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Prime Minister Gives a Clarion Call for Aatmanirbhar Bharat; Announces Comprehensive Package of Rs 20 Lakh Crore

Prime Minister Shri Narendra Modi addressed the nation on May 12, 2020. Recalling those who have died battling the pandemic, the Prime Minister said, the crisis that has emerged due to COVID-19 is unprecedented, but in this battle, we not only need to protect ourselves but also have to keep moving forward.

Self-reliant India

Talking about the pre and post COVID-19 worlds, the Prime Minister observed that in order to fulfill the dream of making the 21st century India's, the way forward is through ensuring that the country becomes self-reliant. Talking about turning a crisis into an opportunity, he gave the example of PPE kits and N-95 masks, whose production in India has gone up from almost being negligible to two lakh each, on a daily basis.

The Prime Minister remarked that the definition of self-reliance has undergone a change in the globalized world and clarified that when the country talks about self-reliance, it is different from being self-centered. He said that India's culture considers the world as one family, and progress in India is part of, and also contributes to, progress in the whole world. He noted that the world trusts that India has a lot to contribute towards the development of the entire humanity.

Five pillars of a self-reliant India

Recalling the devastation in Kutch after the earthquake, Shri Modi said that through determination and resolve, the area was back on its feet. A similar determination is needed to make the country self-reliant.

He said that a self-reliant India will stand on five pillars viz. Economy, which brings in quantum jump and not incremental change; Infrastructure, which should become the identity of India; System, based on 21st century technology driven arrangements; Vibrant Demography, which is our source of energy for a self-reliant India; and Demand, whereby the strength of our demand and supply chain should be utilized to full capacity. He underlined the importance of strengthening all stakeholders in the supply chain to increase, as well as fulfill, the demand.

Aatmanirbhar Bharat Abhiyaan

The Prime Minister announced a special economic package and gave a clarion call for Aatmanirbhar Bharat. He noted that this package, taken together with earlier announcements by the government during COVID-19 crisis and decisions taken by RBI, is to the tune of Rs 20 lakh crore, which is equivalent to almost 10 percent of India's GDP. He said that the package will provide a much needed boost towards achieving 'Aatmanirbhar Bharat'.

The Prime Minister observed that the package will also focus on land, labour, liquidity and laws. It will cater to various sections including cottage industry, MSMEs, labourers, middle class, industries, among others. He informed that the details of the contours of the package will be provided by the Finance Minister from tomorrow, in the coming few days.

Talking about the positive impact of reforms like JAM trinity and others, brought about in the last six years, the Prime Minister said that several bold reforms are needed to make the country self-reliant, so that the impact of crisis such as COVID-19, can be negated in future. These reforms include supply chain reforms for agriculture, rational tax system, simple and clear laws, capable human resource and a strong financial system. These reforms will promote business, attract investment, and further strengthen Make in India.

Prime Minister Modi remarked that self-reliance will prepare the country for tough competition in the global supply chain, and it is important that the country wins this competition. The same has been kept in mind while preparing the package. It will not only increase efficiency in various sectors but also ensure quality.

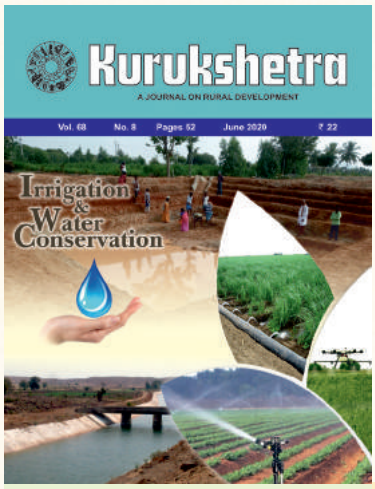
Highlighting their contribution to the country, Prime Minister said that the package will also focus on empowering the poor, labourers, migrants, etc., both from organized and unorganized sectors.

He observed that the crisis has taught us the importance of local manufacturing, local market and local supply chains. All our demands during the crisis were met 'locally'. Now, it is time to be vocal about the local products and help these local products become global, he said.

Living with COVID-19

The Prime Minister noted that several experts and scientists have said that the virus is going to be part of our lives for a long time. But, it is also important to ensure that our life does-not revolve only around it. He exhorted people to work towards their targets while taking precautions like wearing masks and maintaining 'do gaz doori'.

(Source: Press Information Bureau)



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EDITORIAL OFFICE
ROOM NO. 653,
Publications Division,
Soochna Bhawan,
C.G.O. Complex, Lodhi Road,
NEW DELHI-110003
Phone : 011-24362859
E-MAIL : kurukshetrajournal@gmail.com

FOR SUBSCRIPTION ENQUIRIES,
RENEWALS AND AGENCY INFORMATION
PLEASE CONTACT:
JOURNAL UNIT, PUBLICATIONS DIVISION
MINISTRY OF I & B, ROOM NO. 48-53,
SOOCHNA BHAWAN, CGO COMPLEX,
LODHI ROAD, NEW DELHI-110 003
TELE : 24367453
FAX: 24365610
E-MAIL : helpdesk1.dpd@gmail.com
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Editorial

India has been fighting the COVID-19 pandemic firmly and decisively. The country is courageously dealing with challenges emerging out of the pandemic while countering misinformation related to it through Press Information Bureau's Fact Check Twitter handle on a daily basis. In the beginning, Team Kurukshetra would like to express its gratitude to the corona warriors and everyone who has been playing a constructive role to support the country in this hour of need.

To strengthen the economy and India's fight against COVID-19, Prime Minister Shri Narendra Modi announced a special economic package and gave a clarion call for Aatmanirbhar Bharat. The package, taken together with earlier announcements by the government during COVID-19 crisis and decisions taken by Reserve Bank of India, is to the tune of Rs. 20 lakh crore, which is equivalent to almost 10 per cent of India's GDP. Shri Modi said that the package will provide a much-needed boost towards achieving 'Aatmanirbhar Bharat'.

Now, let us talk about the theme of this issue—Irrigation and Water Conservation. Needless to say, the time has come that people must learn how to conserve every drop of water and develop efficient techniques of irrigation. Yes, we need to think about the proper management of water and its use in various activities. Encouragement is key, undoubtedly, there is an urgent need to encourage people so that they take the matters related to water conservation seriously. All available sources and programmes should be converged to see a positive impact in the area of water conservation and its management. Being an agrarian economy, proper water management must be promoted in irrigation activities in the country.

India has demonstrated a big transformation in the agriculture sector in the second half of the 20th century with the 'Green Revolution' but now we need to go for a 'technology revolution' to accelerate the growth in the agriculture sector. Smart agriculture has all the technological inputs that can steer us away from the problems of present-day agriculture. Smart agriculture has the potential to double the food production in 40 years with lesser impact on climate change. It can reduce the losses and wastage by 50 percent.

The lead article focuses on water management to achieve the goal of sustainable agriculture. It states that water is one of the most critical resources for sustainable agricultural development worldwide. Sustainable water management in agriculture aims to match water availability and water needs in quantity and quality, in space and time, at reasonable cost and with acceptable environmental impact. We have also focused in this issue on the crisis related to ground water. For this purpose, farmers need to be made aware and trained about conservation of water.

This time, we have a special article in this issue focusing on COVID-19. India's health system capacities are in place to detect, isolate, test and treat every case and trace every contact to deal with this pandemic. As emphasised by Prime Minister Shri Narendra Modi in his recent addresses to the nation, COVID-19 will remain a part of our lives for quite some time to come and we therefore need to learn to live with it. This will require each one of us to continue to adhere to social distancing norms, including wearing of face covers in public places, as well as focusing on hand hygiene. Precise public health strategies need to be developed at the micro-level with an emphasis on limiting the spread of the infection beyond the existing hotspots while also allowing economic activities to resume in a calibrated manner along the lines of the broad guidelines laid out by the Centre.

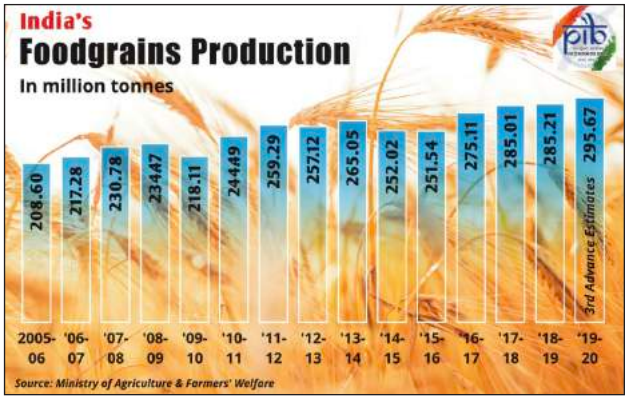
This issue has an article on Yoga to enlighten our readers on how this ancient physical, mental and spiritual practice that originated in India, can keep them mentally and physically fit during COVID-19. We hope that our readers get to know about several key developments related to irrigation, water conservation and COVID-19 taking place in the country through this issue of Kurukshetra.

Water Management: Towards Sustainable Agriculture

Dr. Y S Shivay and Dr. Teekam Singh

With the foodgrain production touching an all-time record level of 284 plus million tonnes (MT) in 2018–19, Indian agriculture has made stupendous progress in ensuring food security to its vast population. Sustainable agriculture is a way of farming according to the location-specific ecosystem and study of relationships between organisms and their environment. Simply stated, sustainable agriculture is a form of agriculture aimed at meeting the needs of the present generation without endangering the resource base of the future generations.

Water is one of the most critical resources for sustainable agricultural development worldwide. Sustainable water management in agriculture aims to match water availability and water needs in quantity and quality, in space and time, at reasonable cost and with acceptable environmental impact. Irrigated areas will increase in the forthcoming years, while fresh water supplies will be diverted from agriculture to meet the increasing demand of domestic use and industry. Furthermore, the efficiency of irrigation is very low, since less than 40 percent of the applied water is actually used by the crops. The sustainable use of irrigation water is a priority for agriculture in arid and semi-arid areas. So, under scarcity of water and changing climate scenario, India has a very formidable and challenging task of feeding 17.5 percent of the world's human population from a meagre 2.3 percent of land area which is further constrained by the fact that the country has only 4 percent of the global water resources at its disposal. In addition to the second largest human population, the country also has to provide feed and fodder to 11 percent of the world's livestock population. Combination of high yielding varieties, enhanced availability of water and fertilisers—the three key inputs in agriculture—transformed India from a country of begging bowl to one with over-flowing granaries.[1] It has imparted stability and resilience to the agricultural production system in the country. With the foodgrain production touching an all-time record level of 284 plus million tonnes (MT) in 2018–19, Indian agriculture has made stupendous progress in ensuring food security to its vast population. The new emerging demands of the relatively more-affluent Indian population, particularly its middle class, coupled with a net cultivated area unlikely to exceed 143 million hectare (MH) in 2050 as well as an estimated rainfed agriculture to cover around 45 percent of



the net sown area, are further compounded with the harsh reality that highly productive agricultural land is being continuously lost out to the industry and urban sectors. How will the country meet the target of 355 MT for foodgrains, 180 MT for vegetables, 182 MT for milk, 15 MT for meat, and 16 MT for fish by 2030, warranting an improvement of 50–100 percent over the current production, in a situation where the natural resources base is continuously degrading and climate change with its attendant impacts is adversely affecting the agricultural production system.[2] The strategies to attain this are water-intensive. Further, increased production is to be achieved through reduced emission of Greenhouse Gases (GHGs) and using cleaner energy. Therefore, development strategies in agriculture need to be centred on regional water availability, water budgeting and its efficient use.

Sustainable agriculture is a way of farming according to the location-specific ecosystem and study of relationships between organisms and their environment. Simply stated, sustainable agriculture is a form of agriculture aimed at meeting the needs of the present generation without endangering the resource base of the future generations. Thus, a holistic and systematic approach is essential for achieving sustainability. Such systems must be resource-conserving, socially supportive,

commercially competitive and environmentally sound. Such systems aim to produce qualitative and nutritious food without harming human health and ecosystem. Thus, such systems generally avoid the use of synthetically compounded fertilisers, pesticides, growth regulators and livestock feed additives, instead they rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, appropriate mechanical cultivation, and mineral bearing rocks to maintain soil fertility and productivity. There are following ways to sustain agricultural productivity:

- Soil management through conservation agriculture, organic farming, integrated nutrient management system and on-farm residue management;
- Efficient water resource management techniques like right method of irrigation, micro-irrigation, life-saving irrigation, use of mulches etc.;
- Crop management includes right time of sowing, cultivation of suitable crops and varieties in rotation, inter cropping, mixed-cropping, integrated pests management, etc.

The sustainability in agriculture i.e. for crops/ cropping systems primarily depends upon the availability of water in its optimum quantity and acceptable quality. Agriculture might not sustain its productivity if irrigation is not sustainable and water supplies are not reliable. Especially in areas of water scarcity the major need for development of irrigation is to minimise water use. Efforts are needed to find economic crops using minimal water, to use application methods that minimise loss of water by evaporation from the soil or percolation of water beyond the depth of root zone and to minimise losses of water from storage or delivery systems. Nowadays, during a period of dramatic changes and uncertain water resources, there is a need to provide support and encouragement to farmers to move from their traditional high-water demand cropping viz. rice–wheat to maize–wheat/ pigeonpea–wheat and irrigation practices to modern, reduced demand systems and technologies. Under scarcity conditions considerable effort has been devoted over time to introduce policies aiming to increase water efficiency based on the assertion that more can be achieved with less water through better management. Better management usually refers to improvement of allocative and/or irrigation water efficiency. The former is closely related to adequate pricing, while the latter depends on the type of irrigation technology, environmental conditions and on scheduling of water application. Thus, water management has been a key issue in realising commendable progress in agricultural production. All India Coordinated Research Project on Water Management, Water Technology Centre, Water and Land Management Institute and various central and state agricultural universities in the country have made remarkable progress in evolving different strategies and technologies for improving sustainable use of available water resources for enhancing water and crop productivity.

Water Resources of India

Rainwater is the primary source to meet the demand of water in Indian agriculture. India annually receives a rainfall of 1,085 mm. Nearly three-fourths of the total rainfall received in India is through south-western monsoon activity. The remaining amount of rainfall comes via pre or post and north-eastern monsoon activity. Total utilisable water resource in the country has been estimated to be about 1,123 billion cubic metres (BCM) (690 BCM from surface and 433 BCM from ground water), which is just 28 percent of the total precipitation. About 80 percent of the water (688 BCM) is being diverted for irrigation, which may increase to 1,072 BCM by 2050. On the basis of the available water resources, the total irrigation potential from surface and ground water resources is estimated to be 139.9 MH. The major source for irrigation is groundwater. Annual groundwater recharge is about 433 BCM of which 212.5 BCM is used for irrigation and 18.1 BCM for domestic and industrial use. By 2025, demand for domestic and industrial water usage may increase to 29.2 BCM. Today at 68.1 MH (2013–14), India has one of the largest net irrigated areas in the world but if one examines the productivity of irrigated areas at the national level, it is only around 3 tonnes per hectare.[3] The efficiency of surface irrigation systems is around 30–40 percent which implies that at least 60 percent of the water being supplied is being lost at various stages in the system.

Efficient Water Management Practices

Efficient and sustainable water management practices in agriculture aims to match water availability and water needs in quantity and quality,

in space and time, at reasonable cost and with acceptable environmental impact. Under water demand management most attention has been given to irrigation scheduling (when to irrigate and how much water to apply) giving minor role to irrigation methods (how to apply the water in the field). Many parameters like crop growth stage and its sensitivity to water stress, climatic conditions and water availability in the soil determine when to irrigate or the so-called irrigation frequency. However, this frequency depends upon the irrigation method and therefore, both irrigation scheduling and the irrigation method are inter-related. The National Agricultural Research System (NARS) through its vast network of State Agricultural Universities (SAUs), Indian Council of Agricultural Research (ICAR) institutions and All India Coordinated Research Projects (AICRPs) have developed a plethora of technologies and practices focusing on enhancing water use efficiency at all levels, which are described below:

1. Laser Land Levelling

Proper land levelling is one of the management options which is generally ignored by most farmers. It increases the water application efficiency which leads to higher yields as well as rise in water use efficiency (Table 1). It also has a direct impact on the nutrient use efficiency.

Table 1. Increment in crop productivity and water saving through Laser Land Levelling

Crop	Grain yield (t/ha)		Water saving over without laser levelled field (%)
	Laser levelled field	Without laser levelling field	
Paddy	6.79	6.50	38
Wheat	4.75	4.55	20
Sugarcane	112.00	98.75	24
Summer mungbean	0.55	0.38	20
Potato	10.00	9.00	25
Onion	10.00	9.00	20
Sunflower	2.25	2.00	20

(Source: *Singh, A.K. 2014. Sustainable Management of Water Resources: Issues and Strategies. (In) Efficient Water Management for Sustainable Agriculture (Rattan, R.K. and Biswas, D.R., Eds.). Bulletin of the Indian Society of Soil Science 29, pp 1–26.*)

2. Irrigation Scheduling

Irrigation scheduling is the decision-making process for determining when to irrigate the crops and how much water to apply. The goal of an effective irrigation scheduling programme is to supply the plants with sufficient water while minimising loss to deep percolation or runoff. It forms the sole means for optimising agricultural production and for conserving water and it is the key to improving performance and sustainability of the irrigation systems. It requires good knowledge of the crops' water requirements and of the soil water characteristics that determine when to irrigate, while the adequacy of the irrigation method determines the accuracy of how much water to apply. In most cases, the skill of the farmer determines the effectiveness of the irrigation scheduling at field level. With appropriate irrigation scheduling deep percolation and transportation of fertilisers and agro-chemicals out of the root-zone is controlled, water-logging is avoided, less water is used (saving water and energy), optimum soil water conditions are created for plant growth, higher yields and better quality are obtained and rising of saline water table is avoided. In water-scarce regions, irrigation scheduling is more important than in conditions of abundant water, since any excess in water use is a potential cause for deficit for other users or uses.

Irrigation scheduling techniques and tools vary greatly and has different characteristics related to their applicability and effectiveness. Timing and depth criteria for irrigation scheduling can be established by using several approaches based on soil water measurements, soil water balance estimates and plant stress indicators, climatic parameters, in combination with simple rules or very sophisticated models.

3. Methods of Irrigation

Once the water requirement of crops is quantitatively and temporally determined then methods of irrigation make water available to crop plants. Water use efficiency mainly depends on the way water is applied in the field. Efficient irrigation method is always aimed at reducing the various losses of water during application. It is very important to employ the correct method of water application to minimise the adverse effects of irrigation. The selection of the right method of irrigation is influenced by soil type, land topography, crops to be grown,

quality and quantity of water available for irrigation and other site-specific variations. Various irrigation methods are described below which are commonly used in different crops and cropping systems under specific situations:

3.1 Check Basin and Border Strip Irrigation: Surface irrigation involves the application of water by gravity flow to the surface of the field. Over the years many surface methods of irrigation have been developed. Among them, the check basin method of irrigation is the most popular. Check basin is the easiest and least costly method, but is usually highly inefficient only less than 20 percent of the water is taken up by the plant. Unfortunately, this is also the most widely used method among Indian farmers in different crops and cropping systems. Farmers also go for surface flooding which is also an inefficient manner of using this precious natural resource.

3.2. Furrow Irrigation: The furrow method of irrigation is generally used to irrigate row crops and vegetables, and is suited to soils in which the infiltration rates are between 0.5 and 2.5 cm/hr. It is ideal for slopes varying from 0.2 to 0.5 percent and a stream size of 1–2 litre/second. Many of the field crops in which water is applied through flooding, check basin or border strip methods, can easily be adapted for furrow irrigation or its modified version i.e. raised bed system and 20–30 percent savings in irrigation water can be achieved by switching over to raised bed furrow irrigation systems.

3.3. Surge Flow Irrigation: Excessive water intake and deep percolation losses are major limitations for irrigation through furrows and border strips. Surge flow irrigation, the intermittent application of water in a series of on and off modes of constant or variable time spans has the potential of reducing intake and percolation losses, increasing the irrigation efficiencies and conserving irrigation water.

3.4. Micro-irrigation*:* Micro-irrigation is one of the most efficient methods of irrigation which not only enhanced water use efficiency but also increased crop productivity. Promotion of micro-irrigation is critical to enhance water-use efficiency in the context of rampant extraction of groundwater for irrigation and high variability in rainfall due to climate change. Micro-irrigation in India is popularised with a subsidy component, by both the central and state governments. As on 2017, the area covered under micro-irrigation is about 8.7 MH, accounting for only about 13 percent of the potential area. Maharashtra, Andhra Pradesh, Telangana, Karnataka and Gujarat together account for about 85 percent of total drip-irrigated area.[4] In case of the sprinkler system, Rajasthan and Haryana top the list. Madhya Pradesh, Punjab and Haryana lag far behind compared to their potential. However, groundwater development in these states is more than 100 percent. In 2006, the Government of India (GOI) started a Centrally Sponsored Scheme (CSS) for micro-irrigation. In 2010, CSS was enhanced in scope and renamed as National Mission on Micro Irrigation (NMMI), which was subsequently brought under the ambit of the National Mission on Sustainable Agriculture. In 2015, NMMI was brought as a scheme under the Prime Minister's Krishi Sinchayee Yojana (PMKSY). The scheme envisages providing end-to-end solution to irrigation supply chain. Micro-irrigation helps in attaining greater water-use efficiency, thereby reducing the pressure on groundwater sources with reduced GHG emissions. Micro-irrigation has the potential to function both as demand- and supply-side management tool. However, only about 15 percent of potential areas could be brought under micro-irrigation, warranting a course correction.[5] Micro-irrigation should be popularised in more water scare and unsustainable water extraction regions to sustain the productivity and water use efficiency. Micro-irrigation mainly includes drip irrigation and sprinkler system water application.

3.4.1. Sprinkler Irrigation: Sprinkler irrigation systems imitate natural rainfall. Water is pumped through pipes and then sprayed onto the crops through rotating sprinkler heads. These systems are more efficient than surface irrigation, however, they are more costly to install and operate because of the need for pressurised water. Conventional sprinkler systems spray the water

into the air, losing considerable amounts to evaporation. Low Energy Precision Application (LEPA) offers a more efficient alternative. In this system the water is delivered to the crops from drop tubes that extend from the sprinkler's arm. When applied together with appropriate water-saving farming techniques, LEPA can achieve efficiencies as high as 95 percent. Since this method operates at low pressure, it also saves as much as 20 to 50 percent in energy costs compared with conventional systems.

3.4.2. Drip Irrigation: Drip method of irrigation gives many advantages over the gravity surface irrigation methods in terms of water savings and yields (Table 2). Drip and micro-sprinkler irrigation systems, which apply water slowly on or below the soil surface as discrete or continuous drips, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line adjacent to the plant row, is often preferred over other irrigation methods because of its high (90 percent) water application efficiency[6] and have been proved as one of the best ways to increase water productivity. Evidences show that the water-use efficiency increases up to 100 percent in a properly designed and managed drip irrigation system. Drip method of irrigation helps to reduce the over-exploitation of groundwater that partly occurs because of inefficient use of water under surface method of irrigation. Water logging and salinity are also completely absent under drip method of irrigation. It also helps in attaining early maturity of crops, higher quality produce, increased crop yields and higher fertiliser-use efficiency, reduction in weed growth, less labour requirement and less electric power consumption, cost of cultivation especially in inputs like fertilisers, labour, tilling and weeding.

3.4.3. Fertigation: The application of fertilisers through the irrigation system (fertigation) became a common practice in modern irrigated agriculture. Localised irrigation systems, which could be highly efficient for water application, are also suitable for fertigation. Thus, the soluble fertilisers at concentrations required by crops are applied through the irrigation system to the wetted volume of the soil. Possible disadvantages include the non-uniform chemical distribution when irrigation design or operation are inadequate, the over-fertilisation in case that irrigation is not based on actual crop requirements and the excessive use of soluble fertilisers.

3.4.4. Subsurface Drip Irrigation: Subsurface Drip Irrigation (SDI) is a low-pressure, low volume irrigation system that uses buried tubes to apply water. The applied water moves out of the tubes by soil matrix suction. Wetting occurs around the tube and water moves

Table 2: Relative Performance of Drip and Traditional Surface Irrigation on Yields, Irrigation Water Use and also Water Use Efficiency of Some Important Crops, Vegetables and Fruits

Crop	Yields (kg/ha)		Irrigation water (cm)		WUE (kg/ha–cm)	
	Surface	Drip	Surface	Drip	Surface	Drip
Vegetables (16) (Av. of 34 cases)	1722	2383 (38.4%)	64.1	35.3 (45%)	398	884 (122%)
Fruits (7 types) (Av. of 16 cases)	1611	2851 (77%)	83.3	57.8 (31%)	262	750 (186%)
Cotton (Av. of 3 cases)	238	313 (31.5%)	85.7	41.1 (51.8%)	28	81 (189)
Ground nut (Av. of 4 cases)	354	940 (165.5%)	74.6	51.4 (31%)	54	178 (230%)
Sugarcane (Av. of 7 cases)	10770	13900 (29.1%)	165.1	109.9 (33%)	716	1306 (82%)
All Crops (Av. of 64 cases)	2938	4072 (38.6%)	94.56	59.1 (37%)	292	639 (119%)

(Source: *Singh, A.K. 2014. Sustainable Management of Water Resources: Issues and Strategies. (In) Efficient Water Management for Sustainable Agriculture (Rattan, R.K. and Biswas, D.R., Eds.). Bulletin of the Indian Society of Soil Science 29, pp 1–26.*)

out in the soil all directions. The potential advantages of SDI are: a) water conservation, b) enhanced fertiliser efficiency, c) uniform and highly efficient water application, d) elimination of surface infiltration problems and evaporation losses, e) flexibility in providing frequent and light irrigations, f) Reduced problems of disease and weeds, g) lower pressure required for operation. Subsurface irrigation is suitable for almost all crops, especially for high value fruit and vegetables, turfs and landscapes. The tube is installed below the soil surface either by digging the ditches or by special device pulled by a tractor. The depth of installation depends upon soil characteristics and crop species ranging from 15–20 cms for vegetables and field crops and 30–50 cms for tree crops. The main disadvantages are the high cost of initial installation and the increased possibility for clogging, especially when poor quality water is used.

3.5. Deficit Irrigation Practices: In arid and semi-arid regions, water availability is usually limited, and certainly not enough to achieve total crop water requirement and the maximum yields. Then, irrigation strategies should not be based on full crop water requirements but should be adopted for more effective and rational use of water based on the critical or sensitive growth stages to water deficit. Thus, at non-sensitive growth stages irrigation is withheld which is called as deficit irrigation.

3.5.1. Regulated Deficit Irrigation*:* Regulated Deficit Irrigation (RDI) is an optimising strategy under which crops are allowed to sustain some degree of water deficit and yield reduction. During RDI the crop is exposed to certain level of water stress either during a particular period or throughout the growing season. The main objective of RDI is to increase Water Use Efficiency (WUE) of the crop by eliminating irrigations that have little impact on yield and to improve control of vegetative growth (improve fruit size and quality). RDI is a sustainable way to cope with water scarcity since the allowed water deficits favour water saving, control of percolation and runoff return flows and the reduction of losses of fertilisers and agrochemicals. It provides for leaching

requirements to cope with salinity and the optimization approach leads to economic viability. The adoption of deficit irrigation implies appropriate knowledge of crop evapotranspiration, of crop response to water deficits including the identification of critical crop growth stages, and of the economic impact of yield reduction strategies.

3.5.2. Partial Root Drying*:* Partial Root Drying (PRD) is a new irrigation technique, first applied to grapevines that subject one half of the root system to dry or drying conditions while the other half is irrigated. Wetted and dried sides of the root system alternate on a 7–14 day cycle. PRD uses biochemical responses of plants to water stress to achieve balance between vegetative and reproductive growth. The PRD has been successfully applied with drip irrigation in grapevines, with subsurface irrigation in grapevines and even furrow irrigation in pear, citrus and grapevines. Improvement of WUE results from partial stomatal closure and reducing evapotranspiration during drying period.

4. Agronomic Practices

Agronomic practices, such as soil management, fertiliser application, and disease and pest control are related to sustainable water management in agriculture and the protection of the environment. These practices are very important for increasing crop productivity as well as WUE. There are large number of traditional and modern soil and crop management practices for water conservation (runoff control, improvement of soil infiltration rate, increase soil water capacity, control of soil water evaporation) and erosion control in agriculture which increase WUE. Some of the important agronomic practices, which increase the water use efficiency, are discussed below:

Contour Tillage: Soil cultivation is made along the land slope and the soil is left with small furrows and ridges that prevent runoff. This technique is also effective to control erosion and may be applied to row crops and small grains provided that field slopes are low. This is one of the techniques to increase better use of the rain water, especially in rainfed areas.

Broad Bed Planting: Cultivation of crop on broad beds and irrigation is applied in furrows. This method helps to save 30–40 percent water and typically suitable for close planted field crops and horticultural row crops.

Conservation Tillage (CT): CT includes zero tillage and retention of crop residuals on the soil surface at planting. Crop residues acts as mulches and reduce evaporation losses and protect the soil from direct impact of raindrops, thus controlling crusting and sealing processes. CT helps to maintain high levels of organic matter in the soil thus it is highly effective in improving soil infiltration and controlling erosion which results in increase of WUE.

Mulch: Mulching with crop residues on soil surface shades the soil, slows water overland flow, improves infiltration conditions, reduces evaporation losses and also contributes to control of weeds and therefore of non-beneficial water use.

Addition of Organic Manures: Increasing or maintaining the amount of organic matter in the upper soil layers provides for better soil aggregation, reduced crusting or sealing on soil surface and increased water retention capacity of the soil.

Addition of Clay or Hydrophilic Compound: This technique increases the water retention capacity of the soil and controls deep percolation. Thus, water availability in soils with low water holding capacity is increased.

Control of Acidity: Lime application to soils with high pH favours more intensive and deep rooting, better crop development and contributes to improved soil aggregation, thus producing some increase in soil water availability.

Weed Control Measure: Adoption of appropriate weed control techniques to alleviate competition for water and transpiration losses by weeds is very important agronomic practice to increase water use efficiency in different crops and cropping systems.

Integrated Pests Management (IPM): IPM techniques aim to increase crop productivity with the same amount of other inputs like water, fertilisers etc. Pests cause severe losses to the different crops and cropping systems. However, timely control of the severe pests and diseases of different crops will not only increase the productivity and profitability to the farmers but also improve water use efficiency and water productivity.

Conclusion

Share of water to agriculture is going to decline in the future due to the stiff competition from the industrial and domestic sectors and compounded further by global warming and associated adverse impact of climate change. Since, water is a critical input for agriculture, therefore, adoption and upscaling of new technologies of efficient water management especially micro-irrigation as quickly as possible in the only viable solution to sustain agricultural productivity.

Footnotes

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(Dr. Y.S. Shivay is a Principal Scientist, at Division of Agronomy, ICAR–Indian Agricultural Research Institute, New Delhi. Email: ysshivay@hotmail.com. Dr. Teekam Singh is a Senior Scientist, at Division of Agronomy, ICAR–Indian Agricultural Research Institute, New Delhi. Email: tiku_agron@yahoo.co.in)

New Mandis Integrated with eNAM

38 additional mandis were integrated with the eNAM platform, thus achieving milestone of integration of 415 mandis as per the planned target. 38 Mandis integrated are in Madhya Pradesh (19), Telangana (10), Maharashtra (4) and One (1) each from Gujarat, Haryana, Punjab, Kerala & J&K. In a press release on May 15, 2020, the Ministry of Agriculture & Farmers Welfare said, with the overall success of 585 mandis in Phase 1 and further expanding its wings to integrate 415 new mandis in Phase 2, the e-NAM platform now has a total number of 1000 mandis across 18 States and 3 UTs.

The Union Minister for Agriculture & Farmers Welfare, Rural Development and Panchayati Raj, Shri Narendra Singh Tomar at a function in New Delhi recently. The Ministers of State for Agriculture & Family Welfare, Shri Parshottam Rupala and Shri Kailash Choudhary, the Secretary (AC&FW), Shri Sanjay Agarwal and senior officers are also seen.

National Agriculture Market (eNAM), a pan-India electronic trading portal was launched on 14th April 2016, by the Prime Minister Shri Narendra Modi, with the aim of networking the existing Mandis on a common online market platform as "One Nation One Market" for agricultural commodities in India.

In last 4 years the e-NAM has registered a user base of 1.66 Cr Farmers, 1.31 lakh Traders, 73,151 Commission Agents and 1012 FPOs. As on 14th May 2020, total volume of 3.43 Crore MT & 38.16 Lakh numbers (Bamboo & Coconut) collectively crossed a remarkable business milestone worth Rs. 1 lakh crore on e-NAM platform. Presently 150 commodities, including Foodgrains, Oilseeds, Fibers, Fruits & Vegetables, are traded on eNAM.

To address the difficulties faced by the farmers due to the COVID-19 lockdown crisis, the Union Minister of Agriculture & Farmers' Welfare, Shri Narendra Singh Tomar, on 2nd April 2020 launched 3 new modules of eNAM.

1. **FPO Module on eNAM:** This enables FPOs to conduct trade of commodities from their collection centres declared as "Deemed Market" or "Sub Market yards". As on 14th May 2020, 1012 FPOs are registered on e-NAM platform, and have traded 3053 MT of agri-produce worth Rs 8.11 Crore. Among these, 42 FPOs traded from their own collection center through recently introduced FPO module.
2. **Warehouse based Electronic Negotiable Warehouse Receipts (eNWR) trading:** For eNWR based trading, WDRA accredited warehouses from Andhra Pradesh (23) and Telangana (14) have been declared as deemed market by respective State Governments. Rajasthan Government has recently declared 138 State Government & cooperative warehouses as sub market yards. Madhya Pradesh, Uttar Pradesh, Gujarat and Punjab have initiated amendments in their respective acts to facilitate warehouse based trade.
3. **Logistics Module:** This facilitates transportation of the commodities from farm to Mandis and from Mandis to warehouse/consumption centres. Nine logistic service providers/aggregators linked with 2.3 lakh transporters and 11.37 lakh vehicles have been on-boarded on eNAM platform.

On 1st May 2020, Inter-Operability between ReMS (Unified Market Portal-UMP) and e-NAM portal was launched. In this new module farmers and traders across ReMS (UMP) of Karnataka and e-NAM platform can conduct inter-platform trade to access more markets for trade using inter-operability features and vice-versa.

(Source: Press Information Bureau)

Smart Agriculture

Dr. Harender Raj Gautam

India has demonstrated a big transformation in the agriculture sector in the second half of the 20th century with the 'Green Revolution' but now we need to go for a 'technology revolution' to accelerate the growth in the agriculture sector. Smart agriculture has all the technological inputs that can steer us away from the problems of present-day agriculture. Smart agriculture has the potential to double the food production in 40 years with lesser impact on climate change. Further, it can reduce the losses and wastage by 50 percent.

Improving water-use efficiency or enhancing agricultural water productivity is a critical response to growing water scarcity. The importance further intensifies if one needs to realise the full benefits of other production inputs, viz., fertilisers, high-quality seeds, tillage and land formation, labour, energy and machinery. According to the Food and Agriculture Organization (FAO), globally irrigated agriculture represents 20 percent of the total cultivated land, but contributes only 40 percent of the total food produced worldwide.[1] Water is a critical resource in agriculture and higher variations in usage can have adverse consequences on crop yields and soil health. Presently, irrigation water-use accounts for 80 percent of the available water.[2] The FAO estimates that over the last century the global water withdrawal grew 1.7 times faster than the population, which aggravates the concern over the sustainability of water use as the demand for agricultural, industrial and domestic uses continues to increase.[3] Improving agricultural productivity, while conserving and enhancing natural resources, such as water, is an essential requirement for farmers to increase global food supplies on a sustainable basis. The role of smallholder farmers and their families in increasing agricultural productivity growth sustainably will be crucial because most of the world's agriculture is carried out by millions of small farmers who produce a large share of the world's food and support their households. We have to realise the importance of judicious use of water by remembering that it takes between one and three tonnes of water to grow one kg of cereal. It is estimated that irrigation requirement has to be lowered to the level of 68 percent of the total demand by 2050.[4]

India has demonstrated a big transformation in the agriculture sector in the second half of the 20th century with the advent of 'Green Revolution' but now we need to go for a 'technology revolution' to accelerate the growth in the agriculture sector. Technology innovation in agriculture has always paid dividends. In the last few decades, focus of Indian agriculture has been to change the traditional irrigation system with the efficient micro-irrigation by incentivising the farmers in the installation costs. The Economic Survey 2018–19 suggests that "focus should shift from 'land productivity' to 'irrigation water productivity'". The document emphasizes that thrust should be on micro-irrigation that can improve water use efficiency because the impact is visible in the field. Impact Evaluation *Study* of National Mission on Micro Irrigation (NMMI) conducted during 2014, covering 64 districts in 13

states, indicate that micro-irrigation has benefited farmers significantly. While the electricity consumption has been reduced by about 31 percent, the irrigation cost has also decreased by an average of 32.3 percent. Furthermore, there was about a 28 percent reduction in total fertiliser consumption in the surveyed states. Micro-irrigation has enhanced average productivity of fruits and vegetables by about 42.3 percent and 52.8 percent, respectively mainly because of crop spacing, judicious use of water and other inputs. All the surveyed states reported increase in farmers' income in the range of 20 percent to 68 percent with an average increase of 48.5 percent.

Now, there is a need to adopt the next version of technology innovations. Smart agriculture has all the technological inputs which can steer us away from the problems of present-day agriculture including the irrigation water constraints. Smart agriculture has been continuously evolving in the last few decades. It is the all-new agricultural production mode and ecosystem which is based on digital agriculture and precision agriculture. Digital agriculture digitises the planning, process and result of agricultural production, such as Big Data, AI, Cloud Computing and Blockchain. Precision agriculture uses information technology to achieve precision management, such as drone, robot and intelligent irrigation. The recent developments, such as Cloud Computing, Internet of Things, Big Data, Blockchain, Robotics and Artificial Intelligence have taken the management of agricultural operations to a much higher level of technology. Smart agriculture allowed for the integration of so far isolated lines of development into smart, connected systems of systems. Integration of these technologies will help the agriculture to evolve in a data-driven, intelligent, agile and autonomously connected system of systems. The operations of each agricultural process will be automatically integrated in the food chain through the semantically active technologies up till the end consumer.

Transformative Discoveries for Smart Agriculture

There is a basket of technologies and innovations that are enable production technology of smart agriculture. The concept, science and applications of such innovations are described below:

Internet of Things (IoT): IoT is described as a network of physical objects. These can be "things" that can be embedded with technologies, software or sensors which further helps in connecting or the exchange of data with other devices or systems via the internet or vice versa. In 2016, more than 5.5 million new "things" got connected every day, thus, creating the huge scope for Internet of Things. There are over 8.3 billion IoT devices connected today.

Artificial Intelligence (AI): It is the science of instilling intelligence in machines so that they are capable of doing tasks that traditionally required the human mind. The term AI is commonly used when a machine mimics cognitive functions such as planning, learning, reasoning, problem solving, knowledge representation, perception, motion, manipulation, social intelligence, and creativity. AI combines automation, robotics, and computer vision. Advances in statistics, faster computers, and access to large amounts of data have augmented the advances in AI, particularly in the field of Machine Learning where significant progress has been made in the areas of image and pattern recognition, natural language understanding, and robotics. Integration of AI and IoT devices further improves the growing and selling processes via predictive analytics. These programmes will help farmers determine which crops to grow and anticipate potential threats by combining historical information about weather patterns and crop performance with real-time data.

Blockchain: It is a recent technological advancement with potential for addressing the challenge of creating a more transparent, authentic, and trustworthy digital record of the journey that food and other physical products take across the supply chain. Blockchain works by mapping data and providing it to users along the value chain simply by scanning a barcode. These barcodes are applied and linked throughout the value chain automatically by grading and sorting robotics. This information not only provides the consumer with transparency, but also reduces risks for producers at the same time making available a cost-effective supply chain analysis to optimise profits. When blockchain is integrated with IoT, it creates an immutable supply chain, ensuring that buyers are getting an authentic product that has not

been damaged along the way. These technologies can also verify whether a product that contains hazardous materials has been disposed of correctly and safely.

Robotics: Powered with advanced AI technology, robots will soon play a defining role in agriculture. Advanced computer vision is also transforming the way drones operate. Drones with AI-enabled vision processing capabilities are being used to assess the real situation on the condition of crops on ground. Autonomous drones and the data they provide can help in crop monitoring, soil assessment, plant emergence and population, fertility, crop protection, crop insurance reporting in real time, irrigation and drainage planning and harvest planning.

Autonomous Swarms: Autonomous swarms combine the technology of swarm robotics with a blockchain-based backend. Swarm robotics involves multiple copies of the same robot, working independently in parallel to achieve a goal too large for any one robot to accomplish. By leveraging the benefits of both swarm robotics and Blockchain, pesticide and fertilizer can be applied more sparingly and planting and harvesting can be done with individual attention to each plant, an impossible task with large-scale machinery. The new approach produces greater yields at reduced cost, while raising the quality of the crop.

Artificial Intelligence of Things (AIoT): Individually, the Internet of Things (IoT) and Artificial Intelligence (AI) are powerful technologies. AIoT is a combination of AI and IoT. AI can complete a set of tasks or learn from data in a way that seems intelligent. Devices empowered with the combination of AI and IoT can analyse data and make decisions and act on that data without involvement by humans.

Big Data: It is a combination of technology and analytics that can collect and compile novel data and process it in a more useful and timely way to assist decision making. Data mining is the computing process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning statistics and database system. Big Data and analytics have the potential to add value across each step and can streamline food processing value chains such as selection of right agri-inputs, monitoring soil moisture, tracking prices of market, controlling irrigations, finding the right selling point and getting the right price.

Focus on Higher Water-use Efficiency

Since the advent of Green Revolution, irrigation has been the main intervention to assure the reliability and productivity of cropping in India and has played a significant role in national food security. The area equipped for irrigation has grown enormously over the past five decades in India. According to the data from NASA's Gravity Recovery and Climate Experiment, Northwest India had the highest groundwater depletion rates in the world in 2002–2008, even though precipitation was above normal for the period. Northwest India's collective water deficit totals an estimated 100 x 109 m^3 per year. There are perhaps 20 million groundwater irrigators and in excess of 14 million tube wells in India. In irrigation systems, efficiency is typically defined as the amount of water used by the plant divided by the total amount of water applied to the field. Another common term used with irrigation is "crop per drop," the idea of growing more food with the same amount of water or less, generally increasing the productivity of water. Of the three major irrigation systems, in general, gravity irrigation systems are considered the least efficient, sprinkler systems more efficient, and micro-irrigation as the most efficient. Using the pressure terminology, unpressurized systems are generally less efficient than pressurized systems.

The country records only 38 percent water-use efficiency in the field of agriculture and much needs to be done to improve it. Conventional surface irrigation provides 60–70 percent efficiency, whereas, higher efficiency of up to 70–80 percent with sprinkler and 90 percent with drip irrigation systems can be achieved. Implementation of smart irrigation by looking into the evapotranspiration parameter of plants to optimise the irrigation cycle is well in play. The use of soil moisture content and temperature sensors are widely prevalent in scheduling irrigation. Drones equipped with hyperspectral, multispectral, or thermal sensors are able to identify areas that require changes in irrigation. Once crops have started growing, these sensors are able to calculate their vegetation index and indicator of health through AI, by measuring the crop's heat signature.

Analog irrigation systems have been used in commercial agriculture for some time and they operate on pre-programmed schedules and timers. As we do not take in to account the data on daily weather conditions, this often leaves farmers unprepared for sudden weather changes and can lead to significant overwatering and waste. Smart irrigation systems are more inclusive to such risks and are equipped with self-governing capabilities that result in more precise watering schedules that reflect the actual conditions of the grow site. Smart irrigation comprises specialised hardware devices, software and services used to obtain real-time data to help farmers make effective decisions pertaining to their farms. The combination of IoT and AI technologies, such as Machine Learning, computer vision and predictive analytics, further allow farmers to analyse real-time data of weather conditions, temperature, soil moisture and plant health. According to the Alliance for Water Efficiency, most smart irrigation technologies fall under two classifications:

1. **Sensor-based Control:** This method leverages real-time measurements from locally installed sensors to automatically adjust irrigation timing to the exact temperature, rainfall, humidity and soil moisture present in a given environment. This data is also supplemented with historic weather information to ensure farmers are able to anticipate unfavourable conditions.
2. **Signal-based Control:** Unlike sensor-based controls, these smart irrigation systems rely on weather updates transmitted by radio, telephone or web-based applications. These signals are typically sent from local weather stations to update the "evapotranspiration rate" of the irrigation controller.

An Italian startup, Blue Tentacles, has come up with a "precision-based" AI system that takes note of humidity, temperature, climate data and forecasts as well as satellite data to help farmers improve their irrigation practices whilst preventing water wastage and conserving energy. This is particularly useful to inexperienced farmers who might need help to improve productivity while reducing water consumption. These digital technologies are already being used by a number of large scale companies. An, agri start-up, Conser Water tracks how water is distributed in a field using satellite and historical data. This allows users to fine tune their irrigation supply and also identify any leaks in the irrigation pipes. Their AI system can learn to identify damaged areas in a pipe without the need for manual inspection. It is a scalable solution working without ground sensors, and farmers would only need a desktop or a smartphone to access the data and receive notifications.

According to one IoT solutions provider, connected sensors could reduce water consumption by 30 percent while improving land management decisions. The company's technology measures moisture in the soil. Then, it provides data to help farmers take action against drought or over watering. In Southern California, farmers place sensors around avocado trees to measure the water levels. The sensors connect to sprinkler systems that treat the thirsty trees as required. At night, the water shuts off at the right times to avoid waste. This setup automates significant parts of the process, allowing farmers to stop engaging in numerous manual tasks. Products based on such technologies are available in the market. In India, Microsoft collaborated with ICRISAT (International Crops Research Institute for Semi Arid Tropics) developing a predictive analytics app that calculated the best crop sowing date for maximising the yield. As a test case, farmers across seven villages were sent text messages with dates for sowing and other advice. Despite meagre rainfall, farmers that used the app boosted their yields by 30 percent. When other farmers witnessed the results, they were also more likely to use the app themselves. In Andhra Pradesh, Vijay Bhaskar Reddy, a software engineer, has developed an IoT-based autonomous irrigation solution, Mobile Motor Controller Device- Kisan Raja which helps farmers monitor, control and utilise water judiciously. This device has helped more than 34,200 farmers across ten states namely Telangana, Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Haryana, Punjab, Rajasthan, Madhya Pradesh and West Bengal. According to research company Markets and Markets, the smart irrigation market was valued at USD 0.83 billion in 2018 and is expected to reach USD 1.76 billion by 2023, at a CAGR of 16.30 percent.

Need for Water Accounting

Water accounting includes sophisticated approaches to demand forecasting on the basis of demographic change, urbanisation, industrialisation and energy production. Water accounting is an essential underpinning to transparent and effective water allocation systems. Such systems have been developed in some countries (e.g. Australia, China, France, Iran, and the US) with varying levels of sophistication and effectiveness. In China, water is allocated to different sectors (e.g. agriculture, urban and rural domestic, sanitation, industry, environment) within a limit on total water use at the national level and in each major river basin. Water accounts are created to assess the volume of water resources available at basin and subsidiary levels, to incorporate long-term inter annual variability in rainfall and weather, and to estimate water availability. Available water includes water stored in dams/reservoirs and underground. The accounts are updated through the year and reassessed at the beginning of each "water year". Water accounts are typically constructed on the basis of catchment-scale hydrologic modelling, required data on rainfall, evaporation and transpiration and stream flow over the entire landscape. In China, remote sensing is being used to quantify the evapotranspiration from all vegetative covers in a basin, allowing better calibration of hydrologic models and also monitoring of actual water use in irrigated areas. Water accounting alone is not sufficient to drive the required shifts in water use as scarcity worsens. Accounting must be accompanied by regular assessments of governance, institutions, public and private expenditure, legislation and the wider political economy of water. Malaysia is a good example of a country in the region which has invested in improving national water accounting and auditing processes. Although Malaysia has abundant water resources, it experiences seasonal water stress. It already has established a National Water Balance System that has been implemented using hydrological and other computer models in the granary regions of the country.

Initiatives of Smart Agriculture

Agriculture industry is a matter of concern for the government as lot of factors such as climate change, population growth and food security concerns have driven the sector to seek more innovative approaches to improve production, productivity and quality in major crops. NITI Aayog came up with a National Strategy for Artificial Intelligence in India, which is aimed at focusing on economic growth and social inclusion. The Government signed an MOU with IBM to use AI to secure the farming capabilities of Indian farmers. The pilot study will be conducted in states like Madhya Pradesh, Gujarat and Maharashtra. After the pilot study, IBM's Watson decision platform will provide a farm-level solution for improving the agriculture sector. It will provide weather forecast and soil moisture information to farmers to take pre-informed decisions regarding better management of water, soil and crop. This initiative was aimed at improving the future of farming by harnessing multiple data points and combine predictive analytics, AI, satellite data, and IoT sensors to give farmers insights on ploughing, choosing crops, spraying pesticides, and harvesting.

In a bid to push innovative technologies in agriculture sector, the government has also launched AGRI-UDAAN to mentor 40 agricultural start-ups from cities like Chandigarh, Ahmedabad, Pune, Bengaluru, Kolkata and Hyderabad, and enable them to connect with potential investors.[5] Maha Agri Tech Project in Maharashtra is another such project which seeks to use innovative technologies to address various risks related to cultivation such as poor rains, pest attacks, etc., and to accurately predict crop yielding. The project will also use this data to inform farmers about several policy requirements including pricing, warehousing and crop insurance. The first phase of the project uses satellite images and the data analysis done by Maharashtra Remote Sensing Application Centre (MRSAC) and the National Remote Sensing Centre (NRSC) to assess the area of land, and the conditions of select crops in select talukas. However, the second phase includes an analysis of the data collected to build a seamless framework for agriculture modelling and a geospatial database of soil nutrients, rainfall, and moisture stress to facilitate location-specific advisories to farmers.

Smart agriculture has the potential to double the food production with lesser impact on climate change. Further, it can reduce the losses and wastage. It is estimated that the IoT has the potential to increase agricultural productivity by 70 percent by 2050.[6] There is a need to develop an infrastructure in our agricultural institutions to

have scientific understanding for such technologies so that the farmers can be trained to use of such technologies and equipments in the field. There is a need for convergence of available institutional resources in the country. We have best technology institutions of the world like Indian Institutes of Technology, National Institutes of Technology, Indian Institute of Science, etc. Our immediate need is to rope in these institutions with our top agricultural intuitions like Indian Agricultural Research Institute, Indian Veterinary Research Institute, National Dairy Research Institute, Indian Institute of Horticultural Research for testing and validation of the suitable technologies in commercially important crops in different parts of the country. In the long run, there should be a collaboration in these technology and agricultural institutions for the development of such technologies for sustaining smart agriculture in the country. There is a need to remember the visionary water administrator and second Prime Minister of Australia, Alfred Deakin who said in 1890 that "It is not the quantity of water applied to a crop, it is the quantity of intelligence applied which determines the result - there is more due to intelligence than water in every case."

Footnotes

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(The author is Professor and Head, Department of Plant Pathology, Dr.Y.S.Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. Email: hrg_mpp@yahoo.com)

Agribot: Saving Water and Spraying Pesticides

It would not be surprising if you see drones deputed in the country's agricultural land spraying pesticides. Trials are being conducted in the fields with Agribot drones. Spraying of pesticides with limited amount of water is one of the great features of the Agribot drone. Where up to 400 litres of water is used for spraying pesticides in one acre field, the Agribot can spray it in 8 litres of water. Pesticides are sprayed about 10 times a year per acre. Accordingly, around 3920 litres of water is saved per acre in a year. There are about 39 crore acres of cultivated land in India. If pesticide spraying is made mandatory by drone, about 1.5 lakh crore litres of water can be saved.

Agribot drones are also being used to control grasshoppers. Amidst the terror of the locust attack, in January 2020, the drone sprayed over 500 hectares of land in 16 days and freed the area from locusts. The spray from the drone on the locust crew starts at 5 am and is repeated again in the evening. It takes about three minutes for a drone to spray on one hectare of land. Around 99 percent of grasshoppers pile up in about 10 minutes. Preparations are being made to eliminate the locusts by drones.

The Agribot drone can cover 50 acres a day with additional batteries. They are also able to operate in inaccessible areas and mountains. In the middle and later stages of the crop the drone can enter the fields for spraying pesticides, whereas this is not possible with heavy equipment. Along with saving water, the use of pesticides is 15 to 35 percent higher with drones than the conventional methods as the amount of chemical is scientifically determined. By spraying pesticides with drones, farmers stay away from chemicals and they do not have any side effects on their health.

By Nimish Kapoor, Scientist 'E' Vigyan Prasar

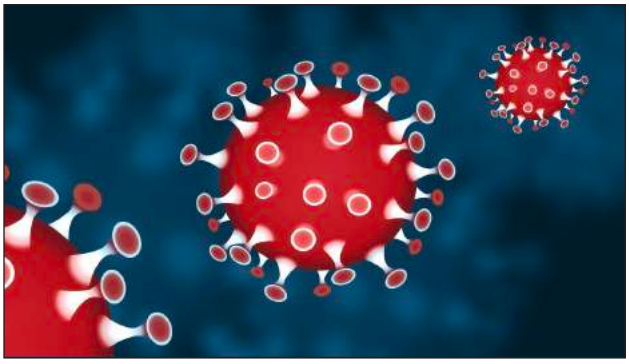
COVID-19: India's Response and the Way Forward

Urvashi Prasad

Several initiatives have been taken by the government to ramp up India's surveillance, testing and contact tracing capabilities as well as prevent the spread of COVID-19 infection. To facilitate effective contact tracing, Government of India has launched the Aarogya Setu application which allows people to assess their risk of contracting the infection based on their location and interactions with others who might be COVID-19 positive or high-risk themselves. Precise public health strategies need to be developed at the micro-level with an emphasis on limiting the spread of the infection beyond the existing hotspots while also allowing economic activities to resume in a calibrated manner along the lines of the broad guidelines laid out by the Centre.

With nearly 4.8 million cases and over 300,000 deaths globally in the span of a few months, the COVID-19 pandemic has devastated health systems and economies alike, including in some of the most developed countries. As of June 04, India had 2,16,919 confirmed COVID-19 cases and 6,075 people had succumbed to the disease. Fortunately, recovery rates in India have been on a constant path of improvement with nearly 39 percent of confirmed COVID-19 patients having recovered from the disease thus far. The fatality rate has also been relatively low at 3 percent, compared to 14 percent in Italy and the United Kingdom.

While several measures such as screening passengers at airports, prohibiting large gatherings in public places and introduction of social distancing norms had been initiated in stages by the Central and state governments, India entered into a nationwide lockdown on 25 March, 2020 when the number of COVID-19 cases and fatalities were still very low. In fact, as per the Oxford COVID-19 Government Response Stringency Index, India's lockdown stringency score was 100 when we had just 0.04 daily COVID-19 cases per million population. In contrast, by the time Italy's lockdown stringency score exceeded 90, the country



was already seeing 79.21 daily COVID-19 cases per million population and 12.29 daily COVID-19 deaths per million population. By imposing a timely nationwide lockdown, India sent out a strong signal that saving lives is the priority for the government.

The lockdown was put in place to achieve the dual objectives of slowing the spread of the infection as well as gearing up the health system to deal with the disease at multiple levels. During this period, efforts have been made to boost health infrastructure and human resource capacity in various parts of the country. Category I dedicated COVID-19 hospitals have been established to manage patients who are severely symptomatic. These hospitals have fully equipped intensive care units, ventilators and beds with assured oxygen support. Category II dedicated COVID-19 health centres have been set up for looking after patients who have moderate symptoms of the disease. To provide isolation and care for those who are afflicted with only a very mild form of the illness, Category III dedicated COVID-19 care centres have been set up by repurposing hostels, schools, stadiums and lodges. Testing laboratories for COVID-19 have also been designated in the public and private sectors.

As of 10 May, 2020, 7,740 facilities in 483 districts had been identified for COVID-19 related care in various states and union territories. There were 6,56,769 isolation beds, 3,05,567 beds for confirmed cases, 3,51,204 beds for suspected cases, 99,492 oxygen supported beds and 34,076 ICU beds. A sum of Rs. 2000 Crore has been allocated for the purchase of 50,000 ventilators from the PM CARES Fund. These ventilators will be utilised by government run COVID-19 hospitals across India for the treatment of critical patients.

To facilitate effective contact tracing, Government of India has launched the Aarogya Setu application which allows people to assess their risk of contracting the infection based on their location and interactions with others who might be COVID-19 positive or at high risk themselves. The application makes use of state-of-the-art Bluetooth technology and artificial intelligence. Within a short period since its launch, Aarogya Setu has already been downloaded in over 10 crore smartphones thus far. It has also alerted at least 1.4 lakh users about the potential risk of catching the infection due to their proximity to COVID positive patients. For creating awareness about measures for boosting immunity, the AYUSH Sanjivani mobile application has also been launched as a collaborative effort between the Ministries of AYUSH and MEITY. The application has been developed with the objective of reaching out to at least 50 lakh people.

Several initiatives have also been taken by the government to ramp up India's surveillance, testing and contact tracing capabilities as well as prevent the spread of the infection in India. For instance, the Consortium for Affordable and Rapid Diagnostics (CARD) has been established for bringing together scientists, laboratories and private players to boost the production of antibody tests which can help us to better understand the extent to which the Indian population has been affected by this infection. The objective of this consortium is to enable the production of around 100 lakh rapid antibody tests that can offer quick results.

Further, various scientific efforts have been initiated to find effective and safe vaccines as well as treatments for COVID-19. For instance, the Department of Biotechnology and Biotechnology Industry Research Assistance Council have shortlisted promising applications received for the development of vaccines, diagnostics and therapeutics that can assist in the fight against COVID-19. A sum of Rs. 100 Crore has also been allocated from the PM CARES Fund for supporting Indian academia, start-ups and industries to develop and produce an effective vaccine that can protect our people from this disease.

A collaborative clinical research study on Ayurveda interventions as prophylaxis and as supplements to standard care for COVID has additionally been launched.

To address the economic challenges posed by the pandemic and lockdown, Prime Minister Shri Narendra Modi has announced a package of Rs. 20 lakh crore as part of the *Aatmanirbhar Bharat Abhiyan*. The package includes a slew of measures for ameliorating the hardships faced by the various segments of society including migrant labour, street vendors, urban poor, small businesses and salaried workers.

As part of the overall package, a scheme for developing affordable rental housing complexes for the urban poor and migrant workers has also been proposed. This measure will help to enhance their ease of living as well as provide them with social security. Additional measures include a 2 percent interest subvention for 12 months for MUDRA-Shishu loanees, Rs. 5,000 crore credit facility for street vendors, Rs. 2 lakh crore credit support for 2.5 crore farmers under the Kisan Credit Card Scheme and Rs. 30,000 crore as supplementary emergency working capital for farmers through NABARD.

For migrant workers, the Central Government will provide a supply of free food grains for two months. A 'One Nation, One Ration Card' scheme is also being rolled out to enable migrant workers and their families to avail benefits under the Public Distribution System from any Fair Price Shop in India regardless of whether they are in their own state or not. Further, special trains are being run across the country to ensure that migrant workers can reach their villages safely during the time of the lockdown. The PM CARES Fund has also allocated an amount Rs. 1000 crore for the welfare of migrant labour. These funds will be disbursed to States and Union Territories who can pass them on to district collectors and municipal commissioners for supporting their efforts in providing food, medical aid and transportation facilities to the poor and migrant workers.

Revival of the economy depends to a great extent on the Medium, Small and Micro Enterprises (MSME) sector. The definition of an MSME has been expanded to allow for higher investment limits and several measures have been announced to boost their growth. These include a Rs. 3 lakh crore emergency credit line for enabling 45 lakh units to access working capital, kickstart business activity and protect jobs. The honourable Finance Minister has also announced that the Central Government will provide subordinate debt to the tune of Rs. 20,000 crore for supporting two lakh stressed MSMEs or those that are considered to be non-performing assets. Further, an MSME fund of funds has been proposed with a corpus of Rs. 10,000 crore for catalysing a Rs. 50,000 crore equity infusion. In order to support microfinance institutions and non-banking finance companies that serve MSMEs, a Rs. 30,000 crore investment scheme will be launched by the Centre alongside an expanded partial credit guarantee scheme of Rs. 45,000 crore.

An important step for salaried workers and tax payers is the extension in the deadline for filing income tax returns for the 2019-20 financial year. The due date has now been pushed to 30 November, 2020. The rates of Tax Deduction At Source (TDS) and Tax Collection At Source (TCS) have also been reduced by 25 percent for the next year, while statutory Provident Fund (PF) payments have been lowered from 12 percent to 10 percent for employers and employees for the coming three months.

It is also important to note that the government has undertaken reforms in several sectors over the last few years that have enabled it to respond to the pandemic better and also prepare for such crises in the future. For instance, in the area of public health, for the first time, a comprehensive effort was made for incorporating traditional medicine within the overall framework for promoting health and well-being through the National AYUSH Mission. In 2017, the first-ever All India Institute of Ayurveda was launched along the lines of AIIMS, New Delhi, for creating synergies between the traditional wisdom of Ayurveda and modern technologies. The honourable Prime Minister also laid tremendous emphasis on cleanliness and hygiene through the Swachh Bharat Abhiyan under which nearly 100 percent of households in rural India now have access to a toilet, compared to merely 29.1 percent in 2005–06.

Further, to build a robust primary healthcare system, the government announced the setting up of 150,000 Health and Wellness Centres (HWCs) between 2018 and 2022 under the Ayushman Bharat initiative. The HWCs that are currently operational across the country are playing an important role through the delivery of essential medicines to patients with non-communicable diseases as well as utilisation of telemedicine for providing quality medical advices to patients in remote and rural areas at a time when social distancing norms have made it difficult for people to have in-person consultations with healthcare providers. The second pillar of Ayushman Bharat is the Pradhan Mantri Jan Arogya Yojana (PM-JAY) that was also launched for providing 10 crore of the poorest and most vulnerable families in the country an annual cover of Rs. 5 lakh per annum for hospitalization-related expenses. By consolidating multiple health insurance schemes under PM-JAY, the government took a major step towards 'One Nation One Scheme' for ensuring that ultimately all citizens can access a common package of secondary and tertiary health services regardless of the state in which they reside. Testing and providing treatment for COVID-19 has also been brought under PM-JAY.

Additionally, the government has invested in tools such as telehealth, mobile health and Artificial Intelligence (AI) for lowering barriers between hospitals and patients, thereby improving access to care, especially in Tier-2 and Tier-3 cities. AI solutions can provide doctors with an unbiased second opinion on diagnosis, treatment options, potential

risks and predicted outcomes. For doctors working under considerable time pressure, AI can prove to be an important supportive tool for collating test reports of patients, studying their medical records and suggesting treatments. Crucially, AI can enable healthcare personnel to detect the dormant signs of diseases, thereby ensuring prevention or treatment at an early stage.

In the area of digital health, the National Health Stack proposed by NITI Aayog in 2018 is an important step. It is designed to offer a suite of advanced technologies which can be incorporated into overall digital health implementation in India. The availability of these "plug-in" modules will simplify and accelerate progress in implementing digital health in facilities and for health payers. It will also facilitate collection of comprehensive healthcare data across the country. The focus of this work will allow policymakers to experiment with policies, detect fraud in health insurance, measure outcomes and move towards smart policy making. Further, in 2019, the National Digital Health Blueprint was released by the government. The key features of the blueprint include a Federated Architecture, a set of architectural principles, a five-layered system of architectural building blocks, Unique Health ID (UHID), privacy and consent management, national portability and Electronic Health Records (EHRs), among others. This blueprint can now be translated into practice through the proposed National Digital Health Mission. In late March, 2020, the Government also released guidelines for telemedicine which will go a long way in scaling up this practice across the country and connecting people in all parts of the country with doctors and specialists.

To achieve social justice and improve the country's ranking in the Human Development Index, Government of India had launched the highly ambitious Aspirational Districts Programme for transforming 112 districts in the country that are lagging behind in specific development parameters. Many of these districts are leading by example in India's fight against COVID-19. Some of the best practices to emerge from these districts during the time of the pandemic include phone booth testing in West Singhbhum, sanitising tunnels in Khunti, telemedicine services in Chitrakoot as well as awareness creation through the community radio in Nuh. Many aspirational districts have manufactured face masks and sanitisers locally as well as made use of cutting-edge mobile testing vans for COVID-19. It is noteworthy that 112 aspirational districts where approximately 20 percent of India's population resides, account for less than 2percentof the country's total COVID-19 positive cases.

Further, to formalise the economy, the government has taken several steps over the last few years to increase the adoption of digital payments. With UPI, the government has created a public infrastructure on which the private sector is continually innovating. The merchant discount rate for digital transactions was also subsidised in a bid to incentivise wider adoption. Digital payments are playing a crucial role at a time when physical cash transactions are being discouraged for health reasons as well. Moreover, the government has also extensively leveraged the JAM Trinity – Pradhan Mantri Jan Dhan Yojana (PMJDY), Aadhaar and mobile telephone for ensuring the funds directly reach beneficiaries in an efficient and transparent manner.

As India enters the next phase of the lockdown, the government's strategy is focused on balancing the public health and economic imperatives. As emphasised by Prime Minister Shri Narendra Modi in his recent addresses to the nation, COVID-19 will remain a part of our lives for quite some time to come and we therefore need to learn to live with it. This will require each one of us to continue to adhere to social distancing norms, including wearing of face covers in public places, as well as focusing on hand hygiene.

Unlike some of the viral pandemics that have affected the world in the past, an unusual feature of the COVID-19 infection is that it remains asymptomatic or only mild symptomatic in a large majority of people. This makes it challenging to contain its spread as people are not even aware about being infected. We therefore need to remain vigilant. Thus far, COVID-19 has not spread evenly across India. In fact, over 99 percent of the active cases till date are concentrated in ten states. Within states, the infection is still largely confined to large urban centres. Therefore, precise public health strategies need to be developed at the micro-level with an emphasis on limiting the spread of the infection beyond the existing hotspots while also allowing economic activities to resume in a calibrated manner along the lines of the broad guidelines laid out by the Centre.

(The author is Public Policy Specialist, NITI Aayog, Email: urvashi.prasad@nic.in)

Water Conservation: Minimizing Wastage

Vishnu Sharma

Since water is a natural resource and it cannot be created in factories or laboratories, the only solution to our looming water crisis is conserving water. The present government has shown unprecedented interest in water conservation, minimising wastage and ensuring equitable distribution. Within a month of the announcement of the creation of the Ministry of Jal Shakti, the government launched a campaign for water conservation and water security named Jal Shakti Abhiyaan or JSA. The Abhiyaan aims to focus on integrated demand and supply management of water at the local level, including creation of local infrastructure for source sustainability using rainwater harvesting, groundwater recharge and management of household wastewater for reuse.

Like in many philosophical traditions of the world, the Indian tradition too puts great emphasis on the importance of water in life. In the ancient Indian tradition, *ap* or water is one of the five *panchmahabhutas* or great elements of life. Early Indian literature belonging to Hinduism, Buddhism, Jainism and other traditions had highlighted the importance of water and its conservation. The rich Ayurvedic literature of the subcontinent has countless treaties on water. It goes to the extent of defining it as *jiva* or life. However, this elixir of life is becoming increasingly scarce due to challenges of rising population, rapid urbanisation, industrial growth and increasing water pollution. Since the second half of the previous century, the world has been urbanising rapidly. According to the Population Division of the UN Department of Economic and Social Affairs (UNDESA), a division established in 1946 to study "population dynamics and monitoring demographic trends and policies worldwide", in 1950, only 30 percent of the world's population lived in urban areas, whereas by 2018 the world population living in the urban setting had grown to 55 percent. The urban population of the world has grown rapidly from 751 million in 1950 to 4.2 billion in 2018. The UNDESA, in 2018, noted:

"Future increases in the size of the world's urban population are expected to be highly concentrated in just a few countries. Together, India, China and Nigeria will account for 35 percent of the projected growth of the world's urban population between 2018 and 2050. By 2050, it is projected that India will have added 416 million urban dwellers, China 255 million and Nigeria 189 million."[1]

The rapid urbanization has led to severe crisis of useable water in the world, particularly in developing countries such as ours. In India, per capita availability of water has decreased from 2209 m^3/year in 1991 to 1545 m^3/year in 2011 and it is estimated to decline further upto 1140m^3/year in the year 2050. Furthermore, demand for water from various sectors viz. irrigation, drinking water, industry, energy and others is expected to rise from 710 billion cubic metre (BCM) in the year 2010 to 843 BCM in the year 2025 and further to 1180 BCM in the year 2050. According to a 2018 NITI Aayog report, currently 600 million Indians face high to extreme water stress and about two lakh people die every year due to inadequate access to safe water. By 2030, the country's water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people and

Jal Jeevan Mission

Vision

Every rural household has drinking water supply in adequate quantity of prescribed quality on regular and long-term basis at affordable service delivery charges leading to improvement in living standards of rural communities.

Mission

Jal Jeevan Mission is to assist, empower and facilitate:

- States/UTs in planning of participatory rural water supply strategy for ensuring potable drinking water security on long-term basis to every rural household and public institution, viz. GP building, school, Anganwadi centre, health centre, wellness centres, etc.
- States/UTs for creation of water supply infrastructure so that every rural household has Functional Tap Connection (FTC) by 2024 and water in adequate quantity of prescribed quality is made available on regular basis.
- States/UTs to plan for their drinking water security.
- GPs/rural communities to plan, implement, manage, own, operate and maintain their own in-village water supply systems.
- States/UTs to develop robust institutions having focus on service delivery and financial sustainability of the sector by promoting utility approach.
- Capacity building of the stakeholders and creating awareness in community on significance of water for improvement in quality of life.
- In making provision and mobilisation of financial assistance to states/UTs for implementation of the mission.

Objectives

The broad objectives of the Mission are:

- To provide Functional Household Tap Connection (FHTC) to every rural household.
- To prioritize provision of FHTCs in quality affected areas, villages in drought prone and desert areas, Sansad Adarsh Gram Yojana (SAGY) villages, etc.
- To provide Functional Tap Connection to schools, Anganwadi centres, GP buildings, health centres, wellness centres and community buildings.
- To monitor functionality of tap connections.
- To promote and ensure voluntary ownership among local community by way of contribution in cash, kind and/or labour and voluntary labour (*shramdaan*).
- To assist in ensuring sustainability of water supply system, i.e. water source, water supply infrastructure, and funds for regular O&M.
- To empower and develop human resource in the sector such that the demands of construction, plumbing, electrical, water quality management, water treatment, catchment protection, O&M, etc. are taken care of in short and long term.
- To bring awareness on various aspects and significance of safe drinking water and involvement of stakeholders in manner that make water everyone's business.

Components under JJM

The following components are supported under JJM:

- Development of in-village piped water supply infrastructure to provide tap water connection to every rural household.
- Development of reliable drinking water sources and/ or augmentation of existing sources to provide long-term sustainability of water supply system.
- Wherever necessary, bulk water transfer, treatment plants and distribution network to cater to every rural household.
- Technological interventions for removal of contaminants where water quality is an issue.
- Retrofitting of completed and ongoing schemes to provide FHTCs at minimum service level of 55 lpcd.
- Greywater management
- Support activities, i.e. IEC, HRD, training, development of utilities, water quality. laboratories, water quality testing & surveillance, R&D, knowledge centre, capacity building of communities, etc.
- Any other unforeseen challenges/ issues emerging due to natural disasters/ calamities which affect the goal of FHTC to every household by 2024, as per guidelines of Ministry of Finance on Flexi Funds.

Efforts should be made to source funds from different sources/programmes and convergence is the key.

(Source: Ministry of Jal Shakti, https://jalshakti-ddws.gov.in/ ;https://jaljeevanmission.gov.in/content/about-jjm#objectives)

an eventual six percent loss in the country's GDP. When we speak of water, we generally mean freshwater because even when 70 percent of our planet is covered with water, only 2.5 per cent of it is consumable. According to the UN Environment's document 'Freshwater Strategy 2017-2021', freshwater plays a fundamental role in support of the environment, society and the economy. Since water is a natural resource and it cannot be created in factories or laboratories, the only solution to our looming water crisis is conserving water. In seven out of India's 10 most populous cities, the depth to groundwater has increased significantly over the last two decades. This is an alarming situation because India is the biggest user of groundwater. According to a report India extracts more groundwater than China and the US the next two biggest pullers of groundwater combined. Half of total clean water needed in our country is met from groundwater. The 2014 report of the parliamentary standing committee on water resources constituted on August 5, 2004, found that the groundwater forms the largest share of India's agriculture and drinking water supply. About 89 percent of groundwater extracted in India is used for irrigation making it the highest category user in the country. Household use comes second with 9 percent share of the extracted groundwater followed by industry that uses only 2 percent of it. Similarly, the Central Ground Water Board (CGWB) has stated in Lok Sabha that 50 percent of urban water requirement and 85 percent of rural domestic water needs are fulfilled by groundwater. This kind of use has caused a reduction in groundwater levels in India by 61 percent between 2007 and 2017.

Towards Water Conservation

The present government has shown unprecedented interest in water conservation, minimising wastage and ensuring equitable distribution. In his first Mann Ki Baat programme in the second term as the Prime Minister of India, Shri Narendra Modi described water crisis as on one of the biggest challenges facing India today. Telling that water is of great importance in our culture he quoted the Rigveda's Apah Suktam or hymn:

आपोहिष्ठामयोभुवः, स्थानऊर्जेदधातन, महेरणायचक्षसे,
योवःशिवतमोरसः, तस्यभाजयतेहनः, उषतीरिवमातरः ।

(Water which is the life force and also, the source of energy. Please bless us like a mother and may your blessings continue on to be showered upon us.)

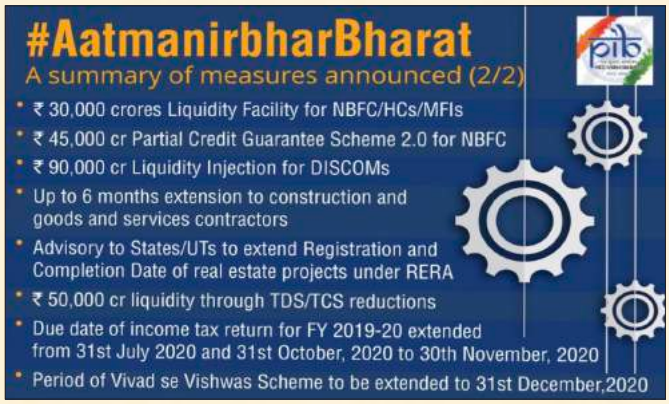
(Contd. on page 28)

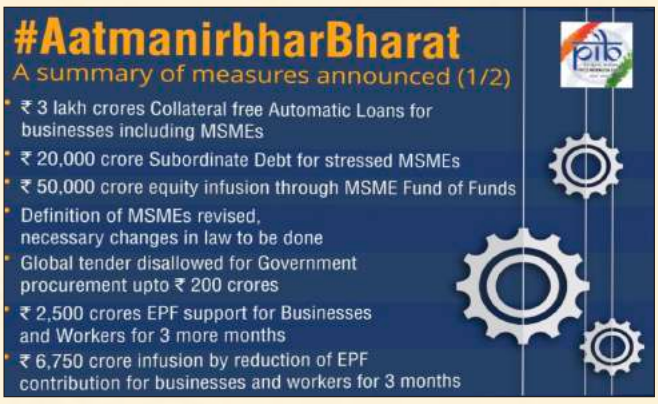
Measures for Relief and Credit Support to Businesses to Support Indian Economy's Fight against COVID-19

Summary of the Roadmap Laid Out by the Union Finance Minister on 13 May, 2020 for Creation of Aatmanirbhar Bharat Abhiyan or Self-Reliant India Movement

Highlights

Finance and Corporate Affairs Minister Smt. Nirmala Sitharaman said, "essentially, the goal is to build a self-reliant India that is why the Economic Package is called Aatmanirbhar Bharat Abhiyan". Citing the pillars on which we seek to build Aatmanirbhar Bharat Abhiyan, she said our focus would be on land, labour, liquidity and law. During the press conference in New Delhi on May 13, 2020, Smt. Sitharaman announced measures focused on getting back to work i.e., enabling employees and employers, businesses, especially Micro, Small and Medium Enterprises, to get back to production and workers back to gainful employment. Efforts to strengthen Non-Banking Finance Institutions, Housing Finance Companies, Micro Finance Sector and Power Sector were also unfolded. Other than this, the tax relief to businesses, relief from contractual commitments to contractors in public procurement and compliance relief to real estate sector were also covered.





Following measures were announced on 13 May, 2020

1. Rs. 3 lakh crore Emergency Working Capital Facility for Businesses, including MSMEs

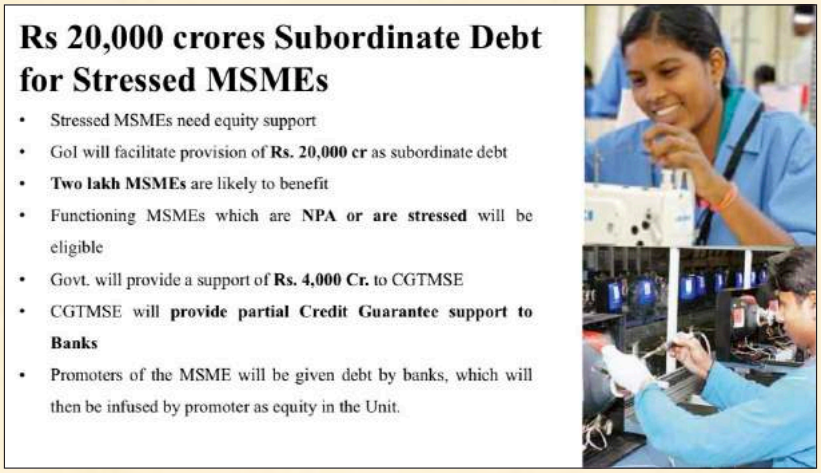
To provide relief to the business, additional working capital finance of 20 percent of the outstanding credit as on 29 February 2020, in the form of a Term Loan at a concessional rate of interest will be provided. This will be available to units with upto Rs. 25 crore outstanding and turnover of up to Rs. 100 crore whose accounts are standard. The units will not have to provide any guarantee or collateral of their own. The amount will be 100 percent guaranteed by the Government of India providing a total liquidity of Rs. 3.0 lakh crore to more than 45 lakh MSMEs.

2. Rs. 50,000 crore equity infusion through MSME Fund of Funds

The Government will set up a Fund of Funds with a corpus of Rs. 10,000 crore that will provide equity funding support for MSMEs. The Fund of Funds shall be operated through a Mother and a few Daughter funds. It is expected that with leverage of 1:4 at the level of daughter funds, the Fund of Funds will be able to mobilise equity of about Rs. 50,000 crore.

3. Rs. 20,000 crore Subordinate Debt for Stressed MSMEs

Provision made for Rs. 20,000 crore subordinate debt for two lakh MSMEs which are NPA or are stressed. Government will support them with Rs. 4,000 crore to Credit Guarantee Trust for Micro and Small enterprises. Banks are expected to provide the



subordinate-debt to promoters of such MSMEs equal to 15 percent of his existing stake in the unit subject to a maximum of Rs. 75 lakh.

4. No Global tenders for Government Tenders of up to Rs. 200 crore

General Financial Rules of the Government will be amended to disallow global tender enquiries in procurement of Goods and Services of value of less than Rs. 200 crore.

5. Employees Provident Fund Support for Business and Organised Workers

The scheme introduced as part of PMGKP under which Government of India contributes 12 percent of salary each on behalf of both employer and employee to EPF will be extended by another 3 months for salary months of June, July and August 2020. Total benefits accrued is about Rs 2500 crore to 72.22 lakh employees.

6. EPF Contribution to be Reduced for Employers and Employees for 3 Months

Statutory PF contribution of both employer and employee reduced to 10 percent each from existing 12 percent each for all establishments covered by EPFO for next 3 months. This will provide liquidity of about Rs. 2250 crore per month.

7. Rs. 30,000 crore Special Liquidity Scheme for NBFC/HFC/MFIs

Government will launch Rs. 30,000 crore Special Liquidity Scheme, liquidity being provided by RBI. Investment will be made in primary and secondary market transactions in investment grade debt paper of NBFCs, HFCs and MFIs. This will be 100 percent guaranteed by the Government.

8. Rs. 45,000 crore Partial Credit Guarantee Scheme 2.0 for Liabilities of NBFCs/MFIs

Existing Partial Credit Guarantee scheme is being revamped and now will be extended to cover the borrowings of lower rated NBFCs, HFCs and other Micro Finance Institutions (MFIs). Government will provide 20 percent first loss sovereign guarantee to Public Sector Banks.

9. Relief to Contractors

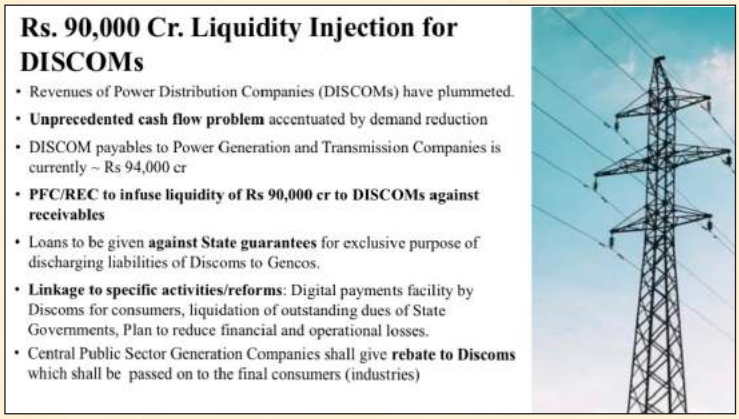
All central agencies like Railways, Ministry of Road Transport and Highways and CPWD will give extension of up to six months for completion of contractual obligations, including in respect of EPC and concession agreements

10. Tax Relief to Business

The pending income tax refunds to charitable trusts and non-corporate businesses and professions including proprietorship, partnership and LLPs and cooperatives shall be issued immediately.

11. Rs. 90,000 crore Liquidity Injection for DISCOMs

Power Finance Corporation and Rural Electrification Corporation will infuse liquidity in the DISCOMS to the extent of Rs. 90,000 crore in two equal installments. This amount will be used by DISCOMS to pay their dues to Transmission and Generation companies.



12. Tax related measures

- Reduction in Rates of 'Tax Deduction at Source' and 'Tax Collected at Source' - The TDS rates for all non-salaried payment to residents, and tax collected at source rate will be reduced by 25 percent of the specified rates for the remaining period of FY 20-21. This will provided liquidity to the tune of Rs. 50,000 crore.
- The due date of all Income Tax Returns for Assessment Year 2020-21 will be extended to 30 November, 2020. Similarly, tax audit due date will be extended to 31 October 2020.
- The date for making payment without additional amount under the "Vivad Se Vishwas" scheme will be extended to 31 December, 2020.

(Source: Press Information Bureau)

(Contd. from page 25)

It was in this programme that Shri Modi announced the creation of Jal Shakti Ministry by merging Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Drinking Water and Sanitation. He told, "This will allow faster decision-making on all subjects related to water." Shri Modi also informed that he had written letter to the Sarpanchs and Gram Pradhans across the country suggesting them that in order to save water, to collect water, to save the very drops of the rainwater, they should convene a meeting of the Gram Sabha and sit and discuss the resolution to this problem with the villagers.

Schemes for Water Conservation

Under the leadership of Prime Minister Shri Narendra Modi, the government has successfully launched various schemes with the multipurpose aim of conserving water, minimising its wastage and ensuring equitable distribution. Two major such schemers are Jal Shakti Abhiyaan and Pradhan Krishi Sinchayee Yojana.

Jal Shakti Abhiyaan: Within a month of the announcement of the creation of the Ministry of Jal Shakti, the government launched a campaign for water conservation and water security named Jal Shakti Abhiyaan or JSA[2]. The Abhiyaan aims to focus on integrated demand and supply management of water at the local level, including creation of local infrastructure for source sustainability using rainwater harvesting, groundwater recharge and management of household wastewater for reuse. According to its website, the JSA is a time-bound, mission-mode water conservation campaign. The JSA has two phases. The firstphase ran from July 1to September 15,2019 for all states and Union Territories; and the time period of the second phase wasfrom October 1to November 30,2019 for states and UTs receiving the retreating monsoon (Andhra Pradesh, Karnataka, Puducherry and Tamil Nadu). During the campaign, officers, groundwater experts and scientists from the Government of India worked together with state and district officials in India's most water-stressed districts or districts with critical or over-exploited groundwater levels as per the Central Ground Water Board (CGWB) 2017 for water conservation and water resource management by focusing on accelerated implementation of five target intervention. The JSA aims at making water conservation a *jan andolan* through asset creation and extensive communication. The JSA is a collaborative effort of various ministries of the Government of India and State Governments. Under the JSA, teams of officers from the central government will visit and work with the district administration in 1592 water-stressed blocks in 256 districts to ensure five important water conservation interventions such as water conservation and rainwater harvesting, renovation of traditional and other water bodies/ tanks, reuse, borewell recharge structures, watershed development and intensive afforestation. These water conservation efforts will also be supplemented with special interventions including the development of Block and District Water Conservation Plans, promotion of efficient water use for irrigation and better choice of crops through Krishi Vigyan Kendras.A large-scale communications campaign has also been planned alongside the JSA involving mass mobilisation of different groups including school students, college students, swachhagrahis, Self Help Groups, Panchayati Raj Institution members, youth groups (NSS/NYKS/NCC), defence personnel, ex-servicemen and pensioners, among various others.

Pradhan Mantri Krishi Sinchayee Yojana: The Cabinet Committee on Economic Affairs (CCEA) chaired by Prime Minister Modi on July 1, 2015 had given approval to the launch of the scheme with the duel aim of '*Har Khet Ko Pani*' and improving water use efficiency 'More crop per drop' in a focused manner.

According to the press release of the CCEA on July 2, 2015 the PMKSY was formulated by amalgamating the then-running schemes like Accelerated Irrigation Benefit Programme (AIBP) of the Ministry of Water Resources, River Development and Ganga Rejuvenation, Integrated Watershed Management Programme (IWMP) of Department of Land Resources (DoLR) and the On Farm Water Management (OFWM) of Department of Agriculture and Cooperation (DAC). The scheme has been divided into 99 prioritized projects with different timelines. Total expected expenditure in the complete project is estimated to be 77595 crore rupees with Central share of 31342 crore rupees. Total irrigation potential utilisation after completion of the entire project is expected to be 76.03 lakh hectares. Many projects which were at standstill such as Gosikhurd (2.5 lakh ha.) Maharashtra, were streamlined and put on track for timely completion.

Category	No. of Projects	Fund required for completion (Rs. in crore)			Central Share (Rs. in crore)	Irrigation Potential Utilisation (Lakh Ha.)
		AIBP	CAD	TOTAL		
Priority-I projects (Completion by 3/2017)	23	7956	5466	13423	6535	14.53
Priority-II projects (Completionby 3/2018)	31	8080	4825	12905	4269	12.95
Priority-III projects (Completion by 12/2019)	45	32510	18757	51268	20538	48.55
TOTAL	**99**	**48546**	**29049**	**77595**	**31342**	**76.03**

The major objective of the PMKSY has been to achieve convergence of investments in irrigation at the field level, expand cultivable area under assured irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance the adoption of precision-irrigation and other water saving technologies, enhance recharge of aquifers and introduce sustainable water conservation practices by exploring the feasibility of reusing treated municipal-based water for peri-urban agriculture and attract greater private investment in precision irrigation system.

The scheme also aims at bringing concerned ministries, departments, agencies, research and financial institutions engaged in recycling of water, under a common platform, so that a comprehensive and holistic view of the entire "water cycle" is taken into account and proper water budgeting is done for all sectors namely, household, agriculture and industries.

The programme is supervised and monitored at the national level by an Inter-Ministerial National Steering Committee (NSC) under the Chairmanship of the Prime Minister with Union Ministers of all concerned Ministries. Accordingly, on August 6, 2015 a National Executive Committee (NEC) was constituted under the Chairmanship of the Vice Chairman of NITI Aayog to oversee programme implementation, allocation of resources, inter-ministerial coordination, monitoring and performance assessment, addressing administrative issues, etc. At the state level the scheme is administered by a State Level Sanctioning Committee (SLSC) chaired by the Chief Secretary of the respective states.

The details of the project under PMKSY, as per a 2017 Water Resources Ministry release, are as under[3]:

Apart from this, to encourage stakeholders like water user associations, institutions, corporate sector, individuals, Non-Governmental Organisations (NGOs), gram panchayats, urban local bodies to adopt innovative practices of groundwater augmentation like creating awareness through people's participation, rainwater harvesting and artificial recharge, promoting water use efficiency, recycling and reuse of water, the government in 2007 launched the Groundwater Augmentation Awards and National Water Award.

Footnotes

1 UNDESA. 2018. 'The Speed of Urbanization Around the World', Population Facts. UNDESA, Population Division. Available at: https://population.un.org/wup/Publications/Files/WUP2018-PopFacts_2018-1.pdf

2 Ministry of Jal Shakti. 2019. 'Jal Shakti Abhiyan for Water Conservation Launched'. Press India Bureau, Government of India. Available at: https://pib.gov.in/newsite/PrintRelease.aspx?relid=191069

3 Ministry of Water Resources. 2017. 'Press Brief about The Achievements of The Ministry of Water Resources, River Development and Ganga Rejuvenation During the Last Three Years'. Press Information Bureau, Government of India. Available at: https://pib.gov.in/newsite/PrintRelease.aspx?relid=165747

(The author is a senior journalist based in Delhi. He has been covering national and international affairs for over a decade. Email-simplyvishnu2004@yahoo.co.in)

Solution to Groundwater Crisis

Bhuwan Bhaskar

Farmers need to be made aware and trained about conservation of water. There are many farmers across the country who have developed unique models of cultivation where each drop of rain water falling within their farm land is preserved. One thing is very clear. We cannot create water. We can only preserve water that we already have with us and that we will get in future in the form of rains.

While presenting the General Budget for 2020–21, Finance Minister Nirmala Sitharaman announced that the government will identify 100 most 'water stressed' districts and comprehensive measures on addressing this shortage will be chalked out. Ms Sitharaman further told that this will be a part of the Jal Jivan mission, for which Rs 3.06 lakh crore has been earmarked. The proceeds outlined for the Jal Jivan is slated to be used for augmenting existing water resources, recharging of lakes, water desalination, rain water harvesting as well as sewage water treatment.

Announcement of such a huge cash spending on a problem which had so far been mostly heard only in seminars, closed door discussions and by the way of NGO activism, was no aberration. The preface of this development had been written in 2018 when NITI Aayog, the top intellectual body of the Central Government, came up with its maiden the Composite Water Management Index (CWMI). This was the first ever effort in independent India to fathom the water crisis scientifically at every inch of the country. NITI Aayog described it as "the first comprehensive collection of country-wide water data in India based on in-depth structured questionnaires followed by focus group discussions to generate qualitative information." The scenario that this decorated document unveiled left little option with the government to further delay the response to the looming water crisis in front of the country.

Ground Water Crisis in India: How severe is it?

According to the maiden CWMI report released by the NITI Aayog in 2018, 21 major cities (Delhi, Bengaluru, Chennai, Hyderabad and others) are racing to reach zero groundwater levels by 2020, affecting access for 100 million people. Nearly 40 percent of the population will have absolutely no access to drinking water by 2030, and 6 percent of India's GDP would be lost by 2050 due to water crisis. However, 12 per cent of India's population is already living the 'Day Zero' scenario, thanks to excessive groundwater pumping, an inefficient and wasteful water management system and years of

deficient rains. The CWMI report also states that by 2030, the country's water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people. It has been reported that in many parts of the country the water table is declining at the rate of 1-2 m/year.[1]

As per the international norms, a country is classified as water stressed and water scarce if per capita water availability goes below 1700 cubic meter and 1000 cubic meter, respectively. To keep things in perspective with respect to India, quoting Mr. T Mohapatra, Director General, Indian Council for Agriculture Research (ICAR) would be relevant, who pointed out that the per capita annual water availability has declined to 1508 cubic meter in 2014 from 5177 cubic meter in 1951. While briefing a section of media on water management in agri sector on September 5, 2019, he warned, "The per capita availability of water is estimated to decline further to 1465 cubic meter by 2025 and 1235 cubic meter by 2050. If it declines further to around 1000-1100 cubic meter, then India could be declared as water-stressed country."

Government's Response So Far

Equipped with the broad scientific data about rapidly deteriorating qualitative as well as quantitative water tables across India, the Narendra Modi Government established a whole new ministry to fight the menace in its second term. In May 2019, as Modi 2.0 government took the reign of the country in its second term, the Prime Minister merged two ministries Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Drinking Water and Sanitation to create a new ministry, which was named as Ministry of Jal Shakti. The ministry launched Jal Shakti Abhiyan in an effort to over bridge the water challenge being faced by 1592 water-stressed blocks in 256 districts by the way of a campaign for water conservation and water security. It was decided on the highest level that water conservation efforts would be unleashed to ensure five important water conservation interventions: water conservation and rainwater harvesting; renovation of traditional and other water bodies/tanks; reuse borewell recharge structures; watershed development and intensive afforestation.

Nevertheless it is very clear that government's capability to address the problem is limited as the actual users of ground water are common people. So, the government can play its role by two ways. One, by extending policy incentives to stop the misuse of ground water and two, by unleashing a movement on the model of 'Swachh Bharat Abhiyan' to create awareness among people against wasting water.

Anatomy of the Problem

While talking about the water crisis, potability is only a small part of the problem. In fact, many developed countries have already found a solution of potable water by turning sea water into drinkable water on mass scale. But the real catastrophe waiting to happen, is in agriculture. As per the Land Use Statistics 2014–15, the total geographical area of the country is 328.7 million hectares, of which 140.1 million hectares is the reported net sown area. As per a World Bank report, India withdrew a total of 761 billion cubic meter ground water in 2018 out of which 688 billion cubic metre was used for agriculture. This is 90 percent of the total ground water withdrawn in a year. The other side of the problem is that out of the total water volume needed for agriculture, 70 percent is groundwater today. Both the data, if put together, gives us a glimpse about the possible ways to find a solution of this grim problem, which we will discuss in the last section of this article.

Venturing deeper into the problem takes us to another anomaly. We, as a country, have a troubling record of rationalising crop selection on the basis of availability of water and that is a big part of the problem. According to various research reports a kg of rice needs 2500–4000 L of water for production whereas it takes 2515 L of water to produce a kilogram of sugar in Maharashtra, according to the Commission for Agricultural Costs and Prices (CACP). Looking at Indians' fondness for rice and sugar, it should not be a shock for anybody to note that 60 percent of total water consumed in agriculture is guzzled by only these two crops. Export also plays its role in it as India is one of the biggest exporter of rice and sugar. Just in 2018–19, India exported 38.55 lakh tonne of Basmati Rice to around 90 countries. Now if we assume an average 3500 L of water is used to produce 1 kg of rice, we virtually exported 13.5 billion litres of ground water in the guise of rice. Similarly, we exported 37 lakh tonne sugar during 2018–19 marketing year and so, in a way, we exported more than 9 billion litres of our ground water.

Punjab, a celebrated story of agricultural success, is gradually turning into a graveyard of agriculture. The result of the policy of excessive subsidy on chemical fertilizers and pesticides on one hand and encouragement to farmers for unbridled use of groundwater by providing them free electricity on the other, has resulted in double whammy. One, the state is devoid of ground water and two, the upper crest under soil has developed a layer of hard chemical residue due to which the rain water simply flows away without seeping into the ground. So, there is little bewilderment that Punjab has the highest ground water development ratio. The level of ground water development is very high in the states of Delhi, Haryana, Punjab and Rajasthan, where ground water development is more than 100 percent with Punjab being on top with 172 percent. This implies that in these states, the annual ground water consumption is more than annual ground water recharge. Not only that, incentives to waste water has also worsened the state's water productivity. Punjab requires two to three times as much water as Bihar and West Bengal to produce a kilogram of rice.

How will it impact the farmers?

Farmers often give such maths a cold shoulder terming it a luxury because they think it is something they are supposed to worry about in favour of comparatively affluent people. What they don't comprehend is that it is them, who is most affected by this anomaly. The adversity befalls upon them in two ways. Sinking water level increases their cost of cultivation and decreases the production level at one hand, and increases their cost of living on the other hand. Marathwada region in Maharashtra is a classic case in this context. In the eight districts of Marathwada, on an average, one tonne sugarcane crop needs about 70000 L of water while a total of 18.1 lakh tonnes of sugarcane was produced in Marathwada during 2018–19. That simply means, Marathwada's ground water was depleted by 126700 million litres just in one year. Incidentally, Marathwada's average yield per acre is about 50 tonnes, while the State's average yield is 80 tonnes. And in a city like Aurangabad, people pay around Rs. 1000 for a water tanker carrying 2500 L of water. Just remember, this is the same quantity that is used to make a kg of sugar. So, in a way, the 1.25 lakhs sugarcane farmers, along with lakhs other, are also buying a kg of sugar in a whopping Rs. 1000.

But this is not the only way how farmers are getting impacted by the ground water crisis. Water scarcity impacts farmers' profit negatively, established a study titled 'The Efficiency of Rationing: Agricultural Power Subsidies, Power Supply and Groundwater Depletion in Rajasthan' published in 2018. This study found that farmers facing greater water scarcity sink deeper wells and are more likely to grow water-hardy crops and make investments in water-conserving irrigation technologies. Despite these investments, water scarcity still decreases profits and lands them in debt, according to the study. In many parts of the country, where the ground water has reached to the level of rocks beneath soil, the productivity has gone down drastically and the cost of cultivation has shot up. Even in the selection of crops, the farmers in such areas don't find much option. Even if the water table goes down below 600 ft plus, the cost of borewell increases multiple times. There are strong links between cash cropping, the failure of borewells, overwhelming debts and farmer suicides in the semi-arid regions of northern and western Andhra Pradesh and other parts of the Deccan plateau, according to a study published in *Third World Quarterly* in 2013.

What is the solution?

One thing is very clear. We cannot create water. We can only preserve water that we already have with us and that we will get in future in the form of rains. But again the rain data across the globe describes the challenge. While at just over 260 cubic km per year, India uses 25 percent of all groundwater extracted globally, ahead of the US and China, while it receives only four percent of the global precipitation and ranks 133 in the world in terms of water availability per person per annum.

So, the approach to control the situation before it gets out of hand must have multi-directional dimensions. And because 90 percent of the water is used by agriculture, no solution will work lest we should keep cultivation in the centre. The key to the solution is producing more with less water. This goal can be achieved in two ways, one by shifting from more water guzzling crops to lesser ones and two, by creating awareness among farmers to use micro-irrigation tools. To achieve the optimum result with the first approach, ICAR's two bodies, National Institute of Agricultural Economics and Policy Research and Indian Institute of Farming Systems Research at Modipuram, Meerut, are working

toward this aim. The crop planning would be based on local climatic conditions, water availability and overall demand-supply situation and could help the government to plan its incentives in such ways that farmers will adopt those recommended crops, according to the ICAR.

Experts say there is a need to double the area under micro-irrigation from the current level of nine million hectares. But it is easier said than done. In spite of the fact that almost all states have subsidy on getting micro-irrigation system, it is flouted by the lower lever corruption by the related companies in connivance with agriculture department officials. This discourages farmers from going for it. Moreover, due to lack of awareness, most of them think that micro-irrigation is only for the regions where farmers don't have much water availability. To change the mind set of the producers, the government needs to rope in private sector along with its own agencies for successfully running focussed awareness programmes around benefits of micro-irrigation. The farmers should be taught how flood irrigation results in wastage of water and energy as well as reduce the efficiency of fertilisers. Also, there should be stress laid on the need for scheduling of irrigation process and said technologies like moisture sensor and other software that are available to achieve this aim.

Other than to use the available water judiciously, the farmers also need to be made aware and trained about conservation of water. There are many farmers across the country who have developed unique models of cultivation where each drop of rain water falling within their farm land is preserved. Subhash Sharma, a progressive farmer from Yavatmal in Vidarbha, Maharashtra practises natural farming. Sharma has developed a 5-point technology to preserve the rain water pouring in his farmland. The first point is about the natural way of farming in which many small insects who live in the soil work as the carrier of water. Sharma claims that 30 percent of the total water received by the area seeps into ground water through millions of these small insects. The second point of the technology is called 'grid-locking' where grids are made at every 6–8 feet. Crops are sown on the grids, which hold the water. The third point is 'micro-locking' for the farms where crops can't be sown on grids. The fourth point is 'contour farming' where green fodder is cultivated to hold the water and the fifth point of this technology is by creating a 'locking trench'. In this method, the whole farm land is given a slope towards one side and a trench is dug parallel to the slope side. Sharma, for example, has dug 80 feet long trench along one side of his farm. This trench is 6 ft deep and 4 ft wide. To provide a locking inside the trench, he has created multiple lock chambers of 4 ft height at every 10 ft length. And thus he claims that not a single drop of water received by the area of his filed moves out of it. The result is mind blowing. If the area in Yavatmal where Sharma's land is situated, gets 100 cm rainfall in one full year, his 7 hectares of land receives a total of 70 million litres water. Even if we assume 20 percentof it evaporates, the ground beneath Sharma's farm gets 56 million litres of water. Sharma claims that half of it, means 28 million litres of water he uses for farming purpose and rest half enriches not only his ground water, but also helps in increasing the water table of the adjacent farms.

But depleting ground water is not the only problem faced by the farmers. Just 130 kms North West from Yavatmal, there is another block Daryapur in Amravati district. Farmers can easily get water just at less than 50 ft in this area. But it is of no use to them because it is so saline that farmers can't use it in farming. So, farmers have resorted to farm ponds in big numbers in this block. Farm ponds are basically an idea to collect rain water in a small part of one's farmland by digging a pond so that he/she could get water for captive usage. So, micro-irrigation, farm pond and natural farming could be the way to move on. In a nutshell, the challenge before us is formidable. Nevertheless, the silver lining is that there are easy remedies available. Only thing we need is a perfect combination of government's and people's efforts. With all means of communication, it has to be made a part of national conscience that ground water rejuvenation has no option and that it is needed not only for future generations, but also for the present population.

Footnote

1 Singh, Dhirendra Kumar and Anil Kumar Singh. 2002. 'Groundwater Situation in India: Problems and Perspective', *International Journal of Water Resource Development*. pp. 563–580.

(The writer is Assistant Vice President with a national commodity exchange. The views are personal, Email: bhaskarbhuwan@gmail.com)

Yoga for Transforming Human Lives

Dr. Neha Gupta

Since the outbreak of COVID-19, the Ministry of AYUSH also came up with the guidelines to lift immune system and protect ourselves from the virus. Along with Ayurveda-based home remedies, the guidelines suggest actively practising yoga/meditation. Together with physical asanas, yoga also entails teachings for healthy sattvic diet and thought management, which can support during immunodeficiency.

Lockdown announced in India to curb COVID-19 has led people to stay longer at home with the desire of preventing themselves from catching the disease with better science of living. Consequently, the demand for yoga services has increased manifold along with equivalent rise in supply. It may be noted that yoga is not just a set of exercises but a healthy lifestyle including meditation, which is the ultimate goal for unbiased self-realisation. Sage Patanjali declared yoga's eight limbs as yama, niyama, asanas, pranayama, pratyahara, dharana, dhyana, and samadhi (Ashtanga Yoga). To explain, yogic system begins with regulating our way of thinking and emotions by following certain external and internal disciplines: (i) yamas, as self-restraints or moral rules, cover practice of ahimsa or non-violence (not harming anyone), satya (truth), asteya (no stealing), brahmacharya, and aparigraha (non-attachment); and (ii) niyamas, as compliances, for cleanliness, namely, shaucha, santosha (satisfaction, ability to accept), tapas (persistence), svadhyaya (self-introspection, study of vedas), and ishvarapranidhana (surrender to God). Different age groups can do various postures/asanas to move from dis-ease to ease. Controlling of breath and of senses are vital to detoxify body and mind (not trapped by desires) and balance the life force, followed by practice of dhyana. Many gurus namely Swami Vivekananda, Paramahansa Yogananda, etc., helped to spread the teachings of yoga even outside India.

Asanas, mudras and pranayama are crucial in classical Hatha Yoga, which gained huge importance during the 20th century (with its revival efforts by Swami Sivananda and his disciples and by Sri Tirumalai Krishnamacharya as father of Modern Yoga). Western countries openly embraced this Indian science. However, descriptive texts on the same emerged since 11th century. '*Ha*' signifies solar/pranic (active) energy and '*tha*' represents lunar/mental energy. Hatha Yoga is simply their balance to keep the body healthy with movement of subtle currents that lead

toward spirituality and higher consciousness. As endorsed by Prime Minister of India at United Nations General Assembly in 2014, the International Day of Yoga (IDY) is celebrated on June 21 every year since 2015. During that time, India also set up the Ministry of AYUSH to promote Ayurveda, Yoga, Naturopathy, Unani, Siddha and Homeopathy, so as to restore the recognition for ancient Indian knowledge, mainly for yoga (dominated by West, largely United States).

Yoga with meditation are nothing less than essential food and medicine for our body and mind as without any side-effects they can naturally strengthen functioning of vital organs, muscles and bones, improve respiratory and lymphatic systems, activate central nervous system, help in overcoming hormonal imbalance by stimulating endocrine system, manage psycho-somatic disorders and provide high endurance, and enable better blood circulation and oxygen supply. Yoga essentially means union of body, mind and soul with the power to improve lives of human beings. The year 2020 could be the best time to realise yoga's importance as a preventive, restorative and healing therapy.

Asanas: Types and Relevance

"sthirasukham aasanam - Posture is that which is firm and pleasant" (Patanjali Yoga Sutras, verse 46)[1]

Patanjali explained the meaning of asanas as the postures which can be held in relaxed and steady manner for a lengthier duration. Subsequent commentaries actually listed the following postures: "Padmasana, Virasana, Bhadrasana, Svastikasana, Dandasana, Sopasraya, Paryanka, Krauñcha (heron)-nisadana, Hasti (elephant)-nisadana, Ustra (camel)-nisadana, and Sama-samsthana."[2] These were the seated postures requiring upright position of spine, neck and head. Texts also mentioned that these asanas became yogic only when done comfortably and motionless (not recklessly or in pain).

It is believed that Adiyogi Lord Shiva disclosed the secrets of 84 asanas, which were confirmed in the Hatha yogic texts of Shiva Samhita, and Goraksha Sataka/Paddhathi. Latter highlighted asanas' derivations based on 84 lakh living beings with each asana reflecting a set of 1 lakh species, and thus described two postures as special, i.e, heros (siddha-asana) and lotus (kamala-asana). Hatha Yoga Pradipika (15th century) stipulated 4 asanas as more suitable, namely, Siddhasana, Padmasana, Bhadrasana and Simhasana. Listing of 84 asanas (even non-seated ones) was attempted by Hatha Ratnavali text (17th century). As per Gheranda Samhita, Shiva had taught 84 lakh asanas as per number of species; while 84 were considered as significant. It offered description of 32 asanas for success of mankind: "Siddha, Padma, Bhadra, Mukta, Vajra, Svastika, Simha, Gomukha, Vira, and Dhanur; Mrita, Gupta, Matsya, Matsyendra, Goraksha, Paschimottana, Utkata, and Sankata; Mayura, Kukkuta, Kurma, Uttanakurmaka, Uttanamanduka, Vriksha, Manduka, Garuda, and Vrisha; Shalabha, Makara, Ushtra, Bhujanga, and Yoga."[3] Modern form also incorporates majority of hatha yoga asanas. This section presents such and more poses as per different categories:

Sitting Asanas: They have meditative qualities thereby allowing us to move inwards, and are practised for long to calm an anxious mind, ease breathing, and also help in growth of muscles and lengthening of spine with better posture, viz., Sukhasana/Easy Pose (useful in hip-opening, strengthening nervous, hormonal and cardiovascular systems); Padmasana/ Lotus Pose (useful for Kundalini awakening, making joints/ligaments flexible and strengthening ankles, along with above-mentioned benefits); Baddha Konasana/ Butterfly Pose (useful to release stored tensions, strengthen genitals, stretch groins, allow proper functioning of prostate glands, kidney, urinary bladder, etc.). These asanas support women during menstruation, menopause and pregnancy, and also help to reduce heat during summer. Gomukhasana/ Cow Face is seated pose for aid in sciatica and for pain or stiffness in arms, neck, shoulder, hip joints and back muscles. Vajrasana/Thunderbolt (diamond) Pose is generally practised post meals for better digestion, with benefits of stimulating pancreatic function, resolving acidity and issues of urinary infection, and providing flexibility to lower body with healthy sexual organs. Malasana/Squat Pose reduces weight, heals root and sacral chakras (advantageous for women) and supports organs in abdomen. These poses provide relief in constipation and during back, ankles and calf muscles' pain.

Standing Asanas: They strengthen legs with proper alignment, teach us grounding as well as balancing, take care of muscles in abdomen region, back, buttock, hands, knees, etc., so that we retain mobility: (i) Tadasana/Mountain or equal standing pose: it involves all muscles and joints to activate

nervous system, improves body posture and height (also useful for women); (ii) Virabhadrasana I, II and III/(Warrior-I, II, III): these three asanas provide comfort in chaotic routines, make lungs healthy, expand our shoulders and chest cavity, rectify cramps in lower back muscles or in legs, build core strength, improve digestion by removing extra fat/waste, and instil strength, patience and focus; (iii) Vrksasana/Tree Pose: it includes putting weight on one leg so as to develop stability and stay in present moment, heals flat feet and sciatica, opens hip and strengthens inner thighs/groin, etc. (iv) Trikonasana/Triangle Pose: it is useful as warm-up for overall health, along with above-mentioned benefits, and makes core and abdomen stronger.

Forward Bending Asanas (Seated/Standing): They revitalise back muscles, spine, legs, arms, knees, thighs, shoulders, hip-joints, abdomen, and nervous system, as well as heal throat chakra and digestive system. These include: Adho Mukha Svanasana/Downward-Facing Dog Pose (also useful for supplying blood and oxygen towards head, treating piles, and preparing us for inverted asanas); Balasana/Child Pose (lessens stress by supplying blood to brain, heals cervical/spondylitis and gastric problems, gives rest to hips, chest, stomach and muscles around vertebrae of the spine, stimulates Third Eye/Ajna chakra) followed by extension to Shashankasana/Rabbit Pose (tones muscles of abdomen and pelvic regions); Padahastasana/Hand to Foot Pose (inverted pose useful in relieving fatigue and heaviness from body, stretching lower back, hamstring and calves, improving upper part's blood circulation); Parsvottanasana/Side Stretch (balances the body); Kurmasana/Tortoise (advanced pose for body's flexibility); Paschimottanasana/Seated Forward Bend (supports abdominal organs by resolving constipation, reduces obesity, helps in insomnia and depression, improves sexual health by providing more blood to reproductive organs, relieving menstruation pain and bloating, etc.); as well as comforting Cat/Cow Pose.

Backward Bending Asanas (Seated/Standing): They are heart-openers which activate the heart chakra by removing clogged emotions, help in stretching and giving strength/elasticity to abdomen, ribcage, spine, legs, hip muscles, etc., and revitalise our breath, namely, Chakrasana/Wheel Pose (provides more blood to brain and supports nervous system, solves problems related to kidney, respiratory system, thyroid gland and infertility); Setu Bandha Sarvangasana/Bridge Pose (usually practised by sports persons - opens and powers chest as well as neck, cleans lungs and helps in asthma, prevents heart blockages by carrying blood to arteries, relaxes muscles of heart, back, thighs, calves, etc., and cures leg pain, stiff shoulders, insomnia, depression, migraine headaches, fatigue and anxiety, prevents varicose veins, also heals root and thyroid chakras); Ustrasana/Camel Pose (beneficial in case of back pain, injury to spine, and stretches front part including chest, diaphragm, lungs, etc.); Purvottanasana/Inclined Plane/Reverse Plank Pose (gives extreme power and toning to ankles, arms and wrist, back, shoulder, and heals abdominal organs mainly intestines).

Inverted Asanas: They are complicated as we turn upside down (can be practised with wall), but have immense benefits in terms of balancing the body, making mind more focused, increasing memory, bringing new perspective/positive thoughts, reducing stress hormones' production, allowing blood flow towards head/scalp and upper part of lungs (improving respiratory system), keeping skin and hair healthy, etc. These include: Sirshasana/Headstand (also stimulates our lymphatic system to increase immunity and remove toxins, improves eyesight, reduces water retention in legs, strengthens arms and shoulders); Sarvangasana/Shoulder Stand (also lengthens spine, resolves cervical and piles, supports heart) along with extension as Halasana/Plough Pose (makes shoulders strong, relieves constipation, mends digestion with weight loss, and useful in diabetes and menopause). Pincha Mayurasana (Forearm Balance Pose) and Adho Mukha Vrksasana (Handstand) are tricky yet healthier ones.

Reclining Asanas in Prone Position (With Backbends): They strengthen the spine column and fight aches in back and neck, remove constipation

with improved digestion, heal heart chakra, and decrease weight, viz., Bhujangasana/Cobra Pose (also positively affects kidney, liver and abdomen, helps cervical, and energises us with better blood circulation); Salabhasana/Locust Pose (restores parasympathetic nerves in spinal region, supports frontal part mainly chest and also buttock and thigh muscles, helps in sciatica, builds confidence, etc.); Dhanurasana/Bow Pose (along with above benefits, deals with asthma, diabetes, stiffness in shoulders and upper thighs, and tones adrenal glands); Ardha Bhekasana/Half Frog Pose (provides relief in hip or leg pain and is useful for people having long sitting work-hours, helps in resolving flat feet issue and prevents knee injury by strengthening muscles, encourages blood flow towards reproductive organs and prostate glands); and Chaturanga Dandasana/ Four Limbed Staff Pose as a low level plank (helps in arm balancing asanas by giving strength to arms, wrists, ankles, back, core, etc.) along with Phalakasana/High Plank Pose (synchronises lower and upper body portions) provide stamina, resolve insomnia, make bone tissues healthier, help in better respiration, and activate Solar plexus/Manipura chakra by generating heat.

Note that Surya Namaskar is an asanas collection with 12 steps: Pranamasana (Prayer Pose: 1st, 12th), Hastauttanasana (Raised Arms Pose: 2nd, 11th), Padahastasana (3rd, 10th), Ashwa Sanchalan asana (Equestrian Pose: 4th, 9th), Dandasana (5th), Ashtanga Namaskara (Eight Points Salute: 6th), Bhujangasana (7th), and Parvatasana (Mountain Pose: 8th).

Arm Balancing Asanas: They strengthen the upper body and core (stretch and tones full body – mainly arms and wrists as they hold body's weight, shoulder, abdomen, lower back, legs, hamstrings, knees, ankles, biceps, triceps, muscles around spinal cord, etc. and gives them required flexibility and blood flow) and help in deeper concentration/ dharana. These include Bakasana/Crane Pose; Kakasana/Crow Pose (helpful for those who sit long on computer; gives lightness and activates solar plexus); Kukkudasana/ Fowl Pose; Pincha Mayurasana; Phalakasana; Vasisthasana/Side Plank Pose (balancing on one arm); Mayurasana/ Peacock Pose (useful to cleanse toxins, massages reproductive system, makes digestive system strong, heals imbalances in navel, helps in case of piles, diabetes, etc.), followed by difficult Vrschikasana/ Scorpion Pose (involves backbend for stimulating chakras above heart and lessening stress).

Twist Asanas: They are much easier with light movement of legs, arms, back, neck, etc. to keep spine in right order, relieve shoulder pain and hip/ knee joint issues, soothe abdominal organs to keep digestion strong and fight constipation. But, one should not haste and be extra careful while twisting. These asanas wring our body and release negative blockages and tones spleen, liver, pancreas, kidney, etc., such as Ardha Matsyendrasana/Half Fish Pose (useful in slipped disc and sciatica) and Jathara Parivartanasana/Abdominal Twist (also relaxes back muscles); Supta Matsyendrasana/ Supine Spinal Twist (moves out toxins from internal organs and allows inflow of fresh blood); and Parivrtta Sukhasana/ Revolved Easy Pose (opens hip and shoulders - for beginners).

Reclining Asanas in Supine Position: They strengthen core and aid in daily activities, viz., Matsyasana/Fish Pose (increases lungs' capacity, mainly for asthma patients, relaxes shoulder, lumbar muscles and cervical, stimulates thyroid, pituitary and pineal glands which secrete melatonin hormone); Navasana/ Boat Pose (nurtures abdominal muscles, hip flexors and helps in digestion, increases will power, etc.); Pavanamuktasana/Wind-Releasing Pose (releases gas and helps bloating and constipation, relaxes intestines and lower back, and heals reproductive system, tones legs); Savasana/ Corpse Pose (done at start and end of yoga session as meditation – gives rest to mind and body, helps in regulating blood pressure, sleep disorders, and preventing lifestyle diseases); Supta Vajrasana/ Reclining Thunderbolt Pose (eases stomach pain, useful for women health, helps in spiritual growth); and Supta Virasana/Reclining Hero Pose (stretches lower body, is hip-opener and bends knees to reduce fatigue).

But guidance is required for asanas performance (preferably in morning) by taking care of precautions in case of high blood pressure, migraine, menstruation, surgery, pregnancy, back/neck pain, injury in spine/ knee/ankle. One needs to protect wrist, eyes and head during inverted/arm balancing poses.

Dealing with Depression and Anxiety

Evidences exist to show positive effects of practising yoga asanas, pranayama and meditation on improving mental and psychological health. It

becomes highly crucial to utilise yogic techniques in easy-to-do manner during pandemic, when there is rising fear and insecurities among all the human beings (i.e., uncertainty of how long the virus will last, of economic slowdown causing job losses, along with feelings of boredom, sadness and loneliness owing to persistent social distancing and work from home).

Pranayama and Meditation for Stress: '*Prana*' means life force (our breath) and '*ayama*' is exercising/extension, such that pranayama is exercise of breathing. The technique helps in strengthening nervous, respiratory and lymphatic systems. Meditation/dhyana is a method of slowing down the wave of thoughts (developing concentration) and feeling relaxed. These can be our weapons to fight against viruses and depression.

Notably, sympathetic nervous system makes us active with fight-or-flight approach, while parasympathetic one lets us rest and digest. But continuous stress mostly keeps us in sympathetic mode thereby not allowing us to sleep well. This adversely affects immunity and brain functioning, but yoga can benefit under proper guidance. To elaborate, in simpler terms: (i) Meditation can be done in various ways depending on what suits each one, viz., focus on inward and outward movement of breath; recite any mantra such as AUM; focus on Anahata/heart chakra or on Ajna chakra which is located between the eyebrows (area where most nerves' endings meet); sit in silence and just observe every thought without judgement; connect with higher consciousness/supreme power or God using visualising techniques; and do yoga nidra. (ii) We should practice pranayama daily (at least few rounds) to channelise prana flow through energy channels in our body called nadis. Pranayama includes: *Bhastrika*, which calms down our mind and enables proper blood flow through deep nostril inhalations and exhalations; *Kapalbhati*, which removes toxins by forced exhalations and allows enhanced digestion by generating necessary heat in the body; followed by *Nadi Shodhan/Anulom-vilom*, which cleans nasal passage/purifies nadis and balances left and right nostril breathing which are connected to our brain; *Sheetali or Shitkari*, which cools/lower down pitta dosh and body's temperature in summers; and *Brahmari*, which includes humming bee sound during exhalation thereby creating vibrations in brain and improving memory. Conscious practice of diaphragmatic breathing (stomach moves out when inhale and goes in when exhale) and left-nostril breathing can aid in shifting to parasympathetic mode, thereby preventing blood pressure, diabetes, etc.

Healing with Nature: As widely known, yoga/meditation helps us to connect better with ourselves (inner nature) as well as with Universe. Oneness is eventually created among all the beings, which is yoga's essence. If you notice, many asanas are inspired by flora and fauna, viz., fish pose, butterfly pose, tree pose, lotus pose, etc. This indicates that humans cannot survive without maintaining harmony with nature, where even animals and plants have lessons for us, viz., to be flexible, able to bend/twist easily, stand firm during adversities, attain balanced and healthy lifestyle, be joyful and not lured by materialistic world, etc.

Yoga can be more beneficial if practised in clear outdoor surroundings, which can enable greater influx of oxygen into our lungs and provide mental healing and relaxation. This is the reason why people go on vacations to hilly places. However, lockdown has too reduced the pollution level in cities with easily visible blue sky, clean water bodies, vibrant chirping of birds, etc. The need is to use this period effectively to heal ourselves and nature, i.e., offer gratitude to nature; observe/feel the greenery around by sitting in balcony, doing yoga with open windows; meditate on how air touches your skin and body parts and on how breath goes in and out; listen to birds by actively engaging all sense organs; and stare at sky/stars with palms facing up to receive more energy. This will assist us in maintaining connection with the five elements, i.e., air, water, space, fire and earth. Further, drinking more water, bathing regularly, and watering the plants, along with deep breathing can help. Walking bare foot on grass or feeling the earth under feet even at home can heal root chakra which deals with fear, leg pain, diarrhoea, constipation, etc.

Yoga and Immunity

Immune system largely consists of white blood cells and lymphocyte cells that protects body when pathogens such as viruses, bacteria, etc. enter. Yoga improves cells' functioning and activates lymphatic system, as well as decreases stress and anxiety levels, which are major factors behind dampening immunity. Number of scientific studies (mainly using experimental approach) show that practice of yoga and mindfulness/transcendental meditation reduces cortisol by bringing in harmony between body and mind, regulates cytokine levels and immune responses, eases inflammation mediators, maintains homeostasis and production of endocrine hormones, prevents autonomic changes and damage to cellular immunity especially during stress, increases mucosal immune functioning, encourages positive impact on signs of immune function such as Natural Killer cell activity, count of B-lymphocytes, etc.[4] Since the outbreak of COVID-19, the Ministry of AYUSH also came up with the guidelines to lift immune system and protect ourselves from the virus. Along with Ayurveda-based home remedies, the guidelines suggest actively practising yoga/meditation at least for 30 minutes a day.

Together with physical asanas, yoga also entails teachings for healthy sattvic diet and thought management, which can support during immunodeficiency. Constant panic and prolong sitting/inactivity are not recommended during pandemic. Some yoga poses for strong immunity and rebalancing of body's defence mechanism even post-COVID are Sukhasana, Ardha Matsyendrasana, Matsyasana, Bhujangasana, Trikonasana, Padahastasana, Balasana, Ustrasana, Utkatasana/Chair Pose, Setu Bandhasana, Halasana, Dhanurasana, Tadasana, Vrksasana, Adho Mukha Svanasana, etc. Pranayama is must to strengthen the power of lungs. Abdomen breathing reinforces gut/gastrointestinal tract that holds about 70 percent of our immunity.

Way To-And Post-IDY 2020

IDY-2020 is round the corner, and are we better prepared this year? During lockdown, I have seen people practising asanas/meditation at their home by using online videos uploaded by yoga institutes or by attending private yoga classes. Given this, the Ministry of AYUSH can now launch proper yoga sessions on TV channel using own Common Yoga Protocol with enrichments of Surya Namaskar, more duration of dhyana, etc. (viz. at 6-7 AM, repeat telecast at 8-9 AM, even post-IDY). Greater advertising and speeches by experts can provide required boost to yoga practice. In fact, promotion of AYUSH system is already Government's rising priority (with ongoing trials) to find a new treatment for virus.

As lockdown may relax and offices/colleges open up, yoga should no longer be treated just an option (as stand by to gym). Loss of jobs/salaries may be inevitable, but we should at least not lose our mental and physical health. Also, substitution of processed foods by homemade ones, as taught under yogic lifestyle, can prevent further damage to immune system. Fear may continue to exist, but yoga can spread optimism and save us by giving a healthier alternative path.

Footnotes

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(The author is a yoga practitioner, kathak dancer and an international trade economist by profession, with PhD from IIT Delhi, and currently working as Fellow at a Delhi-based economic think-tank. Email: nehag.iitd@gmail.com)

Participatory Irrigation Management

Souvik Ghosh and Usha Das

Participatory Irrigation Management or PIM refers to the participation of water users, the farmers, in the management of the irrigation systems. It ensures the involvement of irrigation users in all aspects of irrigation management including planning, design, construction, operation, maintenance, financing, governance and monitoring and evaluation of the irrigation systems, at the primary, secondary and tertiary levels. PIM has resulted an increase in irrigation intensity, cropping intensity and yield with spatial and temporal variations.

Irrigation is critical to agricultural growth and development, bringing a green revolution and self-sufficiency in food production in the country. It has always been emphasized due to its yield-augmenting impact and treated as one of the priority areas of country's agricultural development strategy. Irrigation development in India has been quite remarkable with an increase in irrigation potential from 22.6 million hectares in 1950–1951 to about 123 million hectares by 2007 including 42 million hectares under major and medium irrigation projects, 14 and 67 million hectares under minor surface and minor groundwater lift projects, respectively, making it a world leader in irrigation.[1] Irrigated agriculture is about 48 per cent of net sown area (net irrigated area 68 million hectares) and contributes to 60 per cent of India's foodgrain production.[2]

Phases in irrigation development and management in India reveal several paradigm shifts: 1950–1970 is the era of capital-intensive expansion of irrigation, 1970–1980 is the era of irrigation improvement, and from late 1980s until present is the era of reform. The central challenge facing irrigated agriculture today and in the foreseeable future is per drop more crop.[3] The problems in irrigation sector in India include low irrigation efficiency (30–35 percent), deteriorating physical structures, inadequate maintenance, low cost recovery, under-utilisation (74 percent) of created potential, uncontrolled water delivery, tail-end water deprivation, seepage loss, siltation, waterlogging, and soil salinity. Inequitable and unpredictable water supply among the farmers over space and time lead to the injudicious use of water in the irrigation commands and increase in inequity within the same unit of command area.

In search of the solutions of aforesaid problems, farmers' participation in irrigation management has taken the center stage and the irrigators who were considered as beneficiaries are now considered partners in planning, development, operation and maintenance of irrigation systems. The National Water Policies of India (1987, 2002) have emphasized on farmers' participation in irrigation management based on the concept of people's management of developmental infrastructures that requires local solution to local problems affecting them. Most of the states in India have been implementing the Participatory Irrigation Management (PIM) reform and transferring the irrigation management to Water User Associations (WUAs) with a view to provide equitable, timely and assured irrigation.

What is PIM

PIM refers to the participation of water users, the farmers, in the management of the irrigation systems. It ensures the involvement of irrigation users in all aspects of irrigation management including planning, design, construction, operation,

maintenance, financing, governance and monitoring and evaluation of the irrigation systems at the primary, secondary and tertiary levels. Participation of beneficiaries facilitates the optimal upkeep of irrigation system and effective utilisation of irrigation water with greater participation of the farmers, more investments in the irrigation infrastructure and other irrigated agriculture related services will be need based and hence more effective. In many places, PIM reforms lead to Irrigation Management Transfer (IMT). IMT is the full or partial transfer of responsibility and authority for the governance, management and financing of irrigation systems from the government to WUAs. In India, IMT is mostly followed in case of minor irrigation projects.

Rationale of PIM

Performance of government - managed irrigation systems has been sub-optimal because of deterioration of physical infrastructure due to deferred maintenance, poor water service delivery, lack of accountability, poor incentives (financial) and weak institutional arrangements for infrastructure management. PIM has emerged as an important approach for improving the performance of the irrigated agricultural sector, including productivity and financial and physical sustainability.

As water delivery function influences the profitability of agricultural operations due to increase in irrigated area, cropping intensities and/or crop diversity, yields and economic returns, farmers are interested for participation in irrigation management. Thus, a consensus has emerged regarding WUAs to be the best strategy for long term sustainability of irrigated agriculture. Other reasons for promoting PIM include reduction of the burden of costs, staff requirements and technical or management problems faced by governments, farmers' access and control on operation, maintenance, water delivery and fixation of water rate, improvements in the agricultural productivity and economic profitability of irrigation systems. PIM forms a strong basis for collective action in related areas, such as adoption of modern agricultural practices and input management. Establishment of WUAs builds social capital through improved leadership and capacity building.[4]

Structure of WUAs

Structural development, size and organisation of WUA used to be at the convenience of farmers and the irrigation department. The jurisdiction of a WUA is in between 500 to 750 ha preferably under a minor project covering one or more villages. A minor irrigation project (command area up to 2000 ha) is managed by one WUA, a single tier system. The medium irrigation project (command area more than 2000 ha to 10000 ha) is managed by a two-tier system, having WUAs at minor level and an apex body at project level. In a major irrigation project (command area more than 10000 ha), it is a three-tier system, the WUA at minor level, a federation or a distributary committee at branch canal/distributary level and an apex body at the project level. The WUAs at minor level are federated at the distributary level to co-ordinate the functions of WUAs.

WUA is a registered body and all farmers in its jurisdiction command area become the members. Managing committee of WUA consists of a president, vice president, treasurer and secretary in addition to at least five members. State Irrigation, Agriculture, Command Area Development and Revenue Departments also nominate one officer from each department for inclusion in the managing committee to providing help in its functioning.

The presidents of all WUAs are the members of the distributary committee and these members may elect their president. The state departments may also nominate their officers to the distributary committee.

The distributary committees of the project may be further federated into the project-level committee called the apex body. The main function of the apex body would be to suggest improvement in the operation and maintenance of the irrigation system, environment of the area and rationalisation of water supply to the users other than irrigation. The presidents of the distributary committee are the members of the apex body. These members elect their president.

Legal Framework of PIM

PIM remains the main institutional solution for irrigation management problems in the developing world and is being implemented in nearly 60 countries.[5] In India, adoption of PIM has been slow as compared to some other countries. Different models of PIM are being tried in the country based on the state's water resources, irrigation development, and social and political environment.

Union Government plays the role of a facilitator but the actual implementation of PIM is done by the states as water is a State subject. It is important for creation and successful functioning of any organisation to have adequate legal backup. In India, 16 states viz. Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Nagaland, Odisha, Rajasthan, Sikkim, Tamil Nadu and Uttar Pradesh have either enacted exclusive legislation or amended their Irrigation Acts for involvement of farmers in irrigation management (Table 1).

The states, which are yet to do the enactment, follow various approaches for implementation of PIM. However, states that enacted PIM follow almost similar approach. Andhra Pradesh has done the enactment (Andhra Pradesh Farmers' Management of Irrigation System Act) in 1997 as the first state of India. These enabling laws and/or bylaws ensure formation of WUAs for undertaking management of irrigation, participation of farmers in irrigation management within the operational area of WUA, entrusting legal rights to WUA to receive irrigation water and distribute the same among the members in the operational area, empowering WUA in developing a suitable crop pattern, fixation of water rates for different crops on season-wise area basis, collection of water charges from the farmers for utilisation of irrigation water, generation of resources from donor agencies other than the water charges/maintenance grant, resolving conflicts among stakeholders, etc.[6]

In addition of the bylaws, another important legal document is the transfer agreement or the memorandum of understanding between the WUA and the irrigation department. It includes the terms and conditions of irrigation system transfer, area of operation of WUA, the details of the irrigation system with its present condition and the existing structures with their technical details, the duties and responsibilities of irrigation department and WUA, method of operation and maintenance, supply of irrigation water at agreed time and quantities in different crop seasons. The agreement used to be valid for a specified period; however, on satisfactory performances the agreement may be renewed for a further mutually agreed period. The conditions for termination of agreement are also indicated in the agreement.

Table 1: Position of enactment for PIM in different states of India

Sl. No.	Name of State	Position of issue/ amendment of Irrigation Act
1.	Andhra Pradesh	Enacted the Andhra Pradesh Farmers Management of Irrigation Systems Act, March, 1997
2.	Assam	The Assam Irrigation Water Users Act, 2004
3.	Bihar	The Bihar Irrigation, Flood Management and Drainage Rules, 2003 under the Bihar Irrigation Act, 1997
4.	Chhattisgarh	Enacted the Chhattisgarh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhiniyam, 2006
5.	Goa	Enacted the Goa Command Area Development Act, 1997 (Goa Act 27 of 1997)
6.	Gujarat	Gujarat Water Users Participation Management Act, 2007
7.	Karnataka	Promulgated an Ordinance on June 7, 2000 for amendment of the existing Karnataka Irrigation Act 1957
8.	Kerala	Enacted the Kerala Irrigation and Water Conservation Act, 2003
9.	Madhya Pradesh	Enacted the Madhya Pradesh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhiniyam, 1999 during September 1999
10.	Maharashtra	The Maharashtra Management of Irrigation Systems by Farmers Act, 2005
11.	Nagaland	Nagaland Farmers Participation in Management of Irrigation Systems Act, 2013
12.	Odisha	Enacted the Orissa Pani Panchayat Act, 2002
13.	Rajasthan	Passed the Rajasthan Sinchai Pranali Ke Prabandh Me Krishkon Ki Sahabhagita Adhiniyam, 2000
14.	Sikkim	Sikkim Irrigation Water Tax 2002 and Sikkim Irrigation Water Tax (Amendment) Act, 2008
15.	Tamil Nadu	Enacted the Tamil Nadu Farmers Management of Irrigation Systems Act, 2000
16.	Uttar Pradesh	Enacted the Uttar Pradesh Irrigation Management Act, 2009

(Source: Ministry of Water Resources, Govt. of India http://mowr.gov.in/sites/default/files/CADWM_Status_of_PIM_0.pdf)

Progress of PIM

PIM in India has followed two approaches: legislative and motivational. Andhra Pradesh and Madhya Pradesh first enacted legislation and opted for fast and extensive introduction of PIM. Maharashtra and Gujarat adopted motivational strategy followed by legislation. So far, 84,779 WUAs have been formed in various states covering an area of 17.84 million hectares under various commands of irrigation schemes (Table 2). One-time functional grant of Rs. 1200 per hectare shared by the Centre, State and Farmers in the ratio of 45:45:10, respectively, is being paid to the WUAs as an incentive, the interest from which is used for maintenance. Apart from this, an amount of Rs. 3 lakh (60 percent - Central: 40 percent - State) is being provided to each WUA as one-time Infrastructure Grant for creation of suitable facilities.[7]

Command Area Development and Water Management (CADWM) work is being implemented in 99 prioritised Accelerated Irrigation Benefit Projects (AIBP) under Pradhan Mantri Krishi Sinchai Yojana (PMKSY)/Har Khet Ko Pani (HKKP). Under the restructured CADWM Programme, more emphasis is being given to participatory approach; thus, payment of central assistance to state is linked with the formation of WUAs. As on April, 2016 a total of 4223 WUAs had been created. About 1250 WUAs are formed in states of Assam, Gujarat, Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Odisha and Punjab during 2016–17. Again during 2017–18, another 1372 WUAs had been formed in states of Assam, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Maharashtra, Manipur, Odisha, Punjab and Rajasthan. Further in 2018–19 (upto second quarter) a total of 890 WUAs were formed in states of Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Karnataka, Maharashtra, Odisha and Telangana. Thus, a total of 7735 WUAs have been formed.[8]

PIM has resulted an increase in irrigation intensity, cropping intensity and yield with spatial and temporal variations. However, it is debated that the shift from government managed to farmers' managed irrigation system may be one of the contributing but not the only factor responsible for better agriculture performance. Non-rice producing irrigation systems can be more productive than the rice producing irrigation systems. Effect is found to be varied between sources of irrigation as well as across the command areas of different irrigation systems.

Table 2: Progress of PIM in Different States of India

Sl. No.	Name of State	Number Of WUAs-Formed	Area Covered (Thousand-hectare)
1	Andhra Pradesh	10884	4179.25
2	Arunachal Pradesh	43	10.97
3	Assam	847	95.02
4	Bihar	80	209.47
5	Chhattisgarh	1324	1244.56
6	Goa	84	9.54
7	Gujarat	8278	662.99
8	Haryana	8490	1616.27
9	Himachal Pradesh	1173	140.56
10	J&K	383	32.794
11	Jharkhand	0	0
12	Karnataka	2787	1418.66
13	Kerala	4398	191.22
14	MadhyaPradesh	2062	1999.64
15	Maharashtra	2959	1156.22
16	Manipur	69	29.4
17	Meghalaya	159	20.17
18	Mizoram	390	18.23
19	Nagaland	24	3.44
20	Odisha	20794	1757.71
21	Punjab	4845	610.29
22	Rajasthan	1994	1144.45
23	Sikkim	0	0
24	TamilNadu	1910	935.664
25	Telangana	0	0
26	Tripura	0	0
27	UttarPradesh	802	318.69
28	Uttarakhand	0	0
29	West Bengal	10000	37
Total		84779	17842.208

(Source: Ministry of Water Resources, Govt. of India http://mowr.gov.in/sites/default/files/CADWM_Status_of_PIM_0.pdf)

Women Participation

Representation of women in the WUAs at all levels has been brought in the guidelines issued by the Ministry of Water Resources. Accordingly, many states have amended the enactment with respect to implementation of PIM. Considering the importance of women in terms of their significant contribution in the agricultural labour force, participation of women in management of water resources is ensured through their membership in the WUAs. Some states have already implemented it; for example, in Madhya Pradesh, all farm owners, be it men or women, are rightful members of the outlet committees in WUAs. Where there are no women members, at least one woman from the area must be taken even if she is not a land owner. Further, at least one woman shall be nominated to the Governing Body of the Association.

Way Forward

International Commission on Irrigation and Drainage (ICID) Working Group on Institutional and Organizational Aspects organised an international symposium with the theme 'Global Review of Institutional Reforms in the Irrigation Sector for Sustainable Agricultural Water Management' including WUAs, during the 23rd ICID Congress (8–14 October 2017) in Mexico City. The symposium deliberated upon legal framework and organisational structure including WUAs for water supply services, PIM and management transfer approaches and conditions for successful irrigation and drainage, Public-Private Partnership (PPP) in irrigation and drainage operation and maintenance towards sustainable irrigated agricultural water management. Based on this, a review on institutional reforms in the irrigation sector was done in India besides other countries. Despite the diverse geography and institutional frameworks in irrigation sector, food security remains a major concern in all the countries and regions reviewed. The formation and functioning of WUAs, ageing irrigation and drainage infrastructure and its operation and management remain to be the major institutional and PPP challenges for sustainable agricultural water management in the immediate future.

Water Users' Associations like any other organization may sustain only when:

- The earning is more than the expenditure funds available as and when required
- It has some reserve fund at its disposal
- Ensured supply of irrigation water from the system
- Effective operation plan of the project
- Equitable distribution of water
- Improvement in recovery of water charges from the farmers
- Recovery of water charges for using other source of water in the operational area
- Willingness of the farmers and irrigation agency to make it a success

The issues of rights are beginning to enter the debate on Indian irrigation that needs a lot of attention. Poor people's relative benefit is typically depending on allocation of water rights, which is in proportion to land size rather than, for example, on the basis of an equal quantity of water to every farm households. The concept of WUA does not consider other uses of water (domestic, industrial use, etc.) and also the needs of landless people in irrigation command area that hampers the social support and accentuates rural inequity. Without proper education and interface with all categories of farmers, there will not be widespread acceptance to the idea of farmers assuming management and maintenance responsibilities beyond the on-farm level. Collective efforts by all concerned are required for successful and effective PIM to pave the way for creating virtuous circle in irrigation and farm sector (Fig. 1 on page no 45).

Conclusion

Water forms the backbone for all the future endeavours to achieve the vision of food security. Water management is by nature beyond the work of individuals and thus collective effort by all farmers concerned is required for successful management. Farmers' participation in irrigation management has taken the center stage and the irrigators who were considered as beneficiaries are now considered partners in planning, development, operation and maintenance of irrigation systems. Transfer of irrigation management responsibilities from government agencies to farmers is now an important policy that has resulted variable impact over space and time. The most ideal situation may be when

the demand of taking over of management of irrigation system comes strongly from the farmers.

Footnotes

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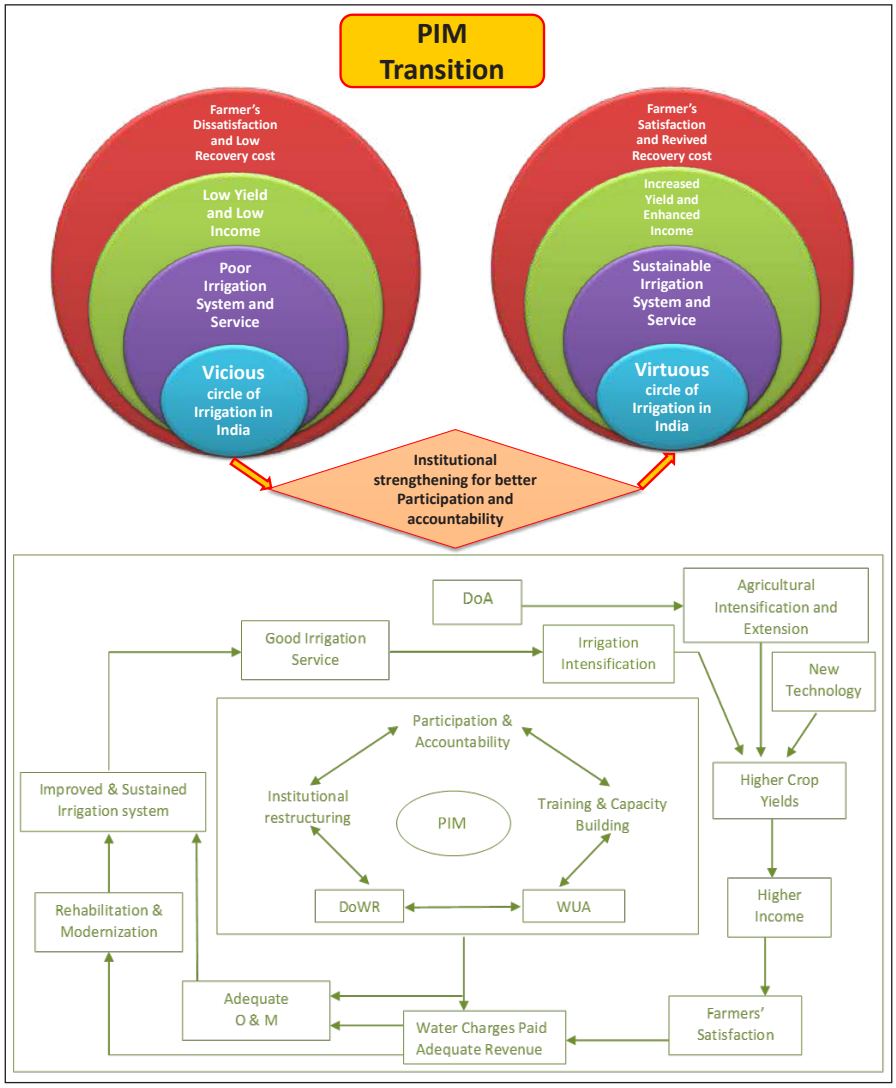


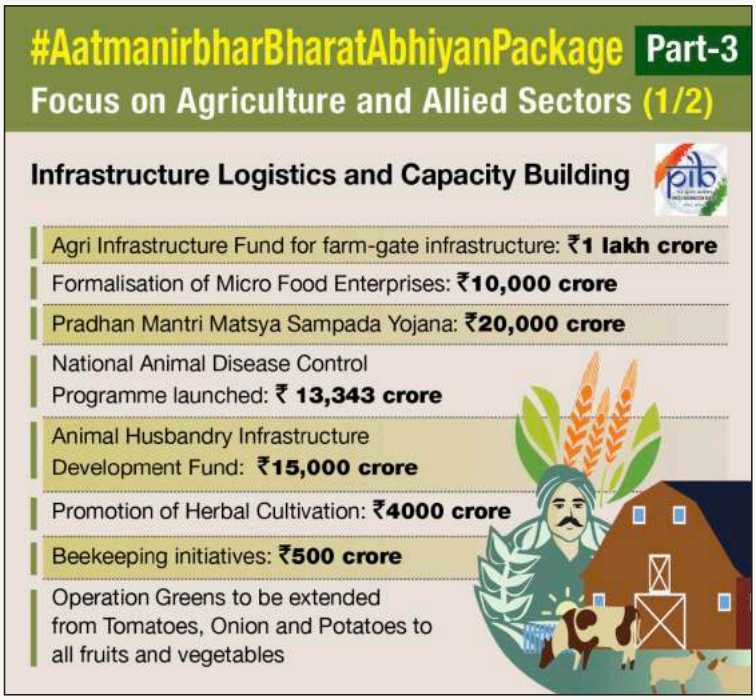
Fig. 1: PIM- Potential Option in Transforming Vicious Cycle to Virtuous Cycle in Irrigation Sector

(Souvik Ghosh is Professor & Ex-Head, Department of Agricultural Extension, Institute of Agriculture, Visva-Bharati University, Sriniketan, West Bengal, Email: souvik.ghosh@visva-bharati.ac.in, Usha Das is with Department of Agricultural Communication, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, Email: usha24.das@gmail.com)

Aatmanirbhar Bharat

Measures to Strengthen Agriculture Infrastructure Logistics, Capacity Building, Governance and Administrative Reforms for Agriculture, Fisheries and Food Processing Sectors

Union Finance & Corporate Affairs Minister Smt. Nirmala Sitharaman in her press conference announced on 15 May 2020 the 3rd Tranche of measures to strengthen Infrastructure Logistics, Capacity Building, Governance and Administrative Reforms for Agriculture, Fisheries and Food Processing Sectors. Outlining what the Government has done over the last 2 months, the Finance Minister said, during the lockdown period Minimum Support Price (MSP) purchases of more than Rs. 74,300 crore, PM KISAN fund transfer of Rs. 18,700 crore and PM Fasal Bima Yojana claim payment of Rs. 6,400 crore have been made.



The Finance Minister announced the following measures:

1. Rs. 1 lakh crore Agri Infrastructure Fund for farm-gate infrastructure for farmers

Financing facility of Rs. 1,00,000 crore will be provided for funding Agriculture Infrastructure Projects at farm-gate & aggregation points (Primary Agricultural Cooperative Societies, Farmers Producer Organizations, Agriculture entrepreneurs, Start-ups, etc.). Impetus for development of farm-gate & aggregation point, affordable and financially viable Post Harvest Management infrastructure. Fund will be created immediately.

2. Rs. 10,000 crore scheme for Formalisation of Micro Food Enterprises (MFE)

A Scheme promoting the vision of Prime Minister Shri Narendra Modi: 'Vocal for Local with Global Outreach' will be launched to help 2 lakh MFEs who need technical upgradation to attain FSSAI food standards, build brands and marketing. Existing micro food enterprises, Farmer Producer Organisations, Self Help Groups and Cooperatives to be supported. The focus will be on women and SC/ST owned units and those in Aspirational districts and a cluster-based approach (e.g. Mango in UP, Tomato in Karnataka, Chilli in Andhra Pradesh, Orange in Maharashtra etc.) will be followed.

3. Rs. 20,000 crore for fisherman through Pradhan Mantri Matsya Sampada Yojana (PMMSY)

The Government will launch the PMMSY for integrated, sustainable, inclusive development of marine and inland fisheries. Rs 11,000 crore for activities in Marine, Inland fisheries and Aquaculture and Rs. 9000 crore for Infrastructure such as Fishing Harbours, Cold chain, Markets etc., shall be provided. Cage Culture, Seaweed farming, Ornamental Fisheries as well as New Fishing Vessels, Traceability, Laboratory Network etc., will be key activities. There will be provisions of Ban Period Support to fishermen (during the period fishing is not permitted), Personal & Boat Insurance. This will lead to additional fish production of 70 lakh tonnes over 5 years, employment to over 55 lakh

persons and doubling of the exports to Rs 1,00,000 crore. The focus will be on islands, Himalayan States, North-east and Aspirational Districts.

4. National Animal Disease Control Programme

National Animal Disease Control Programme for Foot and Mouth Disease (FMD) and Brucellosis launched with total outlay of Rs. 13,343 crore to ensure 100% vaccination of cattle, buffalo, sheep, goat and pig population (total 53 crore animals) for Foot and Mouth Disease (FMD) and for brucellosis. Till date, 1.5 crore cows & buffaloes tagged and vaccinated.

5. Animal Husbandry Infrastructure Development Fund - Rs. 15,000 crore

An Animal Husbandry Infrastructure Development Fund of Rs. 15,000 crore will be set up, with an aim to support private investment in dairy processing, value addition and cattle feed infrastructure. Incentives will be given for establishing plants for export of niche products.

6. Promotion of Herbal Cultivation: Outlay of Rs. 4,000 crore

The National Medicinal Plants Board (NMPB) has supported 2.25 lakh hectare area under cultivation of medicinal plants. Area of 10,00,000 hectare will be covered under Herbal cultivation in next two years with outlay of Rs. 4,000 crore. This will lead to Rs. 5,000 crore income generation for farmers. There will be network of regional *mandis* for Medicinal Plants. NMPB will bring in the area of 800 hectare by developing a corridor of medicinal plants along the banks of Ganga.

7. Beekeeping Initiatives – Rs 500 crore

Government will implement a scheme for:

a. Infrastructure development related to Integrated Beekeeping Development Centres, collection, marketing and storage centres, post harvest & value addition facilities etc;

b. Implementation of standards & developing traceability system;

c. Capacity building with thrust on women;

d. Development of quality nucleus stock and bee breeders.

This will lead to increase in income for 2 lakh beekeepers and quality honey will reach the consumers.

8. From 'TOP' to TOTAL – Rs. 500 crore

"Operation Greens" run by Ministry of Food Processing Industries (MOFPI) will be extended from tomatoes, onion and potatoes to ALL fruit and vegetables. The Scheme would provide 50% subsidy on transportation from surplus to deficient markets, 50% subsidy on storage, including cold storages and will be launched as pilot for the next 6 months and will be extended and expanded. This will lead to better price realisation to farmers, reduced wastages, affordability of products for consumers.

(Source: Press Information Bureau)

Irrigation Projects

Laxmi Devi

The government has put in place a funding mechanism through NABARD for providing loans towards central as well as state share for completion of the identified irrigation projects. The government in its 2016 Budget gave a strong push on increasing irrigation coverage and made major financial outlays for creating new irrigation infrastructure in the country. It had announced that of the roughly 150 then-ongoing irrigation projects under the Accelerated Irrigation Benefits Programme (AIBP) under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), 99 would be expedited and completed by December 2019.

Over dependence on rainfed agriculture has always been a challenge for the country's farm production. The increasing gap between irrigation potential created, through major and minor projects, and the actual usage is affecting the country's crop yields. Substantial agricultural area remains dependent on monsoon, which has grown erratic in recent years due to climate change, causing distress to farmers. However, the government has made efforts to expand the irrigation network.

It may be noted that about 80 percent of the current water use is drawn by agriculture. Irrigated area accounts for nearly 49 percent of the 140 million hectares of agricultural land in India. The remaining 51.2 percent is rainfed but accounts for nearly 40 percent of the country's total food production. The increasing gap also impacts rainfed production in the country.

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Together, these projects, put on the fast track, were to add about 76.03 lakh hectares of cultivable land under irrigation network. The 99 projects were to be completed along with their Command Area Development and Water Management (CADWM) works.

The government put in place a funding mechanism through NABARD for providing loans towards central as well as state share for completion of these identified irrigation projects. Total requirement of funds for completion of the identified 99 projects was estimated at Rs 77,595 crore (Rs 48,546 crore for project works and Rs 29,049 crore for CADWM works) with Central Assistance (CA) of Rs 31,342 crore.

The arrangement of funds for Central share/ Assistance (CA) was made through NABARD as per year-wise requirements to be paid back in 15 years' time keeping a grace period of 3 years. Further, the state governments, if required, were also allowed to borrow funds from NABARD for the state share.

That apart, NABARD was allowed to raise zero cost bonds, the interest rate of which would be borne by the central government to ensure the overall interest rate for state share comes down to about 6 percent and make it attractive for state governments to take requisite funds to meet state share for early completion of projects.

As on January 1 of the 2019–20 fiscal, NABARD has released an amount of Rs 10,469.78 crore under the Long Term Irrigation Fund (LTIF). A maximum of Rs 3,559.38 crore fund was released to Maharashtra followed by Rs 1994.15 crore to Uttar Pradesh, Rs 1,850 crore to Andhra Pradesh, Rs 1383 crore to Gujarat, Rs 827 crore to Odisha and Rs 291.81 crore to Madhya Pradesh in the said period.

Results So Far

The latest figures shared by the Central Water Commission (CWC) under the Ministry of Water Resources (also called Jal Shakti Ministry), show the number of projects to be fast tracked for completion has gone up to 106 now. Out of which, 40 projects have been fully completed till now, while the remaining are in the pipeline.

CWC Chairman R K Jain said, the delay in completion of identified 99 projects has not been due to the lack of funds but mainly because of land acquisition.

"In some cases, there are disputes between the contracting agencies. Some railway and highway crossing hurdles are also there. In one or two cases, forest clearance issues are also there," he told the writer and pointed out that the central government simply supplements efforts of state governments in creating irrigation facilities by providing technical and financial assistance under AIBP.

Even some minor works are still pending in the completed 40 projects, according to the CWC Member S K Halder who said any project is declared as completed after 90 per cent work is over. "There may be some minor work remaining and that will take its own time," said Shri Halder.

Shri Halder, who is closely monitoring these projects, feels that another 40 projects would be completed by December 2019 or March 2020. The rest 26 projects would be delayed further by six months or a year due to land acquisition and rehabilitation issues besides others.

In some projects which were to complete this month, he said there could be a delay of one to two months because of the nationwide lockdown to prevent the spread of deadly viral disease COVID-19 in the country.

As per the original plan, 99 prioritised projects were to be completed in a phased manner. In first phase, 23 projects were to be completed by March 2017 creating irrigation potential of 14.53 lakh hectares, another 31 projects were to be finished by March 2018 creating irrigation potential of 12.95 lakh hectares in the second phase, while the rest 45 projects were to be completed in the third phase by December 2019 creating 48.45 lakh hectares irrigation network. (See table)

In the first phase, around 18 projects were completed, creating an irrigation network of 3,68,150 hectare (ha). It may be noted that maximum irrigation potential was created in Odisha at 93,600 ha by completing two projects. One was Upper Indravati Project in drought prone districts of Kalahandi and Nawarangpur in Odisha. The other one was Rukura Midium Irrigation project in Gurundia block of Sudargarh district.

Besides Odisha, about 92,060 hectare of irrigation network was created in Maharashtra by completion of four major pending projects. One was Bawanthadi Interstate Irrigation project, which was conceived way back in 1975, in Bhandara district of Maharasthra. The other one was Warna Medium Irrigation project approved in 1967 that got delayed due to non-availability of funds and Lower Panzara

The Estimated Fund Requirement (Central Assistance as well as State Share) for Completion of 99 Projects

Category	No. of Projects	Fund required for completion (Rs. in crore)			Central Share (Rs. in crore)	Irrigation Potential Utilisation (Lakh Ha.)
		AIBP	CAD	TOTAL		
Priority-I projects (Completion by 3/2017)	23	7956	5466	13423	6535	14.53
Priority-D projects (Completion by 3/2018)	31	8080	4825	12905	4269	12.95
Priority-DI projects (Completion by 12/2019)	45	32510	18757	51268	20538	48.45
Total	99	48546	29049	77595	31342	76.03

Note: Figures mentioned are as per infonnation compiled /received from States. However, while processing CA proposals, the figures considered would be as per actual and therefore may change.

(Source: Jal Shakti Ministry)

project approved in 1984 as well as Dongargaon Midium Irrigation project.

Similarly, 91,950 ha irrigation potential was created in Punjab by completing two major pending projects, one was Kandi Canal Extension (Phase-II) and Rehabilitation of Patiala Feeder and the other was Kotla Branch Project.

The other states where projects completed were in Madhya Pradesh (3 projects irrigated 41,100 ha), Chhattisgarh (2 projects irrigated 24,700 ha), Karnataka (1 project irrigated 13, 800 ha), Telangana (3 projects irrigated 9,720 ha) and Andhra Pradesh (1 project irrigated 1,420 ha). In the second phase, 22 projects have been completed.

Projects Implementation

Many of the projects that were fast-tracked for completion in 2016 had remained under-construction for several years, some even for a couple of decades, due to problems in funding, land acquisition, rehabilitation and resettlement of affected people besides inadequate state budgets, etc. The delays had led to major cost-overruns and in many cases the budgetary allocations were barely enough to cover for these escalations in costs.

As irrigation projects have a long construction period, this has resulted in changes in the size and nature of projects after starting work, which adds to delays.

Way Ahead of Farmers to Reap Irrigation Benefit

Farmers are yet to get the benefit from the 40 completed projects out of 99 identified projects under the AIBP as command area development has not started in many projects. In 16 projects, the work is yet to get started, while in another 12, the development has to be expedited.

According to the guidelines for PMKSY, the motto of which is 'Har Khet Ko Paani' (water for every agricultural land by providing end-to-end solutions in irrigation supply chain), the completion of a project includes development of command area besides the main canal and its branches.

On this, CWC Chairman R K Jain said that canals are constructed upto an outlet under AIBP. Outlet is the point from where water comes out of the main irrigation system and flows through field canals and reaches farm fields. But the last mile connectivity of irrigation network is done under the Command Area Development and Water Management Programme (CADWM).

"CADWM is a participatory programme under which farmers are required to contribute some money and form water association, which is little bit lagging," he said. Before the launch of the CADWM, irrigation was provided after completion of a project without waiting for development of command area, but it failed in ensuring water use efficiency and water to last mile. Because of these problems, the government had to introduce CADWM.

In many cases, the states seem to show little or lukewarm interest in command area projects. In one project in Punjab (Kotla branch), for instance, the state government has decided not to further develop the command area after about 60 percent progress in the construction work.

Researcher Pritha Banerjee from think thank ICRIER (Indian Council for Research on International Economic Relations) is of the view that most of the states are not ready for command area development as it requires land acquisition and small farmers are reluctant to part with their lands. In the absence of command area development, farmers in the tail-end on both the sides of the main canal take water from it by using pump sets, which increases their costs and leads to wastage of water. Small farmers, who could not afford additional costs, solely depend on the command area to take the water into their fields, she said.

The expenditure on command area infrastructure is shared by the Centre and the state concerned on a 6:4 basis. Some states have agreed to start the construction of command area, but asked for more funds from the Centre. The water resources ministry will have to decide how it will encourage states to implement these projects.

"There is a lag of 1–2 years. Unless water flows through the canal system for sometime and farmers are confident that they will be getting water, farmers will not come forward to participate in the CADWM," Jain said and noted that the state governments have a major role to play in implementation of both AIBP

and CADWM. CWC is monitoring and facilitating states wherever bottlenecks are found.

Way Forward

Expressing concern over low irrigation coverage, a task force headed by Economic Affairs Secretary Atanu Chakraborty on National Infrastructure Pipeline (NIP) for 2020-2025 projected an investment of Rs 8,94,473 crore to ramp up irrigation network in the next five years by both the Centre and states.

"Investment in the irrigation sector is critical as it directly impacts agriculture and the rural economy in India. As the livelihood of a major proportion of India's population depends on agriculture and allied activities, it is important to minimise the uncertainty owing to dependence of agriculture on rains," the task force said in the final report submitted last month to the Union Finance Ministry.

While pitching for greater participation of private players to bring in efficiencies in irrigation system, the task force suggested key regulatory reforms which include sharper focus on better management of existing irrigation infrastructure than putting more money into building new infrastructure.

It also emphasised the need to increase micro-irrigation coverage as it will go a long way in solving the country's water crisis. This makes private investment imperative in micro-irrigation projects, which are relatively less risky. It also called for according priority status to micro-irrigation projects to ensure greater flow of bank credit to farmers to buy equipment.

Besides, the task force recommended a better method for pricing water for irrigation which must move from area-based fees to quantity-based fee. It also suggested subsidy on water up to a threshold level and putting in place a robust IT and automated system to track efficient use of water resources among others.

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(The author is a senior journalist with news agency PTI and has been covering issues related to agriculture, food, environment, consumer affairs, and rural India for more than 17 years now. Email: pen2laxmi@gmail.com)

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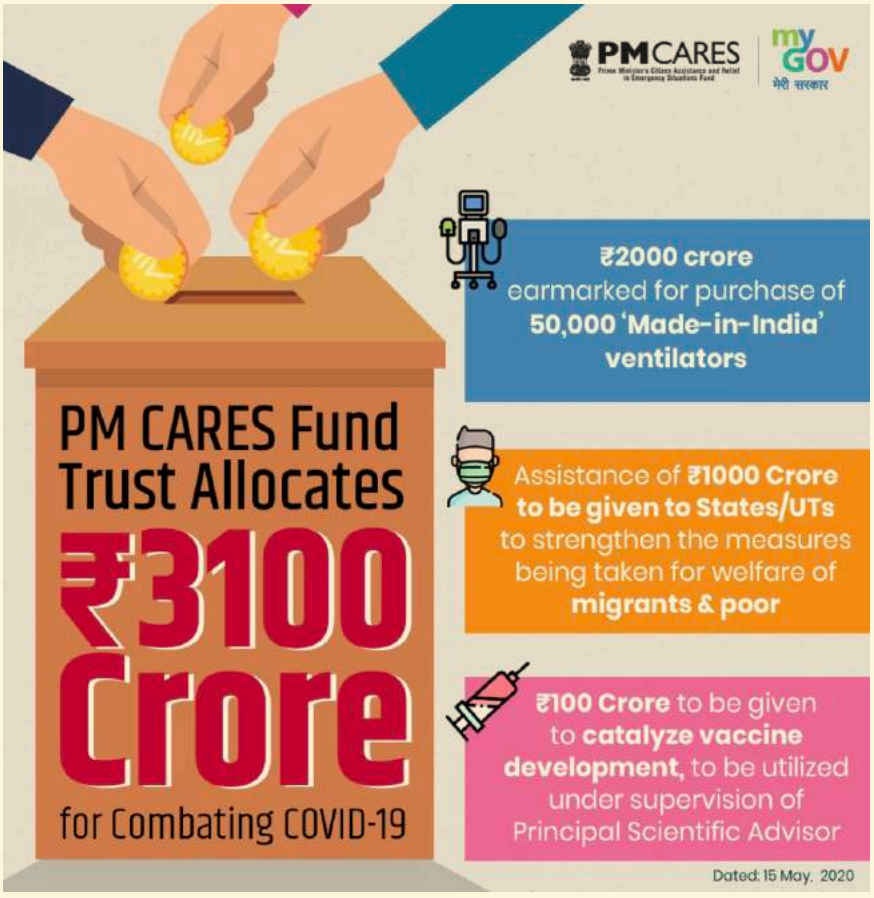

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