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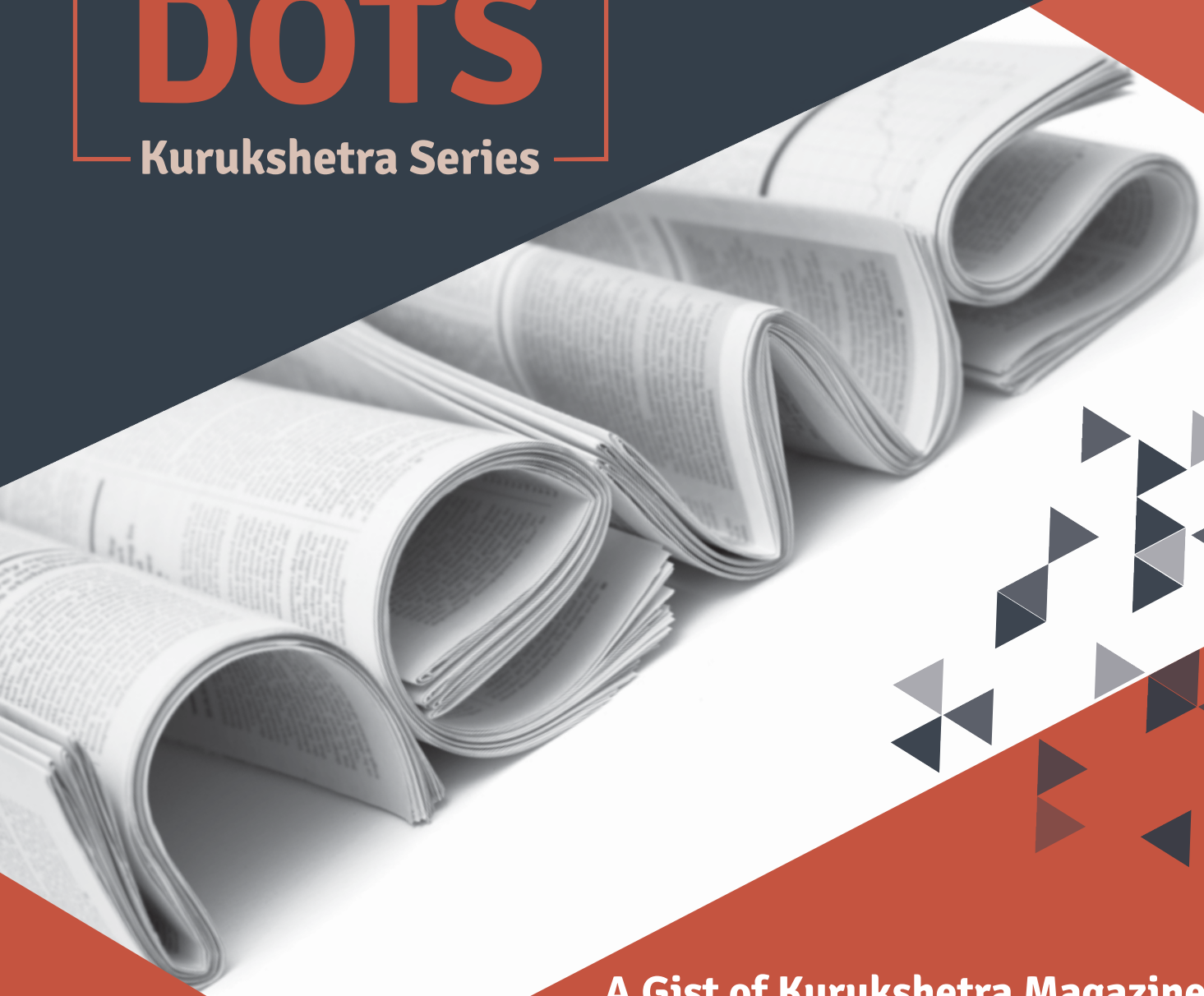

A Gist of Kurukshetra Magazine (June 2020 Issue)

- Water Management
- Sustainable Agriculture
- Participatory Irrigation Management
- Irrigation Projects

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Kurukshetra Compendium

June, 2020

Irrigation and Water Conservation

Water Management: Towards Sustainable Agriculture

- 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.
- 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.
- 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
- 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
- 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.
- 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.
- 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.
- 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.
- Total utilisable water resource in the country has been estimated to be about 1,123 billion cubic metres, which is just 28% 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.
- 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.
- Many parameters like crop growth stage and its sensitivity to water stress, climatic conditions and water availability in the soil determine when to irrigate
- 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.
- **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

- **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.
- 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.
    - **Methods 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.
    - **Check Basin and Border Strip Irrigation:** Check basin is the easiest and least costly method, but is usually highly inefficient only less than 20% 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.
    - **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. 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.
    - **Surge flow irrigation**: It is 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.
    - **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. 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.
    - 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.
    - **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.
    - **Drip Irrigation:** 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 and have been proved as one of the best ways to increase water productivity.
    - **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.
    - **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 out in soil all directions.
    - **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.

- **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. 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 of the crop by eliminating irrigations that have little impact on yield and to improve control of vegetative growth (improve fruit size and quality).
- **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.

- **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 Water Use Efficiency. Some of the important agronomic practices are:
  - **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.
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  - **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.
  - **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.

Smart Agriculture

- 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.
- 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
- 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 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. 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.
- 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.
- **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.
- **Artificial Intelligence (AI):** 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.
- **Blockchain:** 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. 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. 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.
- **Artificial Intelligence of Things (AIoT**): 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:** 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.
- 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 m3 per year.
- 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.

- 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
- According to the Alliance for Water Efficiency, most smart irrigation technologies fall under two classifications:
    - **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.
    - **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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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."
- **Agribot**: 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. 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.

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

- 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 the infection in India.
- 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.
- 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.
- 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*.
- 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.
- 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.
- It has been 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.
- 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. A
- 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 focus of this work will allow policymakers to experiment with policies, detect fraud in health insurance, measure outcomes and move towards smart policy making.
- 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.
- 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.

Water Conservation: Minimizing Wastage

- According to the Population Division of the UN Department of Economic and Social Affairs (UNDESA), a division established in 1946 to study, 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.
- In India, per capita availability of water has decreased from 2209 m3/year in 1991 to 1545 m3/year in 2011 and it is estimated to decline further upto 1140m3/ year in the year 2050.
- 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 an eventual six percent loss in the country's GDP.
- 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.
- 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 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.
- **Jal Shakti Abhiyaan**: 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 aims at making water conservation a *jan andolan* through asset creation and extensive communication.
- **Pradhan Mantri Krishi Sinchayee Yojana**: The Cabinet Committee on Economic Affairs 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.
- 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.
- 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
- 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 in 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.
- **Jal Jeevan Mission:** 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. 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, etc.

Solution to Groundwater Crisis

- 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.
- 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.
- 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.
- The government 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.
- 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). 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.
- 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.
- 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
- 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 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

Participatory Irrigation Management

- 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.

- 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.
- 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.
- PIM forms a strong basis for collective action in related areas, such as adoption of modern agricultural practices and input management. Establishment of Water User Associations (WUAs) builds social capital through improved leadership and capacity building.
- Water Use Association 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.
- 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.
- 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 have either enacted exclusive legislation or amended their Irrigation Acts for involvement of farmers in irrigation management
- 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
- 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
- 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
- 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.
- PIM has resulted an increase in irrigation intensity, cropping intensity and yield with spatial and temporal variations.
- 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.
- 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.

- 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

Irrigation Projects

- 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.
- The 99 projects were to be completed along with their Command Area Development and Water Management (CADWM) works.
- 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
- 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.
- 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.
- 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.
- 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. I
- 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.
- 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.