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Irrigation and Water Conservation

INCREDIBLE RESULTS

CSE 2018 Results

11 Ranks in Top 50 | 28 Ranks in Top 100 | 183 Ranks in the Final List


Rank 11
Pujya Priyadarshni


Rank 16
Dhodmise Trupti Ankush


Rank 21
Rahul Jain


Rank 24
Anuraj Jain

CSE 2017

5 Ranks in top 50 | **34 Ranks** in top 100 | **236 Ranks** in the final list


Rank 3
Sachin Gupta


Rank 6
Koya Sree Harsha


Rank 8
Anubhav Singh


Rank 9
Soumya Sharma


Rank 10
Abhishek Surana

CSE 2016

8 Ranks in top 50 | **18 Ranks** in top 100 | **215 Ranks** in the final list


Rank 2
Anmol Sher Singh Bedi


Rank 5
Abhilash Mishra


Rank 12
Tejaswi Rana


Rank 30
Prabhash Kumar


Rank 32
Avdhesh Meena

CSE 2015

5 Ranks in top 50 | **14 Ranks** in top 100 | **162 Ranks** in the final list


Rank 20
Vipin Garg


Rank 24
Khumanthem Diana Devi


Rank 25
Chandra Mohan Garg


Rank 27
Pulkit Garg


Rank 47
Anshul Agarwal

CSE 2014

6 Ranks in top 50 | **12 Ranks** in top 100 | **83 Ranks** in the final list


Rank 4
Vandana Rao


Rank 5
Suharsha Bhagat


Rank 16
Ananya Das


Rank 23
Anil Dhameliya


Rank 28
Kushaal Yadav


Rank 39
Vivekanand T.S

CSE 2013

5 Ranks in top 50 | **62 Ranks** in the final list


Rank 9
Divyanshu Jha


Rank 12
Neha Jain


Rank 23
Prabhav joshi


Rank 40
Gaurang Rathi


Rank 46
Udita Singh

KURUKSHETRA – JUNE 2020

IRRIGATION AND WATER CONSERVATION

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Chapter 1: Water Management: Towards Sustainable Agriculture

Sustainable agriculture:

- 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.
- The objective is to produce qualitative and nutritious food without harming human health and ecosystem. Such systems must be resource-conserving, socially supportive, commercially competitive and environmentally sound. This would entail farming according to the location-specific ecosystem.
- Such systems generally avoid the use of synthetically compounded fertilizers, 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.
- Important aspects of sustainable agriculture include:
    - Soil management through conservation agriculture, organic farming, integrated nutrient management system and on-farm residue management
    - Efficient water resource management techniques like micro-irrigation, use of mulches etc
    - Crop management techniques like cultivation of crops and varieties suitable to the given ecosystem and water availability, crop rotation, inter cropping, mixed-cropping, integrated pest management, etc.

Water resource Management:

- The sustainability in agriculture primarily depends upon the availability of water in optimum quantity and acceptable quality. It might not be possible to sustain agricultural production if irrigation is not sustainable and water supplies are not reliable.
- 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.

Facts related water resource in India:

- Rainwater is the primary source to meet the demand of water in Indian agriculture.
- 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 will only increase in times to come.
- The major source for irrigation is groundwater.

Challenges:

Water scarcity:

- India has the challenging task of feeding 17.5 percent of the world's human population from a meagre 2.3 percent of land area and access to only 4 percent of the global water resources at its disposal. In addition to the large human population, the country also has to provide feed and fodder to 11 percent of the world's livestock population.
- Irrigated areas will increase in the coming years, while fresh water supplies will be diverted from agriculture to meet the increasing demand of domestic use and industry.

Inefficient irrigation methods:

- The efficiency of current irrigation methods is very low. Less than 40 percent of the applied water is actually used by the crops.
- The efficiency of surface irrigation systems, the dominant mode of irrigation in India, 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.
- More efficient methods like micro irrigation methods have low adoption in India. As of 2017, the area covered under micro-irrigation in India is about 8.7 MH, accounting for only about 13 percent of the potential area. Also there is high regional variability. Maharashtra, Andhra Pradesh, Telangana, Karnataka and Gujarat together account for about 85 percent of the total drip-irrigated area.
- Currently India has one of the largest net irrigated areas in the world but still the productivity of irrigated areas at the national level is only around 3 tonnes per hectare.

Threat posed by Climate change:

- Climate change with its attendant impacts is adversely affecting the agricultural production system.
- Climate change has led to dramatic changes and uncertain water resources, more so in a country like India which is dependent on rain fed agriculture.

<u>**Steps to be taken:**</u>

- A critical aspect of sustainable water management in water deficit areas would be to minimize water use or in other words to increase Water Use Efficiency (WUE).
    - This would involve choosing appropriate irrigation methods that minimize loss of water by evaporation from the soil or percolation of water beyond the depth of the root zone. There is also the need to minimize losses of water from storage or delivery systems.
    - Better agronomic practices should be encouraged and incentivized through appropriate policy measures.
- Need to choose crops using minimal water.
- Governments need to provide support and encouragement to farmers to move from their traditional high-water demand cropping pattern and irrigation practices to modern, reduced demand systems and technologies.
- There is the need to introduce policies aiming to increase water efficiency. This could involve measures such as adequate pricing of the scarce resource to ensure more efficient use of it.

<u>**Efficient Water Management Practices:**</u>

- Some of the technologies and practices focusing on enhancing water use efficiency include the following:

Laser Land Levelling:

- Proper land leveling helps increase the water application efficiency which leads to higher yields as well as rise in water use efficiency. It also has a direct impact on the nutrient use efficiency.

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 minimizing loss to deep percolation or runoff. This requires good knowledge of the crops' water requirements and of the soil water characteristics.
- This optimizes agricultural production with water conservation.
- With appropriate irrigation scheduling deep percolation and transportation of fertilizers 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.

Irrigation methods:

- 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 also important to employ the correct method of water application to minimize 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.

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, thereby reducing the pressure on groundwater sources with reduced GHG emissions. Promotion of micro-irrigation is critical to enhance water- use efficiency.
- Micro-irrigation mainly includes drip irrigation and sprinkler system water application.

Sprinkler Irrigation:

- 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 pressurized water. Conventional sprinkler systems spray the water into the air, losing considerable amounts to evaporation.

Drip Irrigation:

- Drip method of irrigation gives many advantages over the gravity surface irrigation methods in terms of water savings and yields. Drip irrigation systems have high (90 percent) water application efficiency and have been proved as one of the best ways to increase water productivity.
- 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 fertilizer-use efficiency, reduction in weed growth, less labour requirement and less electric power consumption, cost of cultivation especially in inputs like fertilizers, labour, tilling and weeding.
- It also allows fertigation, which is the application of fertilizers through the irrigation system. The soluble fertilizers at concentrations required by crops are applied through the irrigation system to the wetted volume of the soil.

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 the soil all directions. The potential advantages of SDI are:

  - Enhanced fertilizer efficiency
  - Uniform and highly efficient water application
  - Elimination of surface infiltration problems and evaporation losses
  - Flexibility in providing frequent and light irrigations,
  - Reduced problems of disease and weeds,
  - Lower pressure required for operation.
- The main disadvantages are the high cost of initial installation and the increased possibility for clogging, especially when poor quality water is used.

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. In such scenarios, 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. Thus, at non-sensitive growth stages irrigation is withheld which is called deficit irrigation.

Regulated Deficit Irrigation:

- Regulated Deficit Irrigation (RDI) is an optimizing strategy under which crops are allowed to sustain some degree of water deficit and yield reduction. 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).
- 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.

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. Improvement of WUE results from partial stomatal closure and reducing evapotranspiration during drying period.

Agronomic Practices:

- Agronomic practices, such as soil management, fertilizer application, and disease and pest control can apart from increasing crop productivity also help improve WUE.
- Many 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) help increase WUE.

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, apart from being effective in controlling erosion, is also a technique that helps increase better use of the rain water, especially in rain fed areas.

Conservation Tillage (CT):

- CT includes zero tillage and retention of crop residuals on the soil surface at planting. Crop residues act 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 an 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.

Chapter 2: Smart Agriculture

- Though India has demonstrated a big transformation in the agriculture sector in the second half of the 20th century with the 'Green Revolution', now there is the need to go for a 'technology revolution' to accelerate further growth in the agriculture sector.
- The challenges posed by climate change, exponential population growth and food security concerns have driven the agricultural sector to seek more innovative approaches to improve production, productivity and quality.
- There is the need to adopt the next version of technology innovations to garner the benefits offered by smart agriculture.

Smart Agriculture:

- Smart agriculture is the new agricultural production mode and ecosystem which is based on digital agriculture and precision agriculture. Smart agriculture envisages a data-driven, intelligent, agile and autonomously operating system.
    - Digital agriculture digitizes the planning, process and result of agricultural production, through the use of technologies like Big Data, Artificial Intelligence, Cloud Computing and Blockchain.
    - Precision agriculture uses information technology to achieve precision management, such as drone, robot and intelligent irrigation.

Significance:

- Smart agriculture can help solve many of the present-day problems being faced by the agricultural sector.
- Smart agriculture has the potential to double the food production in 40 years with lesser environmental impact. Smart agriculture can reduce the losses and wastage by 50 percent.
- Smart agriculture entails improving water-use efficiency or enhancing agricultural water productivity which would be critical given the growing water scarcity.
    - Presently, irrigation water-use accounts for 80 percent of the available water. It is estimated that irrigation requirements have to be lowered to the level of 68 percent of the total demand by 2050 to ensure availability of water for other purposes.
    - 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.
    - Higher water usage also has adverse consequences on crop yields and soil health.

Initiatives taken by the government:

- The Union government has 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 make pre-informed decisions regarding better management of water, soil and crop.
- In a bid to push innovative technologies in the 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. This move will help provide an impetus to the adoption of technology in the agricultural sector.

Successful examples:

Agribot:

- Spraying of pesticides with limited amounts of water is one of the great features of the Agribot drone. If pesticide spraying is made mandatory by drone, about 1.5 lakh crore litres of water can be saved in India.
- Agribot drones are also being used to control grasshoppers and can also be used to eliminate locusts.
- By spraying pesticides with drones, farmers stay away from chemicals and they do not have any side effects on their health

Microsoft app:

- 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 maximizing the yield. Despite meagre rainfall, farmers that used the app boosted their yields by 30 percent.

Technologies:

- There are a number of technologies and innovations that are enabling production technology of smart agriculture.

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):

- It is the science of instilling intelligence in machines so that they are capable of doing tasks that traditionally required the human mind. AI combines automation, robotics, and computer vision.
- Integration of AI and IoT devices can help improve 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:

- Blockchain technology can help create a more transparent, authentic, and trustworthy digital record of the journey that food and other physical products take across the supply chain.

- This information not only provides the consumer with transparency, but also helps the producers by making available a cost-effective supply chain analysis to optimize profits.

Robotics:

- 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:

- 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):

- AIoT is a combination of AI and IoT. 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.
- 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.

<u>Smart Irrigation:</u>

- 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. India records only 38 percent water- use efficiency in the field of agriculture and much needs to be done to improve it. Smart irrigation can help in this direction.
- Important features of smart irrigation systems:
  - The evapotranspiration parameters of plants are considered to optimize the irrigation cycle.
  - The use of soil moisture content and temperature sensors are widely prevalent in scheduling irrigation. There are 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.
  - Drones equipped with hyper spectral, multispectral, or thermal sensors are able to identify areas that require changes in irrigation.
  - Sensors are also able to calculate plant's vegetation index and indicator of health through AI, by measuring the crop's heat signature
  - Smart irrigation systems are equipped with self-governing capabilities that result in more precise watering schedules that reflect the actual conditions of the grow site.

Way forward:

- Apart from the development of new technologies, there is a need to develop infrastructure in our agricultural institutions to have scientific understanding for such technologies so that the farmers can be trained to use such technologies and equipment in the field.

Chapter 3: Water Conservation - Minimizing Waste

Water scarcity in India:

- 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 up to 1140 m^3/ year 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 an eventual six percent loss in the country's GDP. Water crisis is one of the biggest challenges facing India today.
- In seven out of India's 10 most populous cities, the depth to groundwater has increased significantly over the last two decades. There has been a reduction in groundwater levels in India by 61 percent between 2007 and 2017.
    - 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. 50 percent of urban water requirement and 85 percent of rural domestic water needs are fulfilled by groundwater.

Causative factors:

- Rising population, rapid urbanization, industrial growth and increasing water pollution has led to the Water scarcity. Demand for water from various sectors viz. irrigation, drinking water, industry, energy and others is expected to rise.

Steps to be taken:

- Water conservation, minimizing wastage and ensuring equitable distribution would offer solutions to India's water scarcity.

Governmental measures:

- New Jal Shakti Ministry has been formed by merging the Ministry of Water Resources, River Development and Ganga Rejuvenation and the Ministry of Drinking Water and Sanitation. This will allow faster decision-making on all subjects related to water.
- Various schemes with the multipurpose aim of conserving water, minimizing its wastage and ensuring equitable distribution have been started by the government.

Jal Shakti Abhiyaan:

- Jal Shakti Abhiyaan (JSA) is a campaign for water conservation and water security in India.
- 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.
- The scheme involves 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.

Pradhan Mantri Krishi Sinchayee Yojana:

- The scheme has dual 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 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.

Jal Jeevan Mission:

- This scheme envisages providing drinking water supply in rural areas in adequate quantities 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 by 2024 in adequate quantity of prescribed quality
    - Retrofitting of completed and ongoing schemes to provide FHTCs at minimum service level of 55 lpcd.

Chapter 4: Solution to Groundwater Crisis

Ground Water Crisis in India:

- Water tables across India have been deteriorating rapidly both qualitative as well as quantitative.
- It has been reported that in many parts of the country the water table is declining at the rate of 1-2 m/year.
- 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.

Note:

- 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.
- In India the per capita annual water availability has declined to 1508 cubic meter in 2014 from 5177 cubic meter in 1951. 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 meters, then India could be declared as a water-stressed country.

Anatomy of the Problem:

Irrigational needs:

- 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 groundwater withdrawn in a year.

Selection of crops:

- India has a troubling record of rationalizing crop selection on the basis of availability of water which is also facilitating the falling groundwater levels.
  - Despite rice and sugarcane being water intensive crops, their production continues in even water starved regions like Marathwada. 60 percent of total water consumed in agriculture is used by only these two crops. Export also plays its role in it as India is one of the biggest exporters of rice and sugar. India may be considered as exporting billions of litres of groundwater annually.

Wrong policy incentives:

- 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 added to the problem.
- This has led to major challenges for Punjab, which has reported falling groundwater levels and also 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.

Concerns:

- According to the maiden Composite Water Management Index (CWMI) report released by the NITI Aayog in 2018, 21 major cities (Delhi, Bengaluru, Chennai, Hyderabad and others) are moving towards zero groundwater levels by 2020, affecting access for 100 million people.
- Almost 12 per cent of India's population is already living the 'Day Zero' scenario, due to excessive groundwater pumping.
- 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.

Way forward:

- Despite several schemes, it is very clear that the government's capability to address the problem is limited as the actual users of groundwater are common people. Farmers need to be made aware and trained about conservation of water.
- The government can play a facilitative role in the following ways. One, by extending policy incentives to stop the misuse of groundwater and two, by unleashing a movement on the model of 'Swachh Bharat Abhiyan' to create awareness among people against wasting water. There is the need for a perfect combination of government's and people's efforts.

Crop planning:

- The crop planning should be based on local climatic conditions, water availability and overall demand-supply situation. The government should plan its incentives in such ways that farmers will adopt those recommended crops.

Efficient irrigation:

- There is the need to increase the area under micro-irrigation from the current level of nine million hectares.

Increasing awareness:

- The farmers should be made aware of how flood irrigation results in wastage of water and energy as well as reduce the efficiency of fertilizers.
- Other than to use the available water judiciously, the farmers also need to be made aware and trained about

conservation of water.

Chapter 5: Participatory Irrigation Management

Background:

Irrigation statistics:

- 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.
- 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 food grain production.

Concerns:

- The problems in irrigation sector in India include low irrigation efficiency (30–35 percent), deteriorating physical structures, inadequate maintenance, low cost recovery, under-utilization (74 percent) of created potential, uncontrolled water delivery, tail-end water deprivation, seepage loss, siltation, water logging, and soil salinity.
- Inequitable and unpredictable water supply among the farmers over space and time leads to the injudicious use of water in the irrigation commands and increase in inequity within the same unit of command area.
- 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.

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.

Legal Framework of PIM:

- 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.
- 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.
- In India, 16 states have either enacted exclusive legislation or amended their Irrigation Acts for involvement of farmers in irrigation management. The states, which are yet to do the enactment, follow various approaches for implementation of PIM.
- 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 utilization of irrigation water, generation of resources from donor agencies other than the water charges/maintenance grant, resolving conflicts among stakeholders, etc.

Progress of PIM:

- 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.

Significance:

- Participation of beneficiaries facilitates the optimal upkeep of irrigation systems and effective utilization 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.
- PIM has resulted in an increase in irrigation intensity, cropping intensity and yield.
- PIM results in reduction of the burden of costs, staff requirements and technical or management problems faced by governments.
- 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.

Concerns:

- 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 areas that hampers the social support and accentuates rural inequity.

Conclusion:

- Water management is by nature beyond the work of individuals and thus collective effort by all farmers concerned is required for successful management of the irrigation resources.

Chapter 6: Irrigation Projects

Introduction:

- Over dependence on rain fed agriculture has always been a challenge for the country's farm production. Substantial agricultural area remains dependent on monsoon, which has grown erratic in recent years due to climate change, causing distress to farmers.
- 51.2 percent of the 140 million hectares of agricultural land in India is rain fed.
- As the livelihood of a major proportion of India's population depends on agriculture and allied activities, it is important to minimize the uncertainty owing to dependence of agriculture on rains.
- Investment in the irrigation sector is critical as it directly impacts agriculture and the rural economy in India.

Government initiatives:

- The central government has given a strong push on increasing irrigation coverage and made major financial outlays for creating new irrigation infrastructure in the country. Ongoing irrigation projects under the Accelerated Irrigation Benefits Programme (AIBP) under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) have been expedited.
- Projects were to be completed along with their Command Area Development and Water Management (CADWM) works.
- Central government supplements efforts of state governments in creating irrigation facilities by providing

technical and financial assistance under AIBP. The government had also 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.

Concerns:

Delay in project completion:

- There has been a delay in completion of irrigation projects. The latest figures shared by the Central Water Commission (CWC) under the Ministry of Water Resources (also called Jal Shakti Ministry), show that out of the identified 106 projects only 40 projects have been fully completed till now, while the remaining are in the pipeline.
    - Many of the projects that were fast-tracked for completion have 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.

Cost over runs:

- 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.

Low of command area development:

- Farmers are yet to get the benefit from the completed projects under the AIBP as command area development has not started in many projects.
    - The last mile connectivity of the 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 a water association.
    - Before the launch of the CADWM, irrigation was provided after completion of a project without waiting for development of the command area, but it failed in ensuring water use efficiency and water to the 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. 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.

Impact on farmers:

- In the absence of command area development, farmers in the tail- end on both 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.
- The increasing gap between irrigation potential created, through major and minor projects, and the actual usage is affecting the country's crop yields.

Task force recommendations:

- The task force headed by Economic Affairs Secretary on National Infrastructure Pipeline (NIP) for 2020-2025 has suggested an investment of Rs 8,94,473 crore to ramp up irrigation network in the next five years.
- While pitching for greater participation of private players to bring in efficiencies in the 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 emphasized the need to increase micro- irrigation coverage. It also called for according priority status to micro-irrigation projects to ensure greater flow of bank credit to farmers to buy equipment.
- The task force has recommended a better method for pricing water for irrigation which must move from area-based fees to quantity-based fee. It also suggested putting in place a robust IT and automated system to track efficient use of water resources.