriculture Plan (SAP), already available for RKVY, but also prioritize resources and outline definite annual action plan with a medium to long term horizon. The plan would also enumerate on extension & ICT related activities to be undertaken under supervision of Agriculture Technology Management Agency (ATMA).

DIPs and SIP will provide requisite emphasis on convergence by eliminating overlap of resources & efforts and ensuring optimal utilization of funds available through various Centrally Sponsored/State Plan Schemes.

Each District will be provided one time financial support to prepare District Irrigation Plan. DIPs and SIP are to be finalized within a period of three months

From launching of PMKSY. National Rain fed Area Authority (NRAA) will be associated in preparation of SIP and providing advisories to State Governments for comprehensive irrigation development.

While formulating District Irrigation Plans (DIPs), suggestions of Hon'ble Members of Parliament and Members of Legislative Assembly of that is to be invited and will be included in DIPs after due technical consideration. Highest priority is to be given on valuable suggestions/recommendations of Member of Parliament of that particular district subject to technical/financial viability.

6.0 Cost Norm & Pattern of Assistance:

Technical requirements / standards, pattern of assistance etc. for activities of respective components like AIBP, PMKSY (Har Khet Ko Pani), PMKSY (Per drop more crop) and PMKSY (Watershed Development) will be as per the existing guidelines of the respective Ministries/Departments or as per revised norms including that of additional activities introduced, to be issued by the respective ministries/departments with the approval of concerned Union Minister.

In the absence of equivalent Central Plan Scheme, norms and conditions prescribed by respective State Governments for their schemes may be applied.

In cases where no Central / State Govt. norms are available, a certificate of reasonableness of proposed project cost along with reasons thereof will invariably be given by State Level Project Screening Committee (SLPSC) in each such case.

States should adhere to Govt. approved rate e.g. Schedule of rate of CPWD/PWD/Irrigation Dept. or similar Govt. agencies working in rural areas, for creation of irrigation infrastructure.

7.0 Eligibility criteria:

Instead of incremental budgeting, PMKSY will adopt a dynamic annual fund allocation methodology that mandates States to allocate more funds to irrigation sectors for becoming eligible to access PMKSY funds. For this purpose:

a) A State will become eligible to access PMKSY fund only if it has prepared the District Irrigation Plans (DIP) and State Irrigation Plan (SIP), excepting for the initial year, and the expenditure in water resource development for agriculture sector in the year under consideration is not less than baseline

expenditure. The baseline expenditure will be the average of expenditure in irrigation sector irrespective of state departments (i.e. creation of water source, distribution, management and application from State plan schemes) in State Plan in three years prior to the year under consideration.

b) States will be given additional weightage for levying charges on water and electricity for irrigation purpose, so as to ensure sustainability of the programme.

c) Inter State allocation of PMKSY fund will be decided based on (i) share of percentage of unirrigated area in the State vis-à-vis National average including prominence of areas classified under Dessert Development Programme (DDP) and Drought Prone Area Development Programme (DPAP) and (ii) increase in percentage share of expenditure on water resource development for agriculture sector in State Plan expenditure in the previous year over three years prior to it (iv) improvement in irrigation efficiency in the state.

8.0 Funding Pattern

PMKSY funds will be provided to the State Governments as per the pattern of assistance of Centrally Sponsored Schemes decided by Ministry of Finance and NITI Aayog. During 2015-16, existing pattern of assistance of ongoing schemes will be continued.

9.0 Programme Architecture:

PMKSY will be implemented in area development mode only by adopting a 'decentralized State level planning and projected execution' structure that will allow States to draw up their own irrigation development plans based on DIPs and SIPs with a horizon of 5-7 years. Initial phase of implementation will be the remaining two years of XII Plan.

States will allocate about 50% of the PMKSY funds by prioritizing projects among those districts having larger share of unirrigated areas, lesser agriculture productivity vis-à-vis State's average and higher population of SC/ST and Small & Marginal Farmers (SMF). States will also give priority to villages identified under Sansad Adarsh Gram Yojana (SAGY) while implementing PMKSY. The remaining 50% may be prioritized for operationalizing /saturating projects which are under terminal stage of completion (water resource development/watershed). Priority to also be given for reducing the gap between irrigation potential created and actually utilized through command area development and precision irrigation.

As PMKSY will be a area-based scheme with projected approach, Project Reports will have to be prepared for each of the PMKSY component based on the comprehensive irrigation plan incorporating all essential ingredients i.e. feasibility Studies, competencies of the implementing agencies, anticipated benefits (outputs/outcomes) that will flow to the farmers/ State, definite time-lines for implementation etc.

Detailed Project Report (DPR) of each cluster will have four sub projects catering to respective components i.e., AIBP, PMKSY(Har Khet Ko Pani), PMKSY (More Crop Per Drop), PMKSY(Watershed Development) depending on the activities covered under the respective components with funding support required. It should be ensured that there is no duplication of funding and/or undertaking similar activities in the same areas under other Plan schemes of Central/State Government and clearly indicate the year-wise physical & financial targets proposed under each project component wise.

In case of large individual project activity costing more than Rs. 25 crore, it will be subjected to third party 'techno-financial evaluation'.

In order to ensure efficient use of water, extension services will focus at targeting in how to make best use of available water through crops/cropping system aligned to agro-ecological conditions and suitable agronomic practices to ensure larger coverage and equity to farmers. In selected areas, few progressive farmers may be sensitized towards this subject and incentivized to experiment with changes in cropping pattern with available irrigation facilities. Farm school component of ATMA scheme would be suitably used to take up this activity. Cluster of 8 to 10 villages may be taken up in districts for saturating those as per the plan for showcasing potential augmentation of water and its efficient use. The success of these clusters in promoting such activities may be replicated in other parts of the district.

Extending the reach of micro irrigation to a larger coverage will be ensured involving companies associated with precision irrigation for awareness campaign, demonstration, capacity building training, providing maintenance service, technical support etc. A greater role of these companies will be specified in the operational guidelines of this component.

The success stories of indigenous practices like Jalmandir; Khatri; Kuhl; Zabo Ooranis; Dongs; Katas; Bandhas etc., innovative projects, participatory management etc. may be captured and documented for sharing with other states and agencies for wider replication.

10.0 Nodal Department:

Since, the final outcome of PMKSY is to ensure access to efficient delivery and application of water at every farm thereby enhancing agricultural production productivity, State Agriculture Department will be the Nodal Department for Implementation of PMKSY. All communication between Ministry of Agriculture (MOA) and State Government would be with and through the nodal department. However, the implementing departments for the four components like AIBP, PMKSY (Har Khet Ko Pani), PMKSY (Per drop more crop) and PMKSY(Watershed Development) will be decided by the respective programme Ministry/Department.

State Governments will utilize the existing mechanism and structure available under RKVY in the state for overall supervision and coordination of the programme. State may also strengthen the existing State Level Agencies available for similar activities for entrusting the responsibility of coordinating the works of PMKSY. State may also restructure the existing SAMETI or SLNA setup of IWMP with inclusion of additional members to address the mandate of PMKSY and function under supervision of National Rain fed Area Authority (NRAA) for implementation of PMKSY. All the proposals need to be vetted by the State Level Coordinating agency before it is put up to Inter Departmental Working Group and State Level Sanctioning Committee. PMKSY will have a strong technical component and domain experts for management of the programme. Engagement of consultants, professionals will be supported from the administrative provisions available to the State under the programme.

Nodal Department/Agency identified by State will collate all the sub projects of each cluster received from different implementing departments/districts as one DPR and place before the Inter Departmental Working Group (IDWG) for scrutiny and State Level Sanctioning Committee (SLSC) for sanction.

Nodal department/agency will also be responsible for monitoring,
Coordinating physical & financial progress with implementing departments/agencies and furnishing consolidated Utilization Certificates (UC) and physical/financial progress reports to Govt. of India.

In addition, nodal department/agency will also be responsible for the following:-

(i) Coordinating preparation of DIPs and SIP;
(ii) Coordinating preparation and appraisal of projects, implementing, monitoring, and evaluation with various Departments and implementing Agencies.
(iii) Management of funds received from the Central, and State Governments and disbursement of the funds to the implementing agencies.

(iv) Furnishing of quarterly physical & financial progress reports to the Department of Agriculture and Cooperation.

(v) Effectively utilizing and regularly updating web enabled IT based PMKSY Management Information System (PMKSY-MIS).

(vi) To convene meeting of SLSPC and IDWG. The meeting notice along with sufficient number of copies (not less than 20) of agenda and project details be sent to DAC so as to reach at least 15 days before the meeting of SLSC to enable Government of India's representatives to come prepared and to participate meaningfully in the SLSC meeting.

11.0 State Level Sanctioning Committee (SLSC):

State Level Sanctioning Committee (SLSC), already constituted under RKVY and chaired by the Chief Secretary of the State, will be vested with the authority to sanction specific projects recommended by the IDWG in a meeting attended by representatives of Government of India.

SLSC will, inter alia, also be responsible for:

a) Approving the State Irrigation Plan(SIP) and District Irrigation Plan (DIP)

b) Sanctioning and prioritizing funding of projects under PMKSY;

c) Monitoring and reviewing implementation of PMKSY;

d) Ensuring convergence with other schemes and that no duplication of efforts or resources takes place;

e) Ensuring that there are no inter-district disparities with respect to the financial patterns/subsidy assistance in the projects;

f) To decide the implementing agency/dept. in the state for particular project depending on the nature of the project and expertise available with the agency/dept.

g) Ensuring that the programme implementation in accordance with guidelines laid down by the concerned programme component Ministry/Department

h) Initiating evaluation studies from time to time, as may be required;

i) Ensuring that all extant procedures and instructions of Govt. of India are followed so that the expenditure incurred on implementation of the projects is barest minimum with due concern for economy in expenditure and also in conformity with the cannons of financial propriety, transparency and probity.

j) To ensure that Panchayat Raj Institutions (PRI) are actively involved in implementation of PMKSY, especially in selection of beneficiaries, conducting social audit etc.

SLSC's may approve PMKSY projects up to twice the amount of State's annual allocation under PMKSY to cater to multi-year duration projects and prioritizing funding based on physical progress.

Existing SLSC shall be strengthened by including members from relevant Departments e.g. Irrigation/water resources and Soil conservation, Watershed, Rural Development/Rural Works, Forest and State Level Nodal Agency (SLNA) under IWMP.
SLSC may also co-opt members from experts in water sector, public/private agencies working in irrigation sector, reputed NGOs working in the field of irrigation, research institutions, leading farmers etc.

Beside Ministry of Agriculture, SLSC will also have Govt. of India's representatives from Ministry of Water Resources, Dept. of Land Resources and Ministry of Rural Development. The quorum for SLSC meetings would not be complete without the presence of at least two representatives from the Government of India.

The SLSC will be supported by the Inter Department Working Group (IDWG), comprising of Secretaries of the line Departments of Horticulture, Agriculture, Rural Development, Irrigation, Surface and Ground Water Resources.

State Nodal Cell/Coordinating Agency will ensure timely receipt of District Irrigation Plans (DIPs), formulation of State Irrigation Plan and its approval by the SLSC. The SNC will then convey the approval and monitor implementation of the work plans by the line Departments.

12. Inter Departmental Working Group (IDWG):

Inter Department Working Group (IDWG), comprising of Secretaries of the line Departments of Agriculture, Horticulture, Rural Development, Water Resources/Irrigation, Command Area Development, Watershed Development, Soil Conservation, Environment & Forest, Departments dealing with Ground Water Resources, drinking water, town planning, industrial policy, science & technology and all concerned departments associated with water sector. The IDWG will be chaired by the Agriculture Production Commissioner/Development Commissioner. In departments, where separate secretaries are not there, Directors will act as
Members of IDWG. Director (Agriculture)/ Engineer in Chief (water Resources/Irrigation) will work as co-conveners of IDWG. The IDWG will be responsible for day to day coordination and management of the Scheme activities

within the State. IDWG will be the coordinating agency among all the ministries/ departments/ agencies/ research/ financial institutions engaged in creation/ use/ recycling/ conservation of water to bring them together under a single platform to take a comprehensive and holistic view of the entire water cycle so as to ensure that each drop of water is put to the best possible use. It will scrutinize /prioritize the project proposals/DPRs in conformity with the guidelines and that they emanate from SIP/DIPs, besides being consistent with technical standards & financial norms. IDWG will further examine and ensure that:

a) Funds available under other schemes of the State Government and /or Govt. of India for the proposed projects have been accessed and utilized/planned for utilization before they are brought under the PMKSY ambit;

b) PMKSY projects/activities should not create any duplication or overlapping of assistance /area coverage vis-à-vis other schemes/programs of State/Central Government;

c) PMKSY funds are not being proposed as additional or 'top-up' subsidy to other ongoing schemes/programmes of State/Central Government excepting for topping up of material cost beyond the approved limit of the respective schemes like programmes (material component is restricted of the 40% of the exact cost under MGNREGS .

d) DPRs have included provision for monitoring and evaluation;

e) Convergence with other State/Central Schemes has been attempted

13. The District Level Implementation Committee (DLIC):

DLIC will form the third tier of the PMKSY. The DLIC will be chaired by the Collector/District Magistrate and will comprise of CEO Zilla Parishad/PD DRDA, Joint Director/Deputy director of Departments of Horticulture, Agriculture, Rural Development, Surface and Ground Water Resources, Irrigation and any other line Departments in the district, District Forest Officer, Lead bank officer of the District.

The Project Director, Agricultural Technology Management Agency (ATMA) will be the Member Secretary of DLIC. In addition, DLIC may have two progressive farmers, and a leading NGO working in the District, if any. The farmers will be nominated for one year from District Farmers Advisory Committee under ATMA. The NGO representative will be nominated by the Collector/District Magistrate.

The DLIC will oversee the implementation and inter-departmental coordination at district level and will have following role:

a. To act as the field level coordinator between the various implementation agencies/line departments in the District and to ensure that the agreed District Irrigation Plan/ Annual Irrigation Plan is successfully implemented

b. To prepare the District Irrigation Plan (DIP), showing the contribution of various funding streams and programmes towards specific outputs and outcomes and seek approval of the SLSC for the same.
c. To prepare Annual Irrigation Plans (AIPs) arising out of the DIPs and to forward them to the SLSC for approval.
d. To monitor the progress of various components of the AIPs, to remove implementation hurdles and make periodic reports to SLSC.
e. To undertake public awareness and publicity efforts for engaging farmers, PRIs, media and other local stakeholders to build support for the implementation of the DIPs.

The Project Director, Agricultural Technology Management Agency (ATMA) will make use of the existing infrastructure and staff under ATMA in districts and blocks for discharging duties under PMKSY.

The DLIC will prepare the District Irrigation Plan (DIP) for the district which will include mapping existing water resource of the district created by various sources of irrigation, measures to identify the water risk status of the district, to identify the new source of water to enhance physical water availability at the farm level, measures to improve water use efficiency and water distribution. The DIP should take into account the outcomes of studies conducted by ICAR on existing and traditional cropping patterns especially in the context of optimal use of water resources. In addition, the traditional water management system of that particular area has to be taken into account, while formulating the DIP. MoWR,RD & GR should consult the State Governments for studying the traditional water management system within a month and provide the information to all the States for incorporation in DIP.

Ministry of Urban Development will incorporate compulsory water harvesting system in their model regulations being framed for Building Construction, and State Governments shall take into consideration these model regulations while formulating their building regulations. District Irrigation Plan will be prepared by IAS and IFS(Forest) officers of three junior most batches. Training modules for formulation of DIP shall be prepared by ICAR institutes in consultation with other relevant institutions and training on model for DIP formulation will be imparted to them by the end of September, 2015 and officers will be completed this task by end of December, 2015. ATMA Management Committee will assist DLIC in coordinating and executing extension related activities under PMKSY.

14.0 National Steering Committee (NSC):

An Inter-Ministerial National Steering Committee (NSC) will be constituted under the Chairmanship of Prime Minister with Union Ministers from concerned Ministries like Water Resources, River Development & Ganga Rejuvenation; Rural Development; Land Resources; Urban Development; Drinking Water & Sanitation; Financial Services; Tribal Affairs; Expenditure; Panchayat Raj; Science & Technology; Environment, Forest & Climate Change; Industrial Policy, Development of North Eastern Region (DONER); Vice Chairman, NITI Aayog; as members with Secretary(A&C) as Member Secretary to provide general policy strategic directions/advisories for programme implementation, protect interstate issues, and provide overall supervision addressing national priorities etc. The NSC will adopt its own working procedure and delegate such powers as it considers fit to the National Executive Committee.

15.0 National Executive Committee (NEC):

A National Executive Committee (NEC) will be constituted under the Chairmanship of Vice Chairman, Niti Ayog with Secretaries of concerned Ministries/Departments and Chief Secretaries of selected States on rotation basis, representatives from professional institutes like NABARD & other financial institutions engaged in creation/use/recycling of water, SAC, MNCFC, ISRO, IMD, ICAR; Additional Secretary & FA of DAC, DoLR, MoWR; CEO of NRAA; Selected Experts as members with Joint Secretary (DAC) in charge of PMKSY as Member Secretary to oversee programme implementation, allocation of resources, inter-ministerial coordination, monitoring & performance assessment, addressing administrative issues etc.

16.0 Release of Funds:

60% of the PMKSY annual allocation will be released as first instalment to the State, upon the receipt of the minutes of SLSC approving implementation of new projects and/or continuation of ongoing projects during the financial year along with lists of projects approved. Release of funds will be made by the respective Ministry/department for the specific component. The concerned implementing ministries /department will be responsible to ensure receipt of utilization certificate and corresponding physical and financial progress while releasing the funds for the specific component. The utilization certificate is to be submitted by the respective implementing department/agency in the State.

In case, total cost of approved project is less than annual outlay, funds to the tune of 60% of approved project cost will be released.

Release of the second and final instalment would be considered on receipt of the following:

a) More than 90% Utilization Certificates (UCs) for the funds released up to previous financial year;

b) *Utilization Certificates (UCs) of at least 50% of funds released in* first instalment during current year; and

c) Performance report in terms of physical and financial achievements as well as outcomes, within the stipulated time frame in specified format.

If a State fails to submit these documents within reasonable period of time, balance funds may be re-allocated to better performing States.

Monitor able targets against funds released will be fixed for all critical sub-components and any achiesvements in a given timeframe will be reported for each activity with respect to baseline/historic data. This may include increase in production area, productivity, use of micro irrigation facilities etc. In this process, Domain. Monitor able targets against each component will be fixed by concerned Ministry/department of GOI such as Department of Agriculture & Cooperation, Ministry of Water Resources, RD& GR, Department of Land Resources and Ministry of Rural Development for all sub-components (MoRD will enter the information only for creation of water sources in the identified rain fed and backward blocks for special focus by MGNREGA funds where DoLR to complete their ongoing watershed programmes). Any achievements in a given timeframe will be reported for each activity with respect to baseline/historic data. This may include increase in production area, productivity, use of precision facilities etc. In this process, the focus should also be on to fix accountability and use technology for not meeting the targets and time frame of implementation.

PMKSY-MIS reports shall be the basis of 'on line monitoring' and judging 'Inter-State performance'; States may establish a dedicated PMKSY-MIS cell for this purpose.

The assets created under "Pradhan Mantri Gramin Sinchai Yojana" will be geo-tagged and mapped on to location maps using Bhuvan application developed by Indian Space Research Organization (ISRO). This activity will be dovetailed with the new Innovative Technology Dissemination component of hand held devices under NAMET. The extension workers or other verification authorities will fill in details of the asset being created or completed under the Scheme by completing online form as an Android application. Asset details of each irrigation source and distribution channel with digitized satellite imagery with necessary information on capacity, sources, inlets, outlets etc. to be uploaded using geo-tagging feature of a GPS enabled

smart phone. In order to fine-tune this activity, village boundaries as per Survey of India (having latitude/longitude details) will be used in conjunction with District/Block codes strictly in keeping with the Farmer's Portal so as to avoid any duplication or contradiction. Each structure will have a unique ID no. with "first two letters of state/abbreviated scheme name/ first three letters of district/year of operationalization/ longitude/latitude". Services of MNCFC will be utilized for such activities.

Twenty five percent (25%) of the projects sanctioned by the State shall have to be compulsorily taken up for third party monitoring and evaluation by the implementing States. Besides, the accounts of all this assets created will have to be put before the Gram Sabha for social audit.

Action plan for monitoring and evaluation will be chosen by SLSC every year in its first meeting based on project cost, importance of the project etc. preferably covering all sectors. The State Government will be free to choose any reputed agencies for conducting the monitoring and evaluation work in their States. Requisite fees/cost towards monitoring & evaluation will be met by the State Government from the 5% allocation retained by them for administrative The focus should also be on to fix accountability and use technology.

Nodal department shall ensure that Project-wise accounts are maintained by the Implementing Agencies and are subjected to the normal process of Statutory Audit. The assets so created and expenditure made there on may be provided to concern Gram Sabha for the purpose of social audit. Likewise, an inventory of the assets created under PMKSY Projects except for those for individual farmers etc. should be carefully preserved and assets that are no longer required should be transferred to the Nodal Department or as per the guidelines of the respective programme components, for its use and redeployment where possible.

Central assistance under PMKSY will be released as per extant guidelines of the Ministry of Finance, Govt. of India.

17.0 Administrative Expenses & Contingencies:

Administrative expenses may be met on pro-rata basis from the programme, not exceeding 5 percent, at each level to strengthen coordination, scientific planning and technical support for effective implementation of PMKSY at the field level. Administrative expenditure for functioning of Coordinating agency/institutions responsible for implementing PMKSY, payments to consultants, outsourcing of specific activities, recurring expenses of various kinds, staff costs etc. are admissible. However, no permanent employment can be created, nor can vehicles be purchased. States may supplement any administrative expenditure in excess of the 5% limit, from their own resources. Govt. of India may retain 1.5% of the PMKSY provision for IEC

activities and another 1.5% of the allocations for administrative, monitoring, evaluation and any contingencies that may arise during the implementation of the scheme by each participating departments. In the first year (2015-16), an amount to the tune of Rs. 75 Cr will be set aside for preparing DIP and SIP, which will be met out of the funds earmarked for DAC.

DAC may set up a technical support group by assigning dedicated officers and staff from its existing strength and engaging consultants, experts. DAC may outsource some technical assignments to specific agencies including studies, training programmes relating to PMKSY activities. Workshops, conferences, awareness campaign, publicity, documentation etc.

18.0 Monitoring & Evaluation:

A web-based Management Information System for PMKSY (PMKSY-MIS) will be developed to collect essential information related to each project. States will be responsible for timely submission/updating project data online in the system (preferably on a fortnightly basis), which will provide current and authenticated data on outputs, outcome and contribution of PMKSY projects in the public Expenses. DAC will evolve suitable mechanism for concurrent evaluation of implementation of PMKSY. DAC may also engage suitable agency for conducting State specific/Pan India periodic implementation monitoring and/or mid-term/end-term evaluation of the scheme. NRAA will be involved in the process of mid- term /end term evaluation of PMKSY programme.

The performance of the States will be reflected in the Outcome Budget document of the respective Ministry/Department.

19.0 Convergence:

PMKSY will ensure convergence with all rural assets/infrastructure based programmes related to water conservation and management programmes/schemes like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Rashtriya Krishi Vikash Yojana (RKVY), Jawaharlal Nehru National Solar Mission and Rural Electrification programmes, 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, Working Plan of State Forest Department etc. The inputs from the Intensive Participatory Planning Exercise (IPPE) already conducted under MGNREGA in 2,500 backward Blocks may be used in preparing the DIP. In most cases the labour intensive works like earth works for source creation may be taken up under MGNREGA. Emphasis be given for utilising MGNREGA fund for de-silting of ponds, canals, defunct water bodies like old ponds, Jal Mandir, khul, Tanka etc. to improve storage capacity and creating scopes for water availability for irrigation

purposes. PMKSY (Per Drop More Crop) fund may also be used for topping up of material cost beyond the specified limit, i.e., 40% in the MGNERGA for lining, inlet, outlet, silt trap, adjustable gates etc. All stake holders viz farmers, Panchayat and grass route level functionaries be made aware of scientific/technical processes of cleaning canals, de-siltation, construction of water harvesting structures etc., through extension activities including use of IEC, short animation films etc. to get maximum benefit of MGNREGA for these works. Other works can be taken up from PMKSY (Har Khet Ko Pani), PMKSY (Watershed) etc. depending on the type and nature of works. Where irrigation source is created, the PMKSY (Per drop more crop) component be potentially made use to improve irrigation efficiency and extend larger coverage from the same source. Department of Land Resources is in the process of starting the World Bank assisted "Neeranchal" project. Neeranchal is proposed to focus on better scientific basin level planning, new technologies for efficient water management, community level hydrology, enhanced production and yields, linkages with markets, real time monitoring systems using state of the art technologies and urban watersheds. Neeranchal will support PMKSY with proper synergy between the two programmes.

Where more than one department has to converge to implement a single scheme, each department may take up a separate component for implementation. Wherever irrigation potential has been created, but is lying unutilized for want of field channels, works for creating such supporting infrastructure shall be taken up under MGNREGA on priority and such works should also be part of the District Irrigation Plan. In respect of the irrigation works to be taken up under MGNREGA, technical support of other line departments would be provided. In fact, such support will enable scientific plans and execution of such works as part of PMKSY.

Ministry of Panchayat Raj shall also be appropriately consulted for ensuring that local/Panchayat level requirements are adequately addressed in DIPs and SIP. PMKSY will also accord priorities to villages identified under Sansad Adarsh Garm Yojana (SAGY).

20.0 Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India may affect changes in the PMKSY operational guidelines, other than those affecting the financing pattern as the scheme evolves, whenever such changes are considered necessary with the approval of NEC.

21.0 These guidelines are applicable to all the States and Union Territories.

Appendix-b

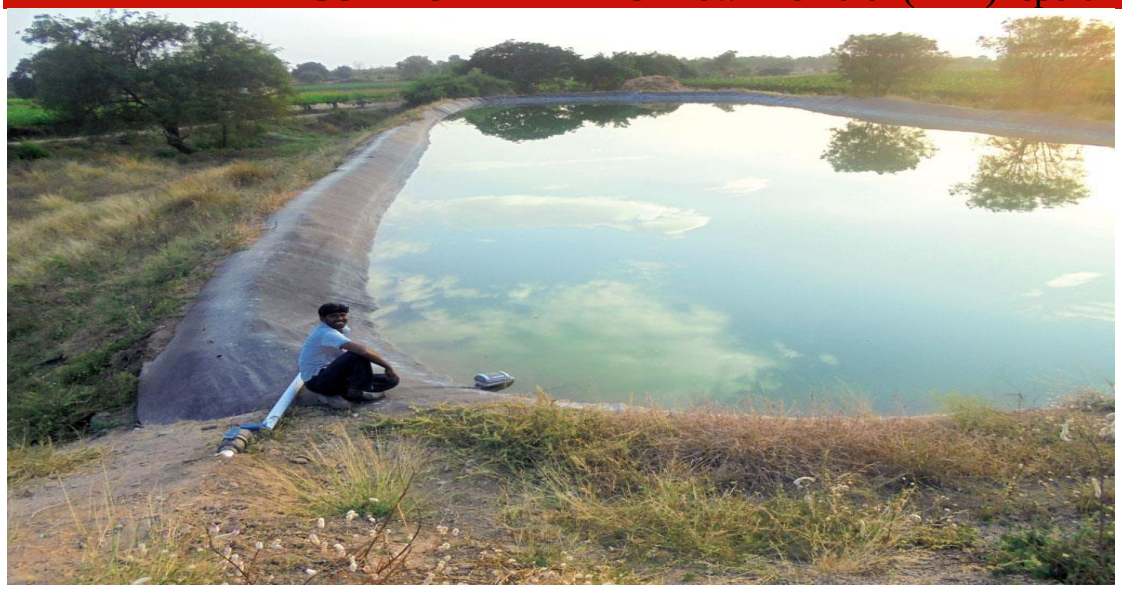
Illustrative Activities under PMKSY (Refer to Para 4.0 of the Guidelines)

Sl . No.	Programme Components	Illustrative Activities
1	AIBP	To focus on faster completion of ongoing Major and Medium Irrigation including National Projects
2	PMKSY (Hark eth ko Pani) Minor	Creation of new water sources through Irrigation (both surface and ground water)
		Repair, restoration and renovation of water bodies; strengthening carrying capacity of traditional water sources, constructions and rain water harvesting structures (Jal Sanchay)
		Command area development, strengthening and creation of distribution network from source to the farm
		Improvement in water distribution system for water bodies 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)	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
4	PMKSY (Per drop More Crop)	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 (Jal Sinchan);
		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.
		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 (Jal sarankchan);
		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, programme 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 enhancing water use efficiency
5	MNAREGA	Water harvesting structures on individual landsof vulnerable sections, creation of new irrigation sources, upgradation/desilting of traditional water bodies, water conservation works etc.
		Supplementing Soil and water conservation works in the identified back ward rainfed blocks by overlaying of the plans with that of watershed projects for development to full potential
		Desiltation of canal & distribution system, Deepening and desiltation of existing water bodies, strengthening of bunds/embankments etc.
		Restoring the potential of traditional water storage systems like Jal Mandir; Khatri, Kuhl, Zabo, Ooranis ,Dongs , Katas, Bandhas etc.through disiltation and deepening activities

A FEW VILLAGES FROM THE DROUGHT-RAVAGED STATES CAN SHOW YOU HOW TO MAKE INDIA DROUGHT-FREE, AND MORE THAN DOUBLE THE INCOME OF FARMERS- Down To Earth (DTE) report



In Kadwanchi, Marathwada, groundwater recharge has enabled farmers to build ponds and do horticulture. Farmers now earn four times the national average (Photo: Jitendra) On February 28, Prime Minister Narendra Modi made an audacious pledge. "I am confident that my dream will come true. My dream is your dream. My dream is with your dream. What is my dream? My dream is that by 2022, when the country celebrates its 75th Independence Day, the income of farmers should double," he said, adding "Can we do it? Can we take a pledge in this regard, the states, the farmers, we all?" Many years after former Prime Minister Indira Gandhi's garibi hatao slogan, Modi's definitive target to fix the problem of farmers has evoked the same hopes. In the context of the current drought, many find this unachievable. There is fierce academic debate over the ways and means to achieve this. But Down To Earth (DTE) reporters found that many villages have insulated themselves from drought, including the current spell. These villages, located in India's most drought-prone areas, are beautiful examples in difficult places. They are no more bothered by the performance of the monsoon. In a span of just two decades, these villages, once hopeless, have scripted economic miracles. In a way, they dreamt before the prime minister, and DTE shows the way they made the dream come true.

A Village of Lakhpatis

In the drought-ravaged Marathwada, residents of Kadwanchi village in Jalana district are least worried about the drought or the next monsoon. In fact, they were not bothered by any drought in the past 20 years, including the drought of 2012, the worst in 40 years. Rather, as one enters into a conversation with residents, the discussion is about

agricultural expansion. And not without reason: in the past 20 years, the income of its residents has gone up by 700 per cent.

LOCATION:
Drought-prone Marathwada

DESIGN:
Harvest water and diversify crops

IMPACT:
700% increase in income

DURATION:
16 years

Kadwanchi is a glowing example of how a well-planned government programme can help in fighting drought and raising the income of farmers. The village has seen a sharp decline in drought vulnerability since 1996, when the Kadwanchi watershed project was

launched. At that time, 100 per cent farmers in the village would report crop failure during a drought. The figure in 2013 stood at 23 per cent. All that the farmers did was conserve water and soil and dig farm ponds. Add to it the carefully thought out cropping pattern that suits the district with annual average rainfall of 730 mm.

The project, launched under the national watershed programme, was implemented in the village between 1996-97 and 2001-02 with a financial outlay of Rs 1.2 crore. "We did not think much of the work the officials were doing. They constructed bunds and trenches, and planted trees in a piece of forestland in the village to showcase how effective these methods are in fighting drought. These steps slowed the flow of running water, increased seepage and recharged groundwater. They had an impact on the nearby areas as well. Within two years, the wells in surrounding areas started recharging and the soil gained moisture. This compelled us to understand the techniques," says Vishnu Bapurao, 58, a farmer whose annual income is more than Rs 10 lakh. The project helped increase the total cultivated area in the village from 1,365.95 hectares (ha) in 1996 to 1,517ha in 2002.

Once the water scarcity was over, the farmers started growing grapes, apart from rice and wheat. This required drip irrigation for which farmers constructed farm ponds. These are small ponds dug by the farmers themselves by taking loans from banks. The ponds store rainwater and provide water throughout the year. The village had 357 ponds in 2015. For grape cultivation and pond construction, the farmers received training by the Krishi Vigyan Kendra (KVK) of Jalana, which also oversaw the implementation of the project. Grape farming phenomenally raised the income of the farmers. According to a 2012 survey by the Central Research Institute for Dryland Agriculture (CRIDA), the average annual income of farmers in the village increased from Rs 40,000 in 1996 to Rs 3.21 lakh in 2012—a 700 per cent rise. As per the latest data by the National Sample Survey Office in December 2014, the nationwide average annual income of farmers is around Rs 72,000. Farmers in Kadwanchi earn four times the national average.

The rise in income also increased the credit worthiness of farmers. "Our study showed that non-institutional money lending decreased to 7.5 per cent and institutional lending shot up to 87 per cent. Almost all families in the village now have a lakhpati," says Pandit Wasre, an agriculture scientist at KVK, who headed the project. "The Kadwanchi project succeeded because the community owned the programmes," says Wasre. "That's why even 15 years after the programme, the structures are intact."

Not very far, at the epicentre of the current drought, Latur, Sandipan Badgire is busy measuring his harvest. In a striking contrast to many farmers in the district who are desperately digging borewells to save crops and invariably landing up in the debt trap, he boasts: “There is no borewell in my farmland and I do not grow sugarcane at all.”

Sandipan Badgire is a proud organic farmer from Latur. Not only does he not need borewells, his per hectare output is higher compared to the farmers who use chemicals and fertilisers (Photo: Nidhi Jamwal)

He is an organic farmer and believes in multi-cropping—the traditional way to ensure crop security. In 1988, at an age of 35, he decided to help his father in farming their 5 ha. At that time, there was no information available on organic farming in Latur and almost all the farmers were dependent on chemicals and fertilisers. From 1988 to 1993, Badgire also practised chemical farming and realised his crop output was going down while the input cost of pesticides was going up.

In 1993, he came across an article on organic farming published in a local Marathi magazine, which set him thinking. After sourcing more information on organic farming and attending a few farmers’ meetings in Pune, Badgire decided to adopt organic farming on his land. Since information was limited, the period between 1993 and 2000 was spent experimenting with rain-fed agriculture and organic farming. He suffered losses, but did not give up. Things started to look up after 2000, as soil fertility increased, and since then Badgire is only making progress.

"I do inter-cropping and crop rotation to keep my farmland healthy. In three acres (1 acre equals 0.4 ha), I grow tur (pigeon pea). Another three acres of jowar (sorghum), three acres of moong (green gram), and two to three acres of soybean. While farmers doing chemical farming have seen a sharp decline in their crop output, my output is still high," claims Badgire. He uses cow dung to make manure for his farm and makes medicine for his crops using cow urine.

Because of the drought this year, several farmers in Latur have lost their crops or not grown any kharif or rabi crop. "A neighbouring farmer did not get any jowar from his one acre land; but in spite of the drought, I have got five quintals (1 quintal equals 100 kg) of jowar from an acre. As against an output of one quintal chana (chickpea) from an acre in chemical farming, my output is at least double." He also has a number of tamarind and babul trees on his farmland which are suitable for semi-arid Marathwada.

The Domino Effect

In the Bundelkhand region, a few villages are overcoming consistent drought by innovating. Six years ago, Haldin Patel, a 36-year-old marginal farmer from Majhout village in Chhatarpur district of Madhya Pradesh was struggling to feed his family of five with an income of around Rs 10,000 a year. He had to do odd jobs in Delhi and Jammu

and lease out his part of the field to tenants and share croppers. On his 1 ha, he used to spend more than half the cost of input on chemical fertilisers. Things changed when farmers were trained to make organic fertilisers using cow dung, cow urine, neem leaves, water, and gram flour. In March 2011, an advocacy group Harit Prayas funded by Caritas, a Rome-based non-profit, started training small and marginal farmers in making fertiliser.

Haldin Patel in his ginger field in Chhhatarpur. Many others like Patel stopped migrating to nearby towns once they started organic farming (Photo: Jitendra)

"I was the only person who dared to prepare my own fertiliser in a village of 250 households after the training," said Haldeen. Though social pressure made him throw the fertiliser in a corner of his field, a little after a month, everybody saw the results. Not only did the ginger sapling mature before its time, it was much better in quality.

Today, the cost of production for Haldin has reduced to less than Rs 5,000 and his income has increased to more than Rs 30,000, after integrating cattle with agriculture. Following Haldin's example, many small farmers opted for organic farming in Majhout and saw an increase in their income.

The effect was also seen in adjoining villages. In a tribal village 13 km from Majhout, agriculture had become a loss-making venture. Farmers had to work as labourers in Jhansi and nearby towns. Till three years ago, the village wore a deserted look. Haldin decided to travel with the Caritas team and convince the farmers about the benefits of organic farming.

LOCATION:
Semi-arid north Karnataka

DESIGN:
Groundwater recharge

IMPACT:
700% increase in income

DURATION:
5 years

Many people, like Mohan Manjhi, stopped migrating since they started organic farming in Karoundia village in Chhatarpur district. “Everybody now rear their cattle and prepare their own fertiliser,” says 42-year-old Manjhi, who owns 2 ha of land. Though organic farming has its benefits, many factors determine the ease with which farmers can reap them. Lack of fodder and shrinking wasteland and grazing land make it tough for small farmers to make their fertiliser.

Many choose not to fully embrace organic farming as it requires time and labour. Those with bigger landholdings or other sources of income also find it inconvenient. But for

small and marginal farmers like Babloo Prajapati who own less than half a hectare, it makes a huge difference. Organic farming has enabled Prajapati to save Rs 5,000 to 7,000 every year, which he says he uses for the education of his children.

Vinod Pandey, a former national coordinator with Caritas India who started the intervention, says, “There are a hundred adjoining villages where we did not intervene but were still influenced by our efforts.” The initiative has been catching up in panchayats like Bhasaur, Cylon, Kavar, Saliya, Dongariya, Amronia, Lahar, Majgowan, Kota, Tapara and Dharmapara of Chhatarpur district.

Replenishing Aquifers

H K Anandappa, 58, sunk more than 11 borewells in the past two decades in his 2 hectare farmland in Karnataka’s Naikanhalli village. Every time they would run dry in a couple of years or fail to yield water right from the start. Tired and desperate, he nursed thoughts of committing suicide. “In 2008, I was heavily in debt,” he says.

64-year-old Maleshappa (left), a farmer from Hulase Katte village, stands near his farm pond, which he built using a recharge borewell. "I am not as dependent on the rains now," he says (Photo: Shreeshan Venkatesh)

A meeting with Maleshappa, a farmer, in 2012 helped him turn things around. Anandappa learnt that apart from drawing water, borewells can help in recharging underground aquifers. Maleshappa had himself practised this technique in his field in Hulase Katte village after learning about it from Devaraja Reddy, a Chitradurga-based consultant in hydrogeology, during a farming workshop.

Anandappa dug his 12th borewell in 2012 and used it to pump water into the ground from a nearby seasonal canal. This solved his problem. With a recharged water table, he could now extract water throughout the year.

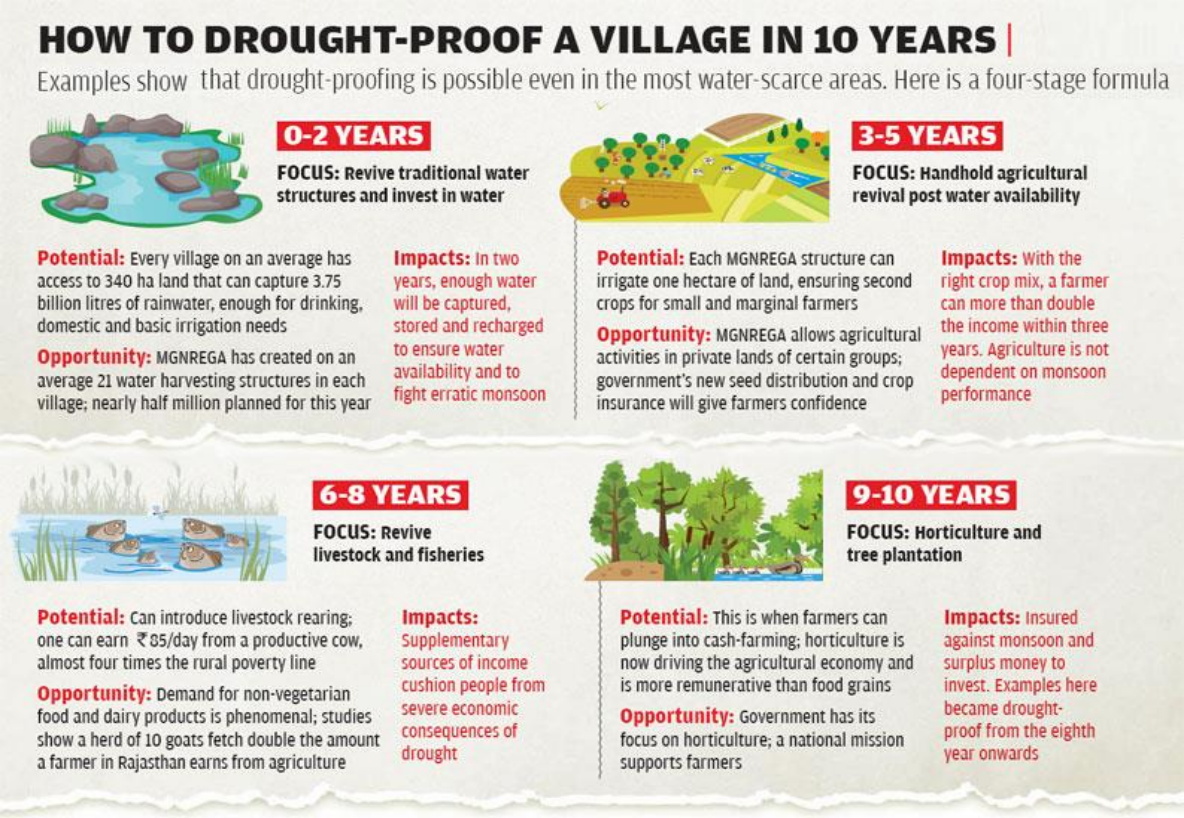
“The idea is to direct surface water to an aquifer through a bore in the ground. Though a simple mechanism, it is difficult to find the right spot for successfully recharging the bore. For instance, the catchment area must be more than a hectare for agricultural purposes,” explains Reddy. Reddy has held several training programmes and workshops in Karnataka and Andhra Pradesh in the past two decades to educate farmers about the method. His clients include state governments, non-profits and individual farmers.

The technique has helped Anandappa increase his income eight times. From Rs 1 lakh per year he earned by cultivating coconut and groundnut before the recharge bore, his income has now jumped to Rs 8 lakh. The borewell has helped him irrigate a larger area, diversify crops, and pay off debts. “I now harvest 2,000 coconuts at a time against the 200 earlier,” he says.

The method is typically useful for Karnataka, a state that has in recent times been severely affected by drought. As per “State Focus Paper 2014-15”, a report by the National Bank for Agricultural and Rural Development, Karnataka is India’s second most drought-affected state after Rajasthan. Between 63 and 72 per cent of the total area of the state is drought-prone, says the report. More than 1,000 farmers committed suicide in the state in 2015.

Although groundwater recharge can improve water security and agricultural productivity in dry and water-scarce regions, its affordability hampers its progress as a tool for drought mitigation. “The question is who will bear the costs of the recharge structures. Basic structures can be built for Rs 30,000, but even this is hardly affordable for those who need such structures the most,” says Reddy.

Though there are schemes to build public recharge systems, there are no subsidies for individual farmers. The government-run Krishi Pragati Grameen Bank is the only bank in the country which offers loans for building recharge structures. “KPGB offers up to Rs 20,000 to farmers depending on the size of the farms to dig recharge bores and recharge structures. Of around 2,000 farmers who availed this loan 75-80 per cent returned the loan. The recovery rate in other kinds of loan is 40 per cent,” says M Shivashankara Setty, manager, KPGB, Chitradurga.



Chhapariya's Fodder Bank

Now, it is the turn of India's most drought-prone state, Rajasthan, where livestock is the second survival crop. In a land where water is perpetually in short supply for human consumption, water to grow fodder for cattle is a luxury. But every family in Chhapariya village is assured two tonnes fodder every year. This is because of a common pasture land which a non-profit developed to help the villagers cope with five consecutive droughts it faced from 1999 to 2004.

During that period, almost all of the 100-odd families of the tribal village in Udaipur district were forced to sell their cattle or see them die due to fodder shortage. More than 60 families were indebted to private lenders because they were not considered credit worthy by government institutions and were paying as much as 40 per cent interest.

In 2003, Udaipur-based non-profit Sahyog Sansthan, decided to develop the common grazing land. The land was severely degraded by soil erosion, drought and overuse. The non-profit asked the residents to allow them to develop about 52 ha of the 80 ha village common land. No one was supposed to let their cattle graze in these 50 ha for six months. The non-profit constructed furrows to arrest the flow of water and retain moisture, built a boundary wall and posted a guard for security. About 4,000 saplings of bamboo and 30

kg seeds of Cenchrus setigerus (dhaman) were also planted. The greening was done in two phases. In the first phase, 39 ha in 2003 and remaining 13 ha in 2004. About 28 ha was left open for grazing and movement of animals throughout the year.

LOCATION:
Desert state of Rajasthan

DESIGN:
Integrate livestock with crops and revive grazing lands

IMPACT:
Income more than doubled

DURATION:
5 years

In developing the grazing ground, a total of Rs 47.5 lakh was spent. The district rural development agency of Udaipur, England-based non-profit Wells for India and village residents contributed 45, 39 and 16 per cent respectively. Villagers contributed mostly in the form of labour, says Hiralal Sharma, head of Sahyog Sansthan.

Once the land was ready for use, it was divided into 10 parts which were then used by the 10 hamlets the village consists of. The hamlets further distributes the land. The 10

pieces of land are used in rotation to ensure that no hamlet is stuck with the same piece of land for consecutive years.

The initiative has seen remarkable results. According to Sahyog Sansthan, the income of the village from grass grown in the common land has risen from Rs 37,500 in 2003 to Rs 84,000 in 2008. The wood grown in the land is also used as fuel. The total wood collected is divided equally among the families. In 2012 and 2013, each family got 650 kg of wood. Apart from developing the grazing ground, Sahyog Sansthan renovated old wells, constructed irrigation channels, introduced soil and water conservation measures and rain water harvesting to help the village residents. In 2005, the non-profit completely withdrew from the maintenance of the ground. Now the village residents are solely responsible for the upkeep.

Informed Success

In the past 13 years, the lives of farmers in seven districts of undivided Andhra Pradesh have changed in a big way. They are not only able to cope with drought-like conditions but also grow crops which assure yield and generate higher income.

In 2003, the Food and Agriculture Organization (FAO) of the United Nations launched a groundwater management programme called Andhra Pradesh Farmer Managed Groundwater Systems in seven most drought-prone districts, two of which now fall in Telangana.

The training given to farmers in groundwater management by FAO and local non-government bodies has enabled them to make feasible and informed decisions about which crops to grow depending on water availability. “Previously, I used to flood the field whenever water was available but the training made me understand when and how much to irrigate,” says G Venkata Konda Reddy, a 52-year-old farmer.

Farmers learnt to measure rainfall and groundwater level, based on which they now advance sowing to October, usually done in December, to save costs on irrigation. Before the training, Reddy was cultivating water-intensive crops, paddy and cotton. Now he has shifted to crops which consume less water, enabling better yield and higher income. “Earlier I was growing seven to eight crops but now I can cultivate up to 14 crops depending on rainfall and water availability.”

A farmer dries millet in R Krishnapuram village in Andhra Pradesh. Groundwater management has allowed many like him to grow waterefficient crops, thereby increasing incomes (Photo: Karnika Bahuguna)

When Reddy was growing cotton, he earned a maximum of Rs 10,000 per acre. Today he earns between Rs 20,000 and Rs 40,000 per acre from groundnut cultivation. Depending on water availability, he also grows green gram, black gram, millet, pulses and vegetables to sustain his income. V Paul Raja Rao, secretary, Bharathi Integrated Rural Development Society, a non-profit, says, "The project has made farmers shift from water-intensive to water-efficient crops besides encouraging diversified cropping."

Under the project, farmers are trained in data collection, soil types, lithology, irrigation systems and water-saving techniques like drip irrigation, mulching, and furrow-irrigation. Besides training, various structures are set up like check dams, percolation tanks and injection wells.

A committee of villagers, panchayat members and hydrologists collects the information about intended cropping patterns and calculates water consumption based on acreage. The resultant groundwater deficit or surplus is then estimated. Farmers use this information, illustrated on walls of the village, to plan their crops in an exercise called cropwater budgeting. In case of severe water deficit, they advance sowing and opt for diversified cropping.

The programme has had other effects. By the late 1990s, an increasingly large number of dug wells fell dry or became seasonal. But today, there is substantial reduction in groundwater usage. According to a 2010 World Bank survey of eight hydrological units in the project area, six reported a reduction under high water use crops. The area under

high water use crops in Yerravanka decreased by almost 11 per cent from 2004-05 to 2007-08, whereas the area under the low-water-use-crops increased by roughly the same amount.

The Lessons

Modi made his strategy clear to achieve the fixed target through a seven-point charter: focus on irrigation; provide quality seeds and increase soil health; avoid post-harvest losses by building warehouses and cold chains, add value through food processing; have a single national market; provide crop insurance coverage; and add ancillary activities like poultry to farming. But these initiatives are not new. The villages have already adopted what Modi proposed. The only differences are in the way these villages implemented the change and the principles behind them. While Modi identified activities to increase the income, the villages have focused on local planning and the involvement of local communities in development.

These villages, which have successfully generated employment and livelihoods from local resources, have followed a common road to prosperity. All the villages have defined their poverty as lack of access to natural resources. One can call it ecological poverty. Thus, their primary aim has been to gain access to local resources like traditional tanks and ponds or the common grazing land. Secondly, community organisations have efficiently partnered with government and non-government organisations. This common road has two major roadblocks as well. Government agencies, the biggest funders of rural development, working with a conventional notion of poverty don't see community initiatives as a viable model of employment generation and poverty eradication. Consequently, government policies are not tuned to the local scenario, making all the efforts futile.

While many factors helped bring changes in these villages—involving voluntary organisations, committed individuals, and government grants and loans—the most important common factor was the key role played by local institutions like community groups and village panchayats.

The pertinent question is: how to learn a lesson from these villages and scale up initiatives at a national level to increase the income of farmers. Modi has the instrument in the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), which recently celebrated its 10th anniversary. The employment programme has all the required elements to replicate the above examples: it mandates the village council to plan; it has a provision of five-year plan for villages; it mandates the creation of structures relevant

to local farming and water security; and more so, MGNREGA has the required funds to carry out the tasks.

In the last decade, MGNREGA has created unprecedented 12.3 million water conservation structures. So, why water scarcity in drought-hit states? Close to 60 per cent of water structures are in the 10 states reeling from drought. It is a problem not with MGNREGA but with the way it has been implemented.

As in Bundelkhand, hundreds of structures were created but with scant regard for local ecology. So, most of the structures failed to do their primary work: capture rain water. The programme, if not designed for long-term development, will lead to sheer wastage of public money.

MGNREGA can meet one of the toughest challenges of India's drought management. A study of India's drought management approaches over the last several decades shows that India largely depended on crisis management. This is despite the fact that over a period of time there have been gradual changes in our approach, at least officially. After the 1966 drought—a situation similar to the current one—government drought management approach changed from ad-hoc crisis management to an anticipatory drought management. In the early 1970s, the Drought Prone Areas Programme (DPAP) and the Desert Development Programme (DDP) were implemented to revive the ecology in hot and cold deserts. The drought in 1987 forced a shift in the focus of the government to long-term measures such as watershed development approach for drought-proofing the country. Many of the above successful examples have adopted this approach. DPAP and DDP were redrafted to make watershed development a unit of the drought-proofing initiative. The drought in 2002 finally prompted policymakers and development practitioners to account for the fact that drought was perpetuated by human-induced factors such as neglect of water harvesting capacity. Since then, rainwater harvesting—specifically, the revival of traditional systems—has been given priority in drought management. All of these changes have been factored into MGNREGA and given a legal stamp for effective implementation.

It is not deficit monsoon that triggers drought but the lack of mechanism to capture rainwater. Most of the above villages have done precisely that. With just 100mm of rainfall in a year, that is, around one-tenth of the country's average rainfall, India can harvest a million litres of water from one hectare of land. Applying the same calculation,

rain captured from 1-2 per cent of India's land can provide its people as much as 100 litres of water per person per day.

The water structures created under MGNREGA—21 structures in every village till now— are the best instruments to ensure that Indian villages become drought-proof. These structures harvest water and recharge the groundwater. Going by the types of water structures created, each of these structures can irrigate one hectare of land. The average cost of irrigation per hectare using these structures come to around Rs 20,000. This is a sharp contrast to government of India's estimate of Rs 1.5-2 lakh/ha based on canal irrigation.

MGNREGA has been effective in mitigating drought. This was evident in 2009, when poor and marginal farmers in chronic drought-prone areas were more prepared than the state government. It is time, we rejuvenated the programme to drought-proof the country. *With inputs from Nidhi Jamwal*

In 2009, MGNREGA was effective in mitigating drought even in the most chronic drought prone areas (Photo: Moyna)