Creating an ecosystem for increasing water-use efficiency in agriculture

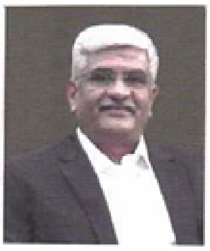
pwc

FICCI

गजेन्द्र सिंह शेखावत
Gajendra Singh Shekhawat

जल शक्ति मंत्री
भारत सरकार
Minister for Jal Shakti
Government of India

सत्यमेव जयते



स्वच्छ भारत

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MESSAGE

Over the years, several new challenges have emerged before the agriculture sector. With fragmentation of agricultural land holdings and depletion of water resources, the adoption of a resource efficient technologies has become critical.

Around 89% of groundwater extracted is used for irrigation. Enhancing water use efficiency at farm level is one of the priority areas of Government of India. As Government, we truly understand the importance of encouraging farmers to improve water use efficiency in their fields. Several policies are formulated with vision of providing better irrigation system, extending coverage of irrigation and providing financial incentives to farmers for optimal water usage.

In the last few years, there has been profound increase in the number of Agtech companies and Start-ups working across the entire agriculture value chain in India. Emerging technologies have the capabilities to ensure efficiency and availability of water in agriculture. However, scaling the adoption of such technologies require a concerted effort. This will require all relevant stakeholders to step up their efforts.

I congratulate FICCI and PwC Team to come up with a knowledge Report that enumerates several important factors and recommendations for optimising the use of water in agricultural sector. I appreciate the team for supplementing the efforts of Government to increase water productivity in agriculture.

जल शक्ति अभियान

(Gajendra Singh Shekhawat)

Office : 210, Shram Shakti Bhawan, Rafi Marg, New Delhi - 110 001
Tel. : No. (011) 23711780, 23714663, 23714200, Fax : (011) 23710804
E-mail : minister-jalshakti@gov.in

त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

MESSAGE

I am happy to know that FICCI team is working on water use in agriculture and preparing a focus report on Sustainable and innovative approaches for water management in agriculture.

It is necessary to formulate effective strategies for conservation of soil and water resource to achieve sustainable agricultural production in future. The farmers should be encouraged to adopt conservative approach to water consumption. A paradigm shift is required in mindset to maximise productivity per unit of land area to optimise productivity per unit of water consumed. Rainfed areas account for 60% of India's net cultivated land. The potential of rainfed areas needs to be tapped through sustainable water management techniques. Climate change has increased risk and unpredictability for farmers, especially small and marginal categories. It is predicted that climate change impact will also lead to significant increase in water erosion. Therefore, development of climate resilient resource conservation techniques cannot be neglected. Solutions such as watershed planning and management, rainwater harvesting and energy-efficient micro irrigation systems, artificial groundwater recharge measures, precision technologies need to be broad based. Concepts like Direct Seeded Paddy (DSP) cultivation is also picking pace with the development of some improved varieties. Ground water, which is the major source of irrigation at present, is rapidly declining. Smart and precise irrigation technologies should be an important component of climate smart sustainable agriculture approach. Therefore, a roadmap for efficient utilisation and conservation is certainly the need of the hour.

I congratulate FICCI for giving attention to issue of water in agriculture sector and coming up with Knowledge Report. I wish all the success in this endeavour.

(T. Mohapatra)

Date: 17th March 2021
Place: New Delhi-110 001

T R Kesavan

Chairman, FICCI National Agriculture Committee &
Group President, TAFE Ltd

India needs to attain sustainability in agriculture by incorporating resource use efficiency as a culture in small holder farming. To achieve this end, a right combination of planning and implementation is required. Farming which is responsive to climate change and use resource use efficient technologies should be the future of Indian agriculture. Government of India is already focusing on such strategies. to accomplish SDGs and making positive efforts to ensure that farming is done in sustainable and water efficient manner.

Agriculture is the biggest user of water. Water scarcity and depletion of water table in some parts of the country has put the spotlight on importance of water saving technology. The rate of groundwater extraction in India is so severe that its water table is depleting at a rate of 0.3 m per year. Rice, wheat, cotton and sugarcane together consume up to 70% of all the water that is used in agriculture. Its time we need to shift our focus towards measuring productivity per litre of water being used in agriculture.

To achieve Prime Minister's vision of "har khet ko pani" the country should focus on better demand management by adapting smart and climate-resilient agricultural practices for water-deficient and water-abundant regions. An integrated agriculture water policy at the national level is imperative for ensuring sustainable water use and management in agriculture. To regulate and control water usage in country, policy makers should be able to make informed decisions. This requires availability of ground level information to know the quantum of groundwater withdrawn and being recharged, annually. Therefore, there is a need to integrate data from all the water withdrawal points by fixing water meters and integrating them with a unified software solution. This will enable robust policy framework.

To remain competitive, farmers need rapid access to technology. Advanced irrigation solutions that can help farmers monitor their crops and help in irrigation planning will be required in long run.

FICCI National Agriculture Committee accord high priority to sustainable and innovative approaches for water use in Agriculture. This report will certainly improve understanding on how to build water efficient agriculture value chain, particularly in the context of future demand for water in agriculture sector.

Kaushal Jaiswal

Managing Director
Rivulis Irrigation India Pvt Ltd

Agriculture is the main stay of India's economy. Effective extension services that assist farmers in adopting new, impactful technologies is very important. Encouraging farmers to use smart solutions for efficient farming is essential in long run. Water is a critical input for agricultural production. Therefore, incentivising farmers to improve water use is a matter of prime consideration. Technologies such as micro-irrigation systems – can improve fertiliser and power use efficiency by 28% and 30% respectively, along with reduction in labour cost and enhanced productivity. At the same time devising easier financing options for small and marginal farmers who face the challenge of having indequate financing for extending their share for MI (Micro irrigation) installation is crucial. This calls for more awareness among lending institutes as well as beneficiaries.

The Government of India has been proactive about water management in Agriculture. Pradhan Mantri Krishi Sinchayee Yojana was launched in July 2015 in this regard. With view to provide impetus to Micro irrigation systems, a Micro irrigation Fund was created with NABARD. Government and industry need to come together for effective implementation of such programs. However, with multiple developmental schemes available in the irrigation sector, run by different government departments, it is necessary to bring in coherence and efficiency. For example, PMKSY – (Per Drop More Crop) scheme can be dovetailed with PMKSY – 'Har Khet Ko Paani'. These two schemes can be operated by the same nodal agency in the state. Such planning will lead to more impactful implementation of Government vision of per drop more crop.

Detail analysis of facts in the Report will certainly provide important inputs for policy interventions in the sector. I congratulate FICCI and PwC team for putting in significant efforts in brainstorming with various stakeholders and doing a meticulous homework in bringing out this Report.

Dr. Ajai Kumar

Head of Government and Industry Affairs, South Asia
Corteva Agriscience

Enhancing productivity level of crops, while conserving natural resource such as water, is crucial for food as well as environmental security. Efficient use of water should be an integral part of sustainable development of global Agriculture.

Rice is an important crop of India. India has the largest acreage under rice in the world. The country is the 2nd largest producer and the largest exporter of rice. Transplanting is the predominant practice in rice cultivation which relies heavily on groundwater to produce a successful crop. It is a well-known fact that groundwater is depleting rapidly, and availability of water will be difficult over a longer period unless interventions are made to reduce the usage of water in rice cultivation. Going forward, the practice of transplanting rice will be a challenge for the sustainability of water resources.

If sustainable use of water is to be ensured in production of Rice, it is important to analyse how productivity can be enhanced with new age solutions that use lesser amounts of irrigation water. Technologies such as Direct seeded Rice can be game changer. Scaling the adoption of such technologies will certainly require meticulous planning to make available appropriate seeds, herbicides and machinery along with cultural change in way the Rice is grown. Its high time that we start focusing on such technologies as stepping stone to sustainable agriculture.

Dilip Chenoy

Secretary General
FICCI

Water is one of the most indispensable resource on earth and is an absolute necessity for agriculture and food production. Agriculture, alone, needs 70 per cent of freshwater available globally. However, due to rapid growth of population coupled with inefficient use of water resources, almost two-third of the total world population face acute water shortage for at least one month in a year. This shortage is more visible in countries like India and China.

The extraction rate of freshwater is an important indicator of water consumption and scarcity. In India, agriculture alone extracts nearly 90 per cent of freshwater available for irrigation. It is important to note that nationally groundwater irrigation consumes around 62 per cent of all water usage[1]. With increasing population and growing food demand, the situation may aggravate further in the near future.

Given the circumstances and in the absence of any considerable initiative towards sustainable water use management, almost five billion people around the world may face water shortage for basic needs by 2050. In its Global Risks Report, 2020, World Economic Forum (WEF), quoted water crisis as the fifth-biggest risk in terms of impact on the global society[2].

Given this alarming situation and ever-increasing importance of water, Government of India has proactively introduced sustainable water management and has also created Ministry of Jal Shakti to carry out specific initiatives. The central and state governments initiatives towards devising new schemes to address this issue is also noteworthy. However, for these schemes to be effective there is a need to promote new technologies for use of water in agriculture. Further, adoption of innovative technologies by small and marginal farmers needs to increase substantially.

This knowledge report provides a deep insight into the present water crisis and looks into effective and efficient use of the scarce water resources for the agriculture sector. I am confident this report would be of great interest to the policy makers, industry, academia and to the agencies working at the grassroot level.

1 National Compilation on Dynamic Groundwater Resources in India, 2019, Central Ground Water Board

2 The Global Risks Report, 2020, World Economic Forum

Ashok Varma

Partner and Leader, Social Sector Advisory
PwC India

The Indian agriculture sector is significantly dependent on freshwater extraction, with groundwater accounting for 62% of all the water used for irrigation in the country.[I] As per the Global Risks Report published by the World Economic Forum (WEF), India's groundwater is depleting at an alarming rate of 0.3 metre per year.[II]

The country's fast-paced economic and demographic growth is leading to higher water demands across all sectors. By 2050, the demand for irrigation water is likely to increase by 45%. Water consumption by industries is also expected to more than double from the current share by 2050, and the domestic water requirement is expected to witness the largest jump of about 250% from the current consumption levels by 2050.[III]

Rice covers almost 29% of the total irrigated crop area and nearly half of the irrigated cereal area in the world. India is amongst the world's leading producers of rice and uses huge quantities of groundwater for its irrigation. Despite being confronted with severe water stress, most irrigated areas in states are usually used for rice and sugarcane cultivation which consumes a lot of freshwater. Presently, India is one of the lowest water-use efficient countries (less than 10%) in the world.

The growing export of agricultural products, especially the ones that utilise more water resources, is akin to the export of water, and there is a need to review this virtual water trade in the medium to long term.

Both the Central Government and state governments have taken initiatives and launched schemes to address the challenges of water-use efficiency in agriculture. Despite these efforts, the adoption of practices and technology for water-use efficiency is low due to several operational challenges. Ensuring accountability and transparency and creating awareness are important to meet time-bound targets pertaining to sustainable water use in agriculture.

The current situation demands a more refined and integrated approach in the form of collaboration, discussion and formulation of policies that are aligned with solutions for the adoption of the latest resilient technologies among small and marginal farmers. This will help in making India a water-efficient and water-secure country.

This report proposes solutions for efficiently implementing the existing schemes and measures that would assist in the greater adoption of sustainable water-use management practices amongst small and marginal famers, and other stakeholders in the agriculture sector.

I National Compilation on Dynamic Groundwater Resources in India, 2019, Central Ground Water Board

II https://www.weforum.org/reports/the-global-risks-report-2020

III Water and related statistics, Central Water Commission, 2015

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1. Executive summary

Water is a necessity for the survival of life on earth. With the ever-growing global population, food demand and industrialisation, there is a strong need to study the availability of water and effectively manage its consumption across the world to ensure sustainability. Nearly two-thirds of the world's population faces water shortages annually for a period of at least one month. More than five billion people worldwide could face a shortage of water for basic needs by 2050.[1] if sustainable water management is not implemented.

India is the second-most populous country in the world with 17% of the global population but only 2.4% of land and 4% of water resources.[2] Over 70% of the country's population is engaged in agricultural practices, which further strains its water resources. Approximately 90% of freshwater extracted in India is used for agricultural purposes, with groundwater contributing to 62% of all the water used for irrigation in the country.[3] This highlights the importance of efficient utilisation of available water resources in the country. The extraction rate of renewable internal freshwater is an important indicator of water scarcity in any country. Per capita renewable resources depend on the total quantity of renewable flows and the size of a country's population.

On the one hand, the availability of adequate irrigation facilities along with other inputs contributes towards better agricultural yield while on the other hand, too much of the same leads to significant declines. Water is often viewed as a resource that is free of cost compared to other agricultural inputs and no restriction on its supply leads to overexploitation and excessive irrigation. Depleting water resources further impacted by the adverse effects of climate change are major areas of concern for India. It is necessary to take a close look at the need for enhancing water-use efficiency (WUE) in agriculture and virtual water trade through India's exports to ensure sustainability of this resource.

The Government of India (GoI) has been proactive towards water management and launched multiple schemes to promote WUE in agriculture. Such initiatives have been renewed periodically as per the changing requirements at local, state and national levels. The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched in 2015 and serves as an output-driven umbrella programme with four components envisioning the increased irrigation potential. The scheme aims to enhance agricultural productivity by covering more area under irrigation and strengthening distribution networks in an integrated manner. The GoI has set a target of covering 100 lakh ha in five years under micro irrigation. The Ministry of Jal Shakti has been created to consolidate interrelated functions pertaining to water management. In addition to initiatives undertaken by the GoI, many states have recognised the challenges of rising water scarcity in their regions and taken adequate steps to address the same.

The key to ensuring sustainability in agricultural water management is approaching the varied aspects such as cropping systems, technology adoption, governance institutions and policy frameworks. Formation of partnership models with the use of modern technology is an important approach to demonstrate how water can be managed successfully for agricultural use. As the need for practising water-efficient agriculture grows, collaboration between stakeholders and formation of partnerships with community mobilisation are very important to integrate the efforts of water management and implement water efficiency effectively.

1 https://www.weforum.org/reports/the-global-risks-report-2020

2 https://www.oav.de/fileadmin/user_upload/5_Publikationen/5_Studien/170118_Study_Water_Agriculture_India.pdf

3 National Compilation on Dynamic Groundwater Resources in India, 2019, Central Ground Water Board

Cultivating smart crops instead of water-intensive crops strengthens the economy and reduces the uncertainty associated with the market vagaries and overuse of irrigation water. The looming water scarcity in India has already led to a paradigm shift towards growing crops that use less water. The adoption of modern and innovative technologies and methods is necessary for smartly using water in agriculture. Precision irrigation methods are solutions that have been developed for effective water use not only in water-scarce regions but also in regions where the availability of water is abundant. Adopting micro irrigation has increased the volume of crop production. Digital irrigation, variable rate technology (VRT) and GPS/ satellite imaging-based irrigation can contribute towards the irrigation of crop fields based on their moisture content and weather conditions. Other technological interventions such as nanotechnology-based irrigation, artificial intelligence (AI) and robotics help in controlling irrigation water, and identifying water pooling and irrigation needs based on locations and weather conditions.

Promoting the adoption of technology amongst the farmers towards achieving the 100 lakh ha target requires ample encouragement via programmes and incentives. The Government needs to promote technology via affordable and encouraging schemes, and mobilise farmers through rigorous extension programmes and training programmes, front-line demonstrations (FLDs) and exposure visits. They should also be made aware of the crucial role played by banks and financial institutions (FIs) in availing schemes for irrigation and sustainable water use. Converging with other existing schemes and creating a package of incentives may be a way to ensure adoption and ease access for beneficiaries. However, technology adoption by farmers needs support through adequate handholding, following up with user experiences and providing maintenance support with active participation from private players.

Formation of partnership models with the use of modern technology is an important approach to demonstrate how water can be managed successfully for agricultural usage. As the need for practising water-efficient agriculture grows, collaboration among key stakeholders with enhanced community participation would play an important role in its effective implementation. Thus, the key to ensuring sustainability in agricultural water management is bringing fine balance and adopting an integrated approach combining all key thematic areas such as cropping systems, technology adoption, community participation, governance institutions and structures, and overall enabling policy frameworks.

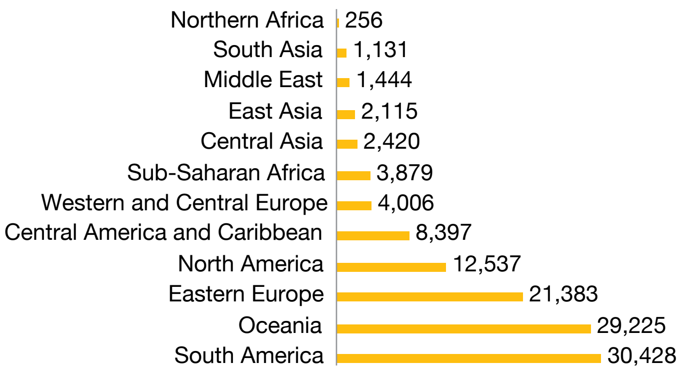
2. Issues related to water usage in agriculture

Water is vital for the survival of living beings and plays a crucial role in the economic development and general well-being of a country. Though three-fourths of the earth's surface is covered with water, the availability of freshwater for human consumption is under stress because of a variety of factors such as population explosion, growing food demand and industrialisation. The demand for water keeps increasing, thereby intensifying the stress on an already finite resource. The current and future status of water resources needs to be reviewed for sustainable water management.

2.1. Global water trends

More than 70% the earth's surface is covered with water. However, unlike oil, it circulates to form closed hydrologic cycles. Further, 97.5% of the water available on earth is saline and unsuitable for consumption. Out of the remaining 2.5% of freshwater, over 68% is locked up in ice and glaciers, permanent snow, soil moisture, etc.,[4] while the rest is available below the ground and in lakes and rivers, and is fit for human needs and consumption.[5] The Americas is the world's largest shareholder of freshwater deposits (45%), followed by Asia (27%) and Europe (15%).[6]

Renewable sources of water across the globe (in sq. mt.)



Source: The World Bank

2.2. The growing water crisis

The global population explosion has caused an international water crisis. Nearly two-thirds of the world's population faces water shortages per year for a period of at least one month and almost half of this population live in India and China.[7] If water is not managed sustainably, more than five billion people worldwide could face inadequate access to water for basic needs by 2050. The World Economic Forum's (WEF) Global Risks Report 2020 cited water crisis as the fifth-biggest risk in terms of impact on the global society.[8]

4 The State of the World's Land and Water Resources for food and agriculture, Food and Agriculture Organization (FAO), 2001

5 Ibid.

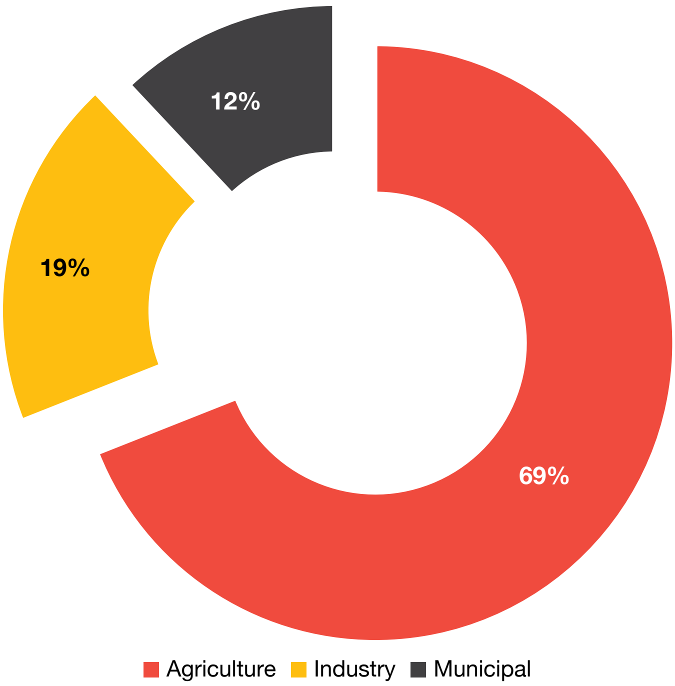
6 Ibid.

7 https://www.weforum.org/reports/the-global-risks-report-2020

8 Ibid.

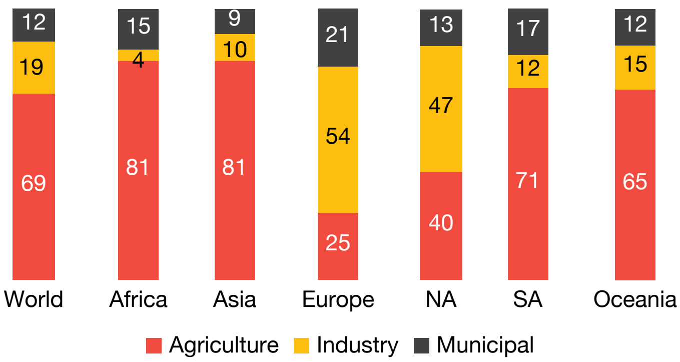
Water use worldwide has increased by nearly eight times over the past century. Population growth, economic development and changing consumption patterns coupled with the consequences of climate change will further increase the stress on water resources. At the global level, the water withdrawal ratios are 69%, 12% and 19% for agricultural, municipal and industrial usage respectively.[9]

Global water withdrawals



Source: Food and Agriculture Organization of the United Nations (FAO)

Water withdrawals: Continent-wise comparison

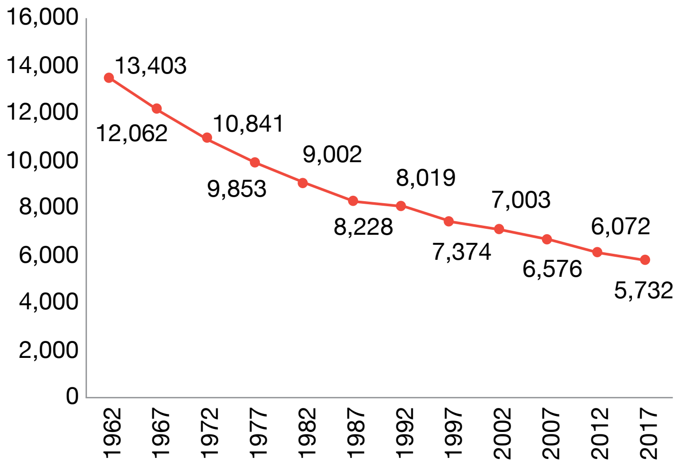


Source: FAO

2.2.1. A decreasing renewable resource

The rate of freshwater extraction should always be less than the rate of replenishment to maintain consistency in the level of water resources. The extraction rate of renewable internal freshwater is an important indicator of water scarcity. Per capita renewable resources of a country depend on the total quantity of renewable flows and the size of the population. If renewable resources decline – as can happen frequently in countries with large annual variability in rainfall – then per capita renewable withdrawals will also fall. Similarly, if the volume of total renewable sources remains constant, per capita levels can fall as a country's population grows. The figure below depicts that per capita renewable resources are declining worldwide because of rainfall variability and population increase. The global population has increased by 42% over the last fifty years and per capita internal freshwater resources have gown down by approximately 48% during the same period.[10]

Renewable per capita internal freshwater resources (in m3)



Source: FAO

2.2.2. Global efforts towards building sustainability and climate resilience

In 2015, all the United Nations (UN) member countries adopted the Sustainable Development Goals (SDGs). The SDGs look to protect the planet and improve livelihoods worldwide by 2030. Goal 6 (Water and Sanitation) focuses on "ensuring availability and sustainable management of water and sanitation for all," and also helps in attaining the remaining 16 SDGs.[11] Awareness about this particular goal is essential for achieving global water security.

9 http://www.fao.org/nr/water/aquastat/data/query/index.html

10 http://www.fao.org/nr/water/aquastat/main/index.stm

11 Sustainable Development Goals Knowledge Platform and PwC analysis

The UN General Assembly (UNGA) has also been proactive about global water security and adopted the resolution 'International Decade (2018–2028) for Action – Water for Sustainable Development' to focus on enhancing the sustainability of water for the decade ending in 2028. The decade will focus on the sustainable development and integrated management of water resources for achieving social, economic and environmental objectives. It will look forward to the implementation and promotion of related programmes and projects, as well as on the furtherance of cooperation and partnership at all levels in order to help achieve internationally agreed water-related goals and targets, including those in the 2030 Agenda for Sustainable Development.[12]

UN member countries signed the United Nations Framework Convention on Climate Change (UNFCCC) treaty in Paris in 2016 to address the concerns of climate change. Under this agreement, the participating nations have sworn to take appropriate steps to hold the rise in global average temperature well below 2°C by the end of this century and adapt to the impacts of climate change by taking climate-resilient measures.[13]

Countries, in concurrence to the decision taken during the Climate Change Conference, are required to share biennial updates on national greenhouse gas inventories and information on actions taken to address the same. India provides biennial updates on the fulfilment of the convention's obligations, including the support required and received.

2.3. Water-related issues specific to India

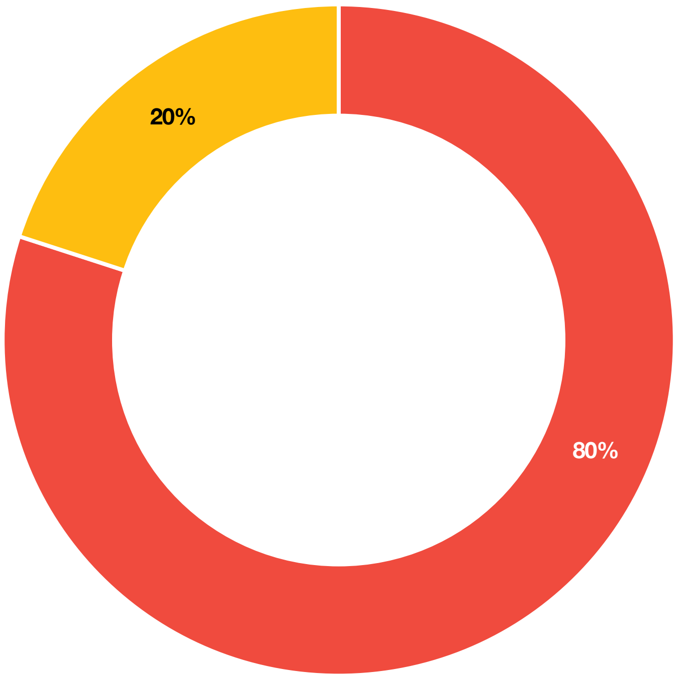
India is a vast country with multiple climatic zones. This factor profoundly influences the availability and utilisation of water resources. The country's rainfed area accounts for 52% of the total cropped area of 140 million ha.[14] It receives an annual precipitation of about 4,000 billion cubic metres (BCM) which creates an estimated average water potential of 1,869 BCM.[15] Despite this, the per capita availability of water is declining year on year and is estimated to reach 1,235 cubic metre by 2050.[16]

In terms of freshwater extraction, India is the leading country in the world and the agriculture sector accounts for approximately 90% of the country's freshwater extraction. Groundwater contributes to 62% of all the water used for irrigation in the country.[17] India's groundwater is depleting at a rate of 0.3 metre per year.[18] The country's fast-depleting freshwater resources will undoubtedly take a toll on the agriculture sector. The annual food demand in India is expected to increase by more than 250 million tonnes by 2050 as a result of the growing population which is expected to reach 1.66 billion by 2050 and increasing purchasing power (per capita income is estimated to increase by 5.5% per annum).[19] The per capita consumption of water-intensive crops such as sugar, fruits and vegetables is expected to rise (32%, 65% and 78% respectively), thereby increasing the water used for cultivating and irrigating them.[20]

2.4. Water availability in India

India accounts for around only 4% of the world's renewable water resources. The country's total average annual water resources stand at 1,999 BCM.[21] Out of this, only 58% can be used beneficially. Thus, the total utilisable water resources in the country, including surface water and groundwater, stand at 1,083 BCM. Topographical and other constraints allow only 690 BCM (37%) of the available surface water to be utilised. India's rechargeable annual groundwater potential has been assessed at around 432 BCM of which 393 BCM is extractable.[22] The country receives more than 70% of its annual rainfall within a period of four months while the remaining 25–30% is received in the remaining eight-month period with many rivers being seasonal in nature.[23]

National water usage



Source: Central Water Commission

12 https://wateractiondecade.org/wp-content/uploads/2018/03/UN-SG-Action-Plan_Water-Action-Decade-web.pdf

13 https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change 14 Rainfed Farming – A Compendium of Improved Technologies by ICAR

15 https://pib.gov.in/newsite/PrintRelease.aspx?relid=168727#:~:text=As%20per%20the%20National%20Commission,is%20available%20as%20natural%20runoff.

16 lhttps://www.thehindubusinessline.com/economy/agri-business/indias-per-capita-water-availability-to-decline-further-icar/

17 http://cgwb.gov.in/Annual-Reports/Final_Annual_Report_CGWB_2016-17_%2003.01.2019.pdf

18 http://social.niti.gov.in/uploads/sample/water_index_report2.pd

19 Ibid.

20 Ibid.

21 https://www.business-standard.com/article/pti-stories/india-s-average-annual-water-resources-potential-at-1-999-billion-cubic-metres-govt-119120500737_1.html

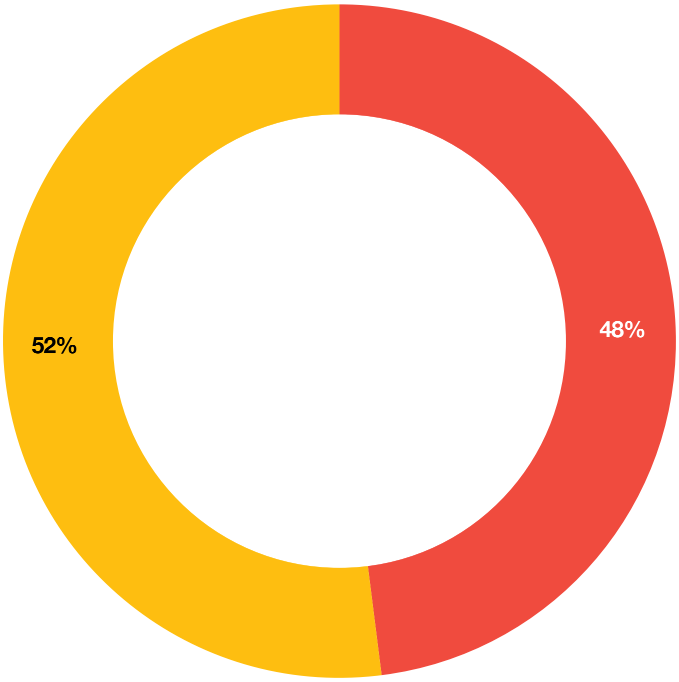
22 National Compilation on Dynamic Groundwater Resources in India, 2019, Central Ground Water Board

23 CWC (Central Water Commission). 2002. Water and related statistics. New Delhi: Water Planning and Projects Wing, Central Water Commission

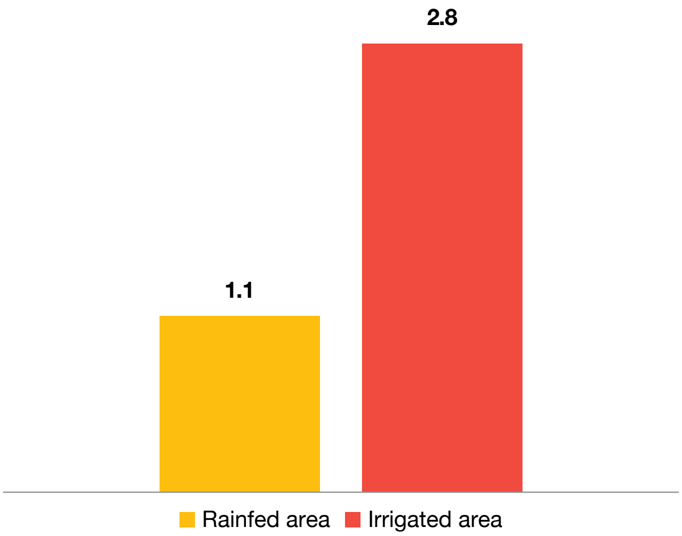
24 https://www.indiatoday.in/science/story/world-water-day-2019-water-crisis-india

As per Government data, 4% of India's groundwater assessment units are in a critical state and 10% are in a semi-critical state due to overexploitation and contamination. As per an assessment of groundwater resources carried out jointly by the Central Ground Water Board (CGWB) and the states in 2013, a decline of more than four metres was observed in the north-western, central and southern regions of the country, with the exception of West Bengal which is located in the eastern region. Haryana and Punjab have exploited around 94% of their groundwater resources, while Rajasthan, Gujarat, most of western Uttar Pradesh and the southern states are not far behind in terms of decreasing groundwater tables. The ever-increasing demands for agriculture, drinking water supply, industries, cultivation of water-thirsty crops, no or nominal electricity charges for groundwater extraction, lower rainfall experienced in arid and semi-arid areas are some of reasons why groundwater is overexploited in India.[24]

Share of irrigated and rainfed area

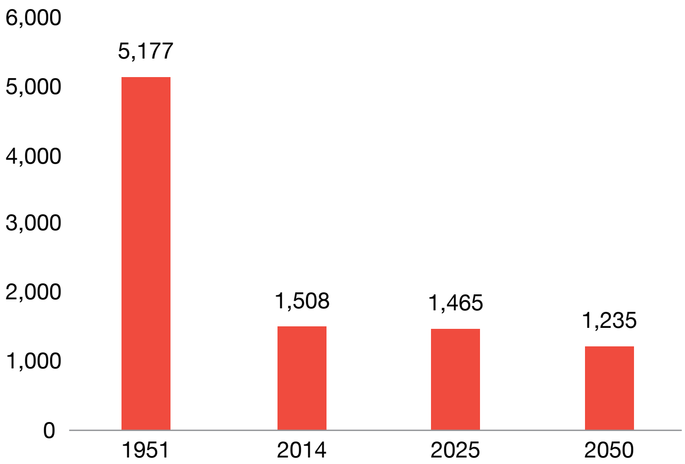


Mean agricultural productivity (in tonne per ha)



Source: Central Water Commission

Per capita annual water availability (in cubic cm)



Source: Central Water Commission

24 *https://www.indiatoday.in/science/story/world-water-day-2019-water-crisis-india*

2.4.1. Understanding India's water-use trend

Population plays a key determinant in India's water demand. The demand for water in the country is rising with the increasing population, changing lifestyles and expanding economic activities.

Understanding India's water demand for different sectors (in BCM)						
Sector	**2010**		**2025**		**2050**	
	Low	High	Low	High	Low	High
Agriculture	543	557	561	611	628	807
Domestic use	42	43	55	62	90	111
Industry	37	37	67	67	81	81
Energy	18	19	31	33	63	70
Others	54	54	70	70	111	111
Total	694	710	784	843	973	1,180

Source: Central Water Commission

Water usage in agriculture, domestic and industries stands at 78%, 6% and 5% respectively.[25] The country's fast-paced economic and demographic growth is resulting in higher water demand across all sectors. The demand for water in irrigation alone is expected to grow by 45% by 2050. This high demand for water in agriculture is also an opportunity to focus on efficiency improvements to increase irrigated areas as well as reduce overall water usage. The water consumption in industries is also expected to more than double from the current share by 2050. The domestic water requirement is expected to increase by about 250% from the current consumption levels. This would mostly be on account of an increased population, improved standards of living and the rising number of households with piped-water connections. It becomes more imperative to focus on sustainable management of water in sectors (such as agriculture) where demand and consumption are higher.

2.5. Agriculture and water usage in India

The agriculture sector is the biggest user of India's water reserves, and this high demand is also an opportunity to focus on efficiency improvements to increase the irrigated area as well as reduce overall water usage.

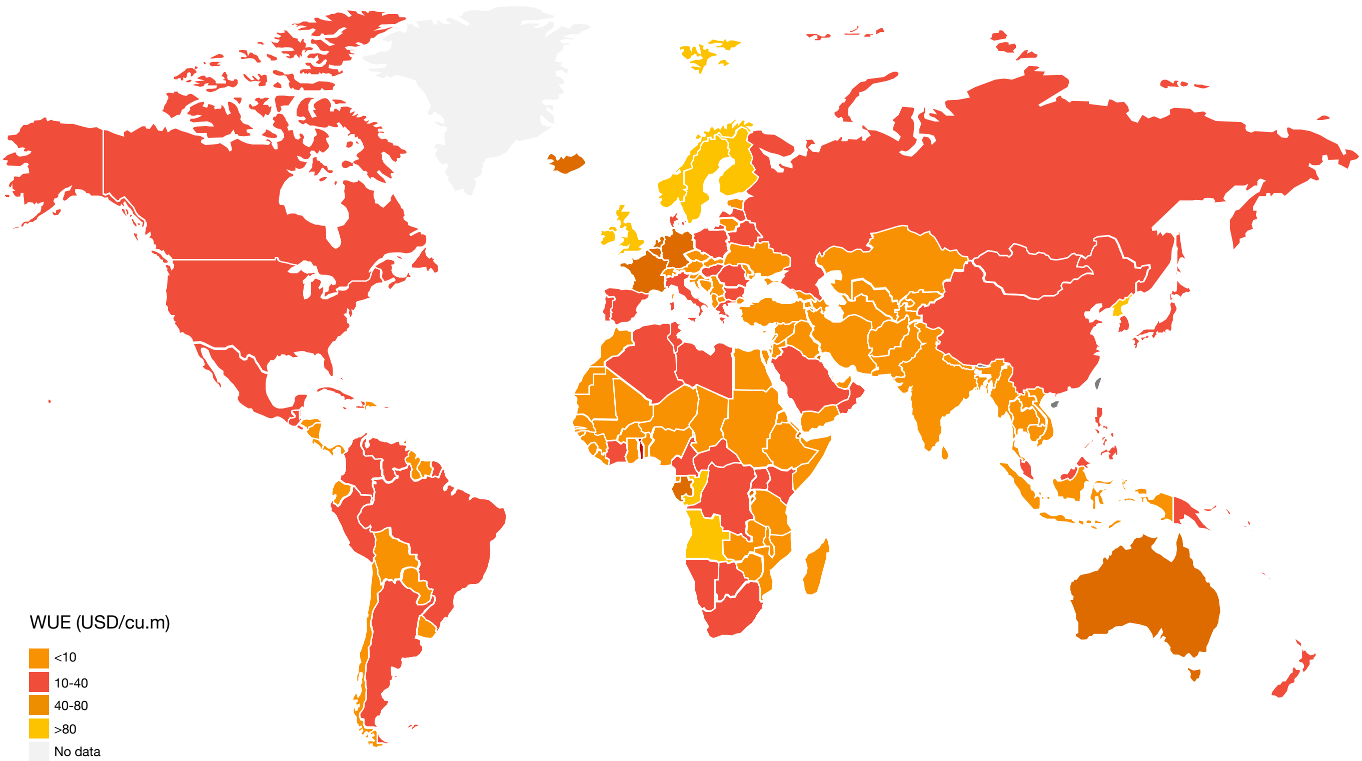
25 National Compilation on Dynamic Groundwater Resources in India, 2019, Central Ground Water Board, and PwC analysis

2.5.1. Water-use efficiency

In simple terms, water-use efficiency (WUE) in the agriculture sector refers to yield from per unit of water consumed. It can also be interpreted as financial returns against water-supply investments. The figure below depicts country-wise WUE.

India is one of the lowest water-use efficient countries in the world. This is highly concerning, considering the volume of water used for agriculture which is still the predominant source of livelihood for a majority of Indians.

Global WUE

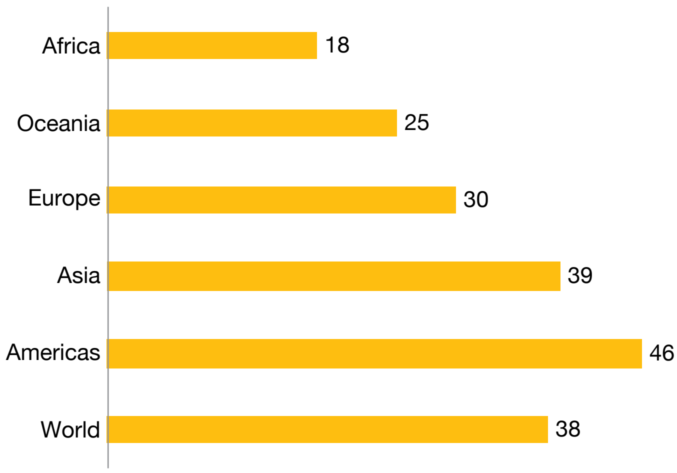


Source: UN Water

2.5.2. Irrigation scenario and scheme efficiency

As per the Food and Agriculture Organization (FAO), over 324 million ha of land worldwide was equipped for irrigation with groundwater in 2012.[26] 21% of the total cultivable land worldwide is currently under irrigation, out of which 70% is in Asia. China and India account for almost 42% of the world's total irrigated land.

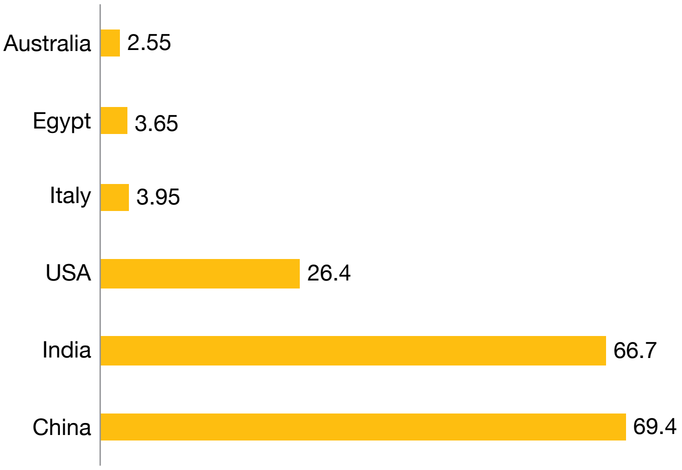
Percentage of area irrigated with groundwater



Source: FAO

26 http://www.fao.org/3/I9253EN/i9253en.pdf

Countries with the largest irrigation area (in million ha)



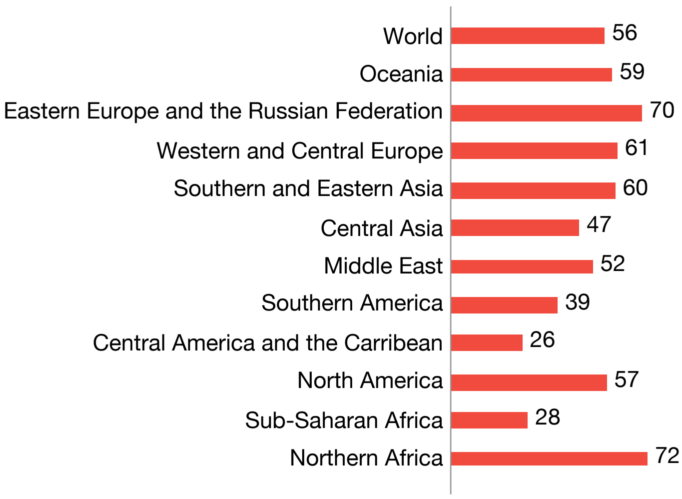
Source: FAO

About 40% of the crops in the world are grown only in 20% of the cultivated area. 78% of the world's irrigated crops are cultivated in Asia alone.[27] Rice is the largest irrigated crop in the world and accounts for almost 29% of the total irrigated crops and nearly half of the irrigated crop area in the world. India is amongst the leading producer of rice in the world which explains the large-scale withdrawal of groundwater for rice cultivation.

Irrigation efficiency is defined as the ratio between the actual amount of water required for irrigation and the amount of water provided to crops through irrigation. As per an FAO analysis, the actual irrigation requirement in the world is 1,500 cubic kilometres (cu. km) of water per year but the actual volume consumed is 2,700 cu. km. This means that 56% extra water is consumed for irrigation. The adjacent figure explains the continent-wise irrigation-scheme efficiency.[28]

Most of the economies in the world have a high irrigation-scheme efficiency.

Continent-wise irrigation scheme efficiency (in %)



Source: FAO

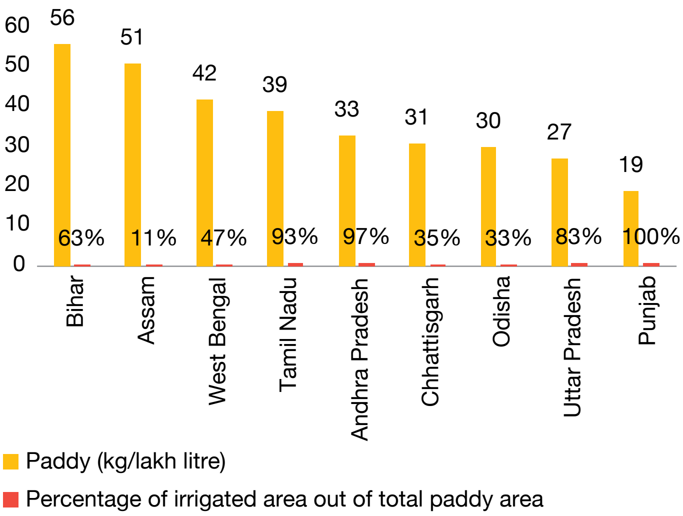
27 FAO and PwC analysis

28 http://www.fao.org/3/I9253EN/i9253en.pdf

2.5.3. Water-guzzling crops

India may be the highest extractor of freshwater, with the agriculture sector alone accounting for 90% of the annual freshwater withdrawals. However, around 49% of the gross cropped area (GCA) is irrigated and dependency on rainfed irrigation is high.[30] The cause for this contradictory situation is the uneven distribution of water for growing the main crops or the geographic variance in the availability of water for irrigation, resulting in higher cost for gaining access. The spatial variations in irrigation-water availability may be due to difficult geographic-accessibility factors, leading to unaffordability for farmers. However, the skewed irrigation-water allocation for certain crops in the same region creates an alarming situation which may be the result of better market accessibility, higher returns and the availability of affordable water and electricity.

State-wise irrigation-water productivity of paddy compared to the percentage of area irrigated under the crop

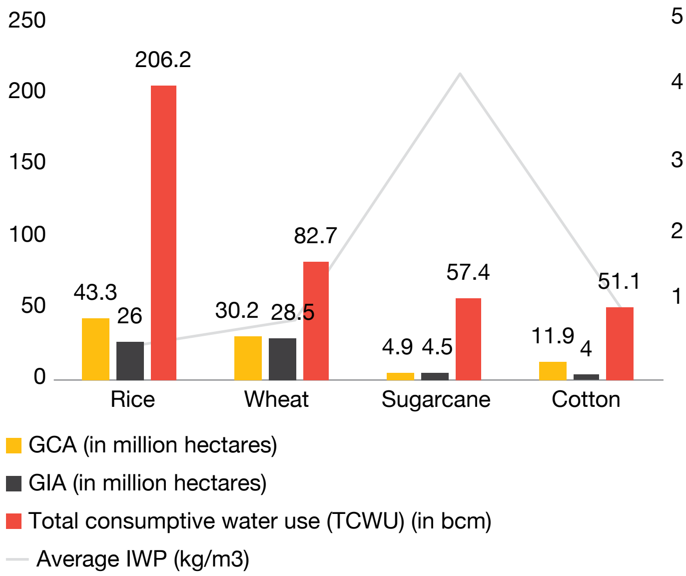


Source: Indian Council for Research on International Economic Relations (ICRIER) and the National Bank for Agriculture and Rural Development (NABARD)

Rice, wheat, cotton and sugarcane account for 46% of the GCA but 65% of the gross irrigated area (GIA). Substantial uneven allocation of irrigation water for the cultivation of these crops clearly indicates that the other main crops, namely pulses, maize and oilseeds, are dependent mainly on rainfed irrigation.

A deeper analysis of the irrigation figures highlights the fact that despite being confronted with severe water stress, both rice and sugarcane cultivation in Punjab and Maharashtra are 100% dependent on irrigation. Punjab has an annual groundwater extraction rate of 166% and the rate of groundwater depletion in the state is alarming. Similarly, the trend of groundwater extraction in Haryana and Rajasthan is adverse.

Four main water-intensive crops – water uptake vs IWP[29]



The figure above clearly indicates that Punjab – where 100% of the area under paddy cultivation is irrigated – has the lowest irrigation water productivity (IWP)[31] compared to other states. Eastern states such as Assam, West Bengal and Bihar are hydrologically more suitable for paddy cultivation.

With reference to sugarcane, the IWP of Uttar Pradesh and Bihar (10.2 kg/m3 and 12.4 kg/m3 respectively) is higher than that of Tamil Nadu, Karnataka, Maharashtra and Andhra Pradesh (between 3.5–4.5 kg/m3).[32] This indicates a disparity between the cropping pattern and the IWP in the states facing water crisis. This issue must be addressed immediately to enhance the efficiency of irrigation.

In terms of wheat cultivation, the IWP and land productivity is higher in Punjab and Haryana is higher at 1.2 and 1 kg/m3 respectively and 4.6 and 4.4 tonnes/hectare respectively. On the other hand, Madhya Pradesh, Gujarat and Maharashtra experience hot and dry weather, and suffer from depleting water resources.

These four major water-intensive crops of the country indicate the requirement of enhancing the efficiency of water management and water productivity in the agriculture sector. With so much at stake, digging deeper into water economics becomes imperative in the context of agriculture.

29 https://eands.dacnet.nic.in/PDF/Pocket%20Book%202018.pdf

30 Indian Council for Research on International Economic Relations (ICRIER) and the National Bank for Agriculture and Rural Development (NABARD)

31 IWP estimates the crop yield obtained per unit of irrigation water applied.

32 ICRIER, NABARD and PwC analysis

2.6. Irrigation economy

With so much emphasis on rethinking the efficiency of water use in agriculture, it becomes important to evaluate the economics of irrigation. On the one hand, ensuring adequate irrigation along with other inputs increases crop yield while on the other hand, too much irrigation leads to decline in yields. The free nature of water compared to other inputs (fertilisers, seeds, etc.) and unrestricted supply from sources (reservoirs, canals, etc.) lead to overexploitation and excessive irrigation. Withdrawal of both groundwater and surface water should be regulated to avoid a crisis.

Water access

The nature of water as an economic good changes with its ownership. Rivers, lakes, etc., are considered to be public resources while water in a privately-owned farm is a private resource. However, water is predominantly used in private capacity whether in a factory or for agricultural purposes. Groundwater ownership is guided by the riparian rights to land, based on which the landowner engages in unmonitored extraction and damages sustainable management in the process. Therefore, the association between water ownership, usage rights and extraction rights should be carefully examined as it can result in influencing WUE as well as rights of ownership.

Water charges

The charges paid by users for gaining access to water are referred to as water charges or pricing. In terms of agriculture, fixed price and flat rate are the two main types of pricing mechanisms. These charges vary on the basis of the area and volume of water supply. Rational water pricing can be implemented via setting up rights for accessing water, capping water allocations depending upon the area, water need (basis crop), irrigation methods, cultivated area, etc. The adoption of these measures requires changing the perception and understanding of users. But it is essential that prior to introducing such measures, the resource should be quantified via assessing its availability in the regions, groundwater levels, productivity per litre, etc. Further, incentivising regulated groundwater withdrawal is more likely to be successful than penalising unregulated withdrawal.

2.7. The impact of virtual water trade on agriculture

The hidden movement of water via import and export of goods and services forms the basis of virtual water trade. Many water-scarce nations are importing water-intensive goods from other countries to support their populations and needs. Depleting water resources heightened by the adverse effects of climate change are major issues of concern for India. To ensure future sustainability of the resource, the country should work towards enhancing WUE in agriculture and assessing virtual water trade through its exports.

It is estimated that India traded 25 BCM of water in 2010 – equivalent to the food demand for around 13 million people[33] – through its agricultural exports. Between 2006–2016, the virtual water export-to-import ratio for India was 4, compared to China's 0.1.[34] India is now a net exporter of virtual water, particularly in the case of rice which consumes more than 200 BCM of water for production. Hence, efficient usage of water in both agriculture and exports has to be managed to ensure sustainability.

Export of virtual water[35]

The efforts towards implementing clear water rights and transparent water pricing for equitable distribution of water are incomplete if the global and local effects of climate change are not taken into consideration. The adverse effects of climate change are more evident today as water-related disasters such as floods and droughts are on the rise. Thus, it is crucial to understand and be aware of the effects of climate change on the availability of water.

Both crop production and export of commodities such as garments, food products and machinery have associated water costs.

India is a historical exporter of virtual water. Between 2006–2016, India exported approximately 26,000 million litres of virtual water annually. India exported approximately 37.1 lakh tonnes of basmati rice in 2014–15. Almost 10 trillion litres of water was used for its production to post-harvest management, of which almost one-fifth was surface and groundwater. Such large-scale withdrawal is a major reason for the increasing burden on the availability of water for domestic use.

Between 2006–2016, India exported nearly 500 trillion litres of virtual water and imported nearly 250 trillion litres, thus becoming a net exporter of virtual water globally. Commodities like rice, tea, meat, pulses and cashew are water-intensive commodities that increase the export of virtual water.

33 https://www.oav.de/fileadmin/user_upload/5_Publikationen/5_Studien/170118_Study_Water_Agriculture_India.pdf

34 Ibid.

35 https://www.indiawaterportal.org/articles/trading-virtual-water

3. Initiatives promoting water sustainability

3.1. Initiatives by the Central Government

The alarming condition of water resources in India requires attention from the Government in the form of policies and schemes that aim to bridge the gap between irrigation potential created (IPC) and irrigation potential utilised (IPU), thereby reducing the country's ultimate irrigation potential (UIP) that has been assessed as 140 million ha (mha).[36] The country's IPC is 112 mha and the IPU is merely 93 mha.[37] The gap of 19 mha (16%) between the IPC and the IPU needs to be lessened.[38] Canal systems requiring maintenance, need of participatory management, shifting land-use pattern, deviation from originally envisaged cropping pattern, command-area development requirement, absence of field channels for last-mile connectivity, etc., are some of the reasons behind the gap.

The Government of India (GoI) has launched innovative initiatives in the form of policies and programmes to reduce overconsumption of water and encourage its sustainable use in agriculture to maximise productivity. Some of the intiatives undertaken by the GoI have been discussed in this section.

The GoI has created the Ministry of Jal Shakti to consolidate interrelated functions pertaining to water management. It formulated various schemes, vision and practices for better management of water resources in the past and renewed them periodically as per the changing requirements at local, state and national levels. Some of the key initiatives formed and implemented by the Government towards sustainable use of water in agriculture are further discussed in this section.

36 https://krishi.icar.gov.in/jspui/bitstream/123456789/34362/1/irrigation_rajni_preprint.pdf (table 1)

37 http://pmksy-mowr.nic.in/aibp-mis/Manual/Paper%20on%20IRRIGATION%20GROWTH%20IN%20INDIA.pdf

38 Ibid.

Key policy initiatives undertaken by the GoI[39]

Har Khet ko Pani 'Pradhan Mantri Krishi Sinchayee Yojana', Ministry of Agriculture and Farmers Welfare, Government of India

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched in 2015 to ensure access to protective irrigation for all agricultural farms in the country.

01

Atal Bhujal Yojana, Ministry of Jal Shakti

Atal Bhujal Yojna was launched in March 2020 for 8,353 water-stressed gram panchayats in seven states by the Ministry of Jal Shakti.

02

Micro Irrigation Fund, NABARD

The Micro Irrigation Fund (MIF) has been operational at NABARD with a corpus of INR 5,000 crore from 2019–20. As of 31 October 2020, the cumulative sanction and release under the MIF stands at INR 3,805.68 and INR 1,094.90 crore, respectively.

03

Jal Jeevan Hariyali, Rural Development Department, Bihar

Jal Jeevan Hariyali started in September 2019 with a focus on water conservation, forestry and energy conservation.

04

Sahi Fasal, Ministry of Jal Shakti

The Sahi Fasal campaign was launched by the National Water Mission in November 2019 to create awareness on appropriate crops, micro irrigation, soil moisture conservation, etc.

05

Jal Jeevan Mission, Ministry of Jal Shakti

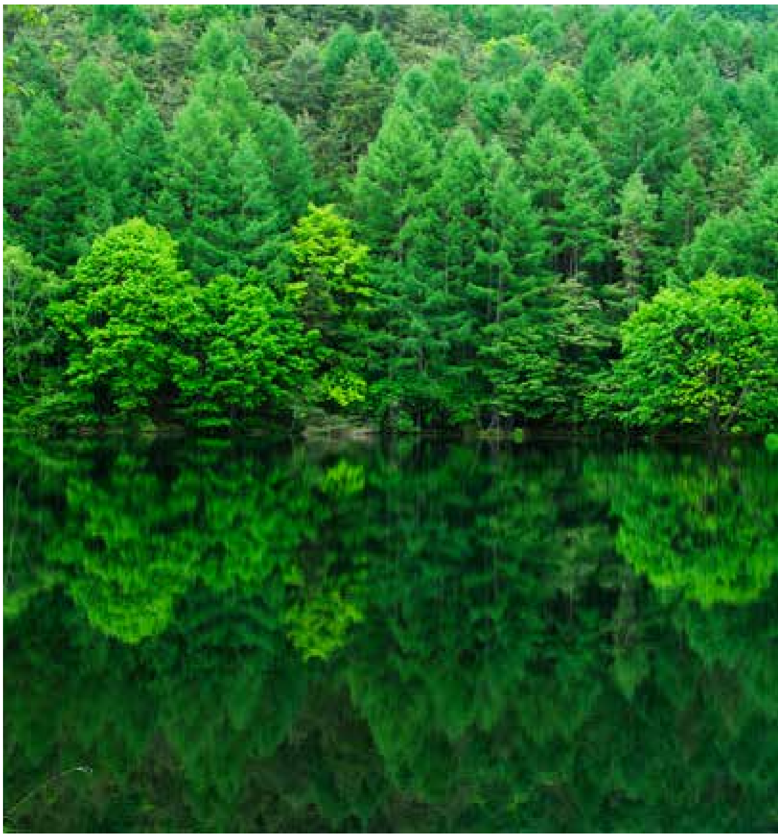
Jal Jeevan Mission envisions to provide safe and adequate drinking water through individual household tap connections by 2024 to all households in rural India.

06

These schemes/programmes not only aim to increase irrigation outreach but also enhance the optimal usage of available water resources and support innovative methods to promote sustainable water-use management in agriculture. All these initiatives are implemented with support from concerned state governments and follow a decentralised planning process to ensure last-mile connectivity and inclusion of small and marginal farmers. Watershed schemes focuses on inclusive and participatory approaches and water-use groups (WUGs) help in the adoption of latest methods and ensure that the benefits reach out to marginal farmers as well.

3.1.1. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

The PMKSY was launched in 2015. It is an output-driven umbrella programme with four components envisioning increased irrigation potential. The scheme aims to enhance agricultural productivity by covering more area under irrigation and strengthening distribution networks in an integrated manner, followed by effective monitoring. The Central Government plans to cover 100 lakh ha under micro irrigation by 2025. To expand micro-irrigation coverage in the states, the National Bank for Agriculture and Rural Development has set up a Micro Irrigation Fund with a corpus of INR 5,000 crore. The figure on the next page highlights some of major achievements of the PMKSY through its four core components:[40]



39 *https://jaljeevanmission.gov.in/and http://pmksy.gov.in/, https://www.nabard.org/content1.aspx?id=1720&catid=8&mid=488, https://www.jaljeevanhariyali.bih.nic.in/JalJeevanHaryali/Default.aspx#, http://mowr.gov.in/schemes/atal-bhujal-yojana an and https://blog.mygov.in/sahi-fasal-campaign/*

40 *http://pmksy-mowr.nic.in/aibp-mis/Manual/State-wise%20Funds%20Released.pdf, http://pmksy-mowr.nic.in/aibp/ http://pmksy-mowr.nic.in/smi-dashboard/smi-dashboard.aspx, http://pmksy-mowr.nic.in/, https://iwmpmis.nic.in/, https://pmksy.gov.in/microirrigation/AtGlance.aspx and https://pmksy.gov.in/microirrigation/Physical_Report.aspx*

Accelerated Irrigation Benefit Programme (AIBP)

1. AIBP covers major to medium irrigation projects that involve an area of more than 2,000 ha.
2. A total of 297 irrigation projects were sanctioned under AIBP out of which 99 were identified as priority projects.
3. Initial indicative outlay was INR 11,060 crore and physical target was 7.5 lakh ha.
4. Total Central Government assistance worth INR 13,257 crore has been released and the share of states released through NABARD is INR 14,086 crore for the period of 2016–20.
5. Rajasthan and Punjab are the best-performing states with more than 95% physical target achievement (up to March 2020).
6. Bihar and Jharkhand are the least-performing states with 68% and 65% physical target achievement respectively (up to March 2020).

Har Khet Ko Paani

1. **Surface minor irrigation (SMI):** The total number of sanctioned schemes are 6,213 and 3,098 have been completed as of March 2020. The total financial outlay is INR 13,374 crore and INR 8,814 crore has been spent as of March 2020. The leading sates are Bihar (94%) and Madhya Pradesh (92%), and the least-performing state is Himachal Pradesh (13%) w.r.t percentage of schemes as of March 2020.
2. **Repair, renovation and restoration (RRR) of water bodies:** Total approved water bodies under the scheme are 2,319 and 1,359 have been renovated as of March 2020. Odisha and Madhya Pradesh are the leading states with >95% of the work completed while Bihar, Andhra Pradesh and Gujarat are the worst-performing ones.

Watershed development

1. Farmers benefitted – 3,075,692
2. Water harvesting structures created/rejuvenated – 475,461
3. Additional area brought under protective irrigation (AABPI) – 1.2 million ha
4. Area brought under plantation (ABUP) – 0.14 million ha
5. Area of culturable wasteland treated – 0.28 million ha
6. Maharashtra, Rajasthan, Gujrat and Karnataka are the best-performing states in terms of effective implementation of the projects

Per Drop More Crop (micro irrigation and other interventions

1. Launched in 2006 as a centrally sponsored scheme (CSS) on micro irrigation, later upscaled to National Mission on MI in 2010 and finally subsumed under the PMKSY in 2015
2. Total area coverage under MI at the national level is 48.01 lakh ha
3. Commonly operated for the Drought Prone Areas Programme (DPAP)/Desert Development Programme (DDP) and north-eastern and hill (NE&H) states
4. Leading states in terms of total area covered under MI are Andhra Pradesh at 8.74 lakh ha, Maharashtra at 7.95 lakh ha and Rajasthan at 7.2 lakh ha
5. Leading states in terms of total area covered as percentage of net sown area are Karnataka at 9.3% and Gujarat at 8.9%

Key innovations under the PMKSY

- Provision of funds for Central share/assistance (CA) has been made through NABARD as per year-wise requirements which would be paid back in 15 years' time, keeping a grace period of three years.
- States can borrow their state share from NABARD whenever required.
- NABARD to raise zero-cost bonds, the interest for which shall be borne by the Central Government.
- A competent nodal authority along with field units from the Central Water Commission shall regularly monitor the physical and financial progress of each priority project.
- Underground piped distribution network (PDN) and micro irrigation have been adopted wherever feasible to increase efficiency and reduce land to be acquired for the projects.
- Pari-passu, i.e. side-by-side implementation of command-area development works in the commands of these projects is envisaged to ensure that the IPC could be utilised by farmers.
- Per Drop More Crop (PDMC)[41] is a high-priority agenda to maximise the output for every drop of water used. The effort focuses on:

promotion micro irrigation in water-intensive crops
use of precision irrigation methods
topping up input cost
creating awareness on micro irrigation
use of water-lifting devices
training and extension activities
coordination and convergence.

Source: PMKSY website and PwC analysis

These initiatives aim at increasing irrigation outreach towards optimal usage of available water resources and supporting innovative methods to promote sustainable water-use management in agriculture.

41 http://pmksy.gov.in/MicroIrrigation/Archive/GuidelinesMIRevised250817.pdf

3.2. State government initiatives

Several state governments have also recognised the problem of rising water scarcity and designed their own participatory irrigation management (PIM) programmes to promote decentralised water management and drive the adoption of sustainable water-management practices. This section highlights some of the prominent programmes undertaken by states and the same could potentially be replicated across India to tackle the issues of water scarcity. Andhra Pradesh (south-eastern coast of India), Madhya Pradesh (central India) and Maharashtra (western India) have implemented suitable reforms and policies in irrigation management and substantially improved their agri-water situation. These states have also worked towards strengthening water institutions and governance structures by adopting ideal regulations to promote PIM. Some of the latest schemes/initiatives launched by states for sustainable water use and conservation are:

Name of the policy/ scheme/initiative	State	Interventions	Results
Jal Jeevan Hariyali Abhiyan[42]	Bihar	• Creation of structures for water conservation • Plantation activities • Creation of check dams • Promotion of use of solar energy • PIM	• Increase in the number of water structures (2,608 check dams constructed) • Development of plantations (41,688 plantations) and increase in the use of solar energy • Increase in the use of drip irrigation and organic farming (805 cases reported) • Convergence among line departments
Narwa, Garwa, Ghurwa aur Badi (canal, cattle, manure pit and kitchen garden)[43]	Chhattisgarh	• Construction of small dams, canals and dikes • Construction of cow sheds and provision for fodder • Creation of manure pits • Promotion of kitchen gardens	• Groundwater recharge • Increase in livelihood opportunities • An integrated method of sustainable development
Neelambar Pitambar Jal Samridhi Yojana[44]	Jharkhand	• Launched in May 2020 • Creation of field bunding • Rejuvenation of nalas (runnels) • Construction of soak pits	• On an average, five schemes of water conservation are running in every village in the Lohardaga district of Jharkhand • Better availability of water for irrigation and day-to-day use
Birsa Munda Krishi Kranti Yojana[45]	Maharashtra	• Providing sustainable irrigation facilities to scheduled tribes • Subsidy towards creation of micro-irrigation systems • Renovation of old wells and water conservation structures	• Area under micro irrigation has increased • Construction of new wells and ponds • Old unused wells were repaired and are now used for day-to-day purposes • Availability of water for irrigation in water-scarce tribal areas

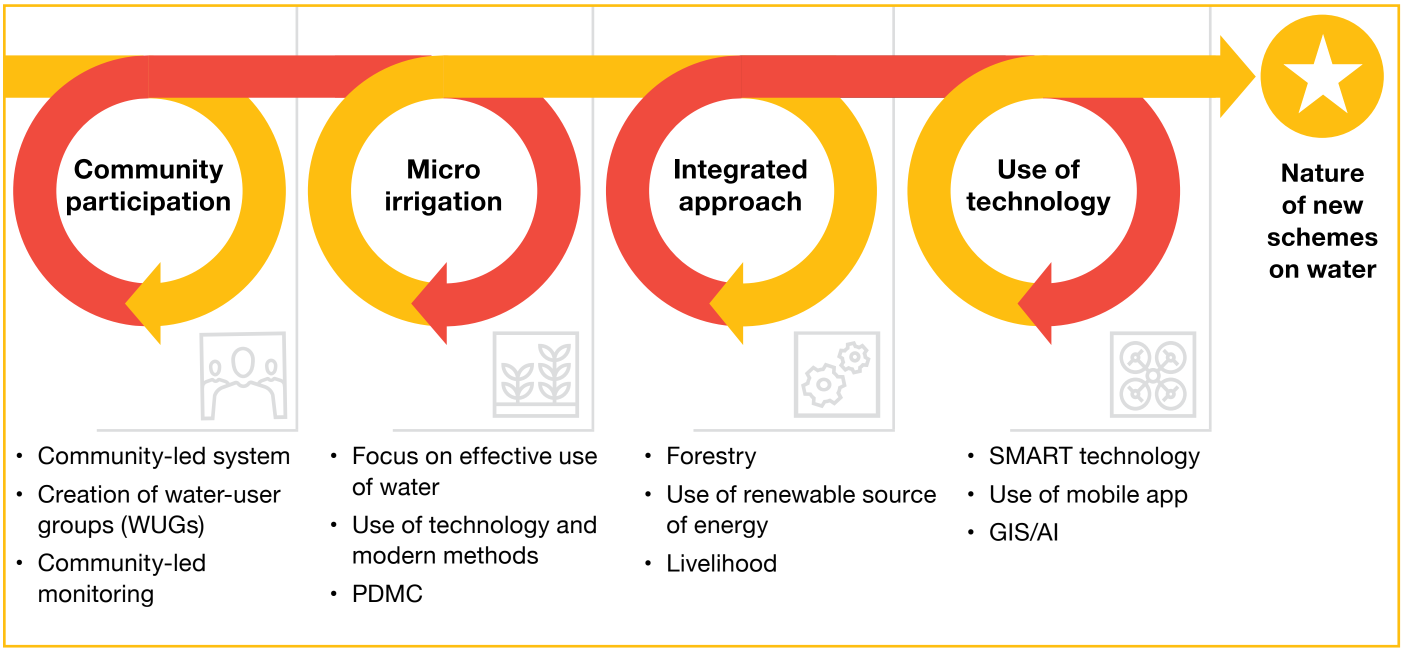
42 *https://www.jaljeevanhariyali.bih.nic.in/JalJeevanHaryali/DashBoard.aspx*

43 *https://www.shasyadhara.com/what-is-narwa-garwa-ghurwa-au-bari-nggb-and-its-schemes-launched-by-the-government-of-chhattisgarh/*

44 *https://www.bhaskar.com/local/jharkhand/ranchi/simdega/news/on-an-average-5-schemes-are-running-in-one-village-under-the-nilambar-pitambar-jal-samridhi-yojana-127493608.html*

45 *http://krishi.maharashtra.gov.in/Site/Upload/Pdf/TSP_scheme.pdf*

Focus and approach initiatives by state governments



Source: PwC analysis

The figure above analyses how the new state government schemes now focus more on integrated approach that help in conserving water and increasing production. States are using modern technology with smart solutions in implementing the schemes and monitoring them. PDMC, i.e. maximising the effect of one drop of water in enhancing productivity can lead to sustainable water use in agriculture. These schemes also provide livelihood opportunities to the beneficiaries, especially small and marginal farmers.

3.3. Observations in scheme implementation

Micro-irrigation systems have been proved to reduce water consumption and enhance the WUE of a region. Despite the existence of both Central and state government flagship schemes on sustainable water use in agricultural operations, there are several challenges in their implementation. The Government has estimated that a potential 69.5 mha can be covered under micro irrigation, but the area covered till 2017–18 was only about 10 mha.[46] Though a potential target of 100 lakh ha has been set by the Government to be achieved between 2019–20 and 2024, the coverage for 2019–20 was only 11.7 lakh ha.[47]

The key challenges or limitations of implementing micro irrigation are detailed below:

Current status

- Main user groups are large farmers and farmer producer companies (FPCs)
- Land documents not readily available with farmers
- Departmental convergence lacking
- Very small number of users

Financial and economic viability		Technology and maintenance	
• Shortage of funds with farmers in case there is a delay in release of subsidy by the Government • Limitation of finances for poor and marginal farmers • Kisan Credit Card (KCC) defaulters	• Cost of latest systems may be expensive, especially for poor and marginal farmers • Small and marginal farmers prefer existing practices	• Inadequate technology knowledge of beneficiaries • Technology to monitor and support is inadequately developed • Systems are accessible mostly by bigger farmers	• Inadequate servicing facilities as lesser users restrict micro-irrigation companies in repairing and maintenance at remote locations • Unavailability of spares in local markets
• Small landholdings • Undulated landholdings in states like Jharkhand • Decreasing farm size due to cultural practice of land division	• Electricity cost is high for latest irrigation systems • Micro-irrigation systems require electric feeders at farm levels which are not available at each farm	• Timing of subsidy release and seasonal cropping pattern • Mismatch in micro-irrigation basedbased cropping and existing cropping	• Large number of outstanding payments for suppliers • Delay in subsidy release
Farm size and energy		**Mismatch and delay**	

Source: PwC analysis post discussion with stakeholders

42 https://www.jaljeevanhariyali.bih.nic.in/JalJeevanHaryali/DashBoard.aspx

43 https://www.shasyadhara.com/what-is-narwa-garwa-ghurwa-au-bari-nggb-and-its-schemes-launched-by-the-government-of-chhattisgarh/

44 https://www.bhaskar.com/local/jharkhand/ranchi/simdega/news/on-an-average-5-schemes-are-running-in-one-village-under-the-nilambar-pitambar-jal-samridhi-yojana-127493608.html

45 http://krishi.maharashtra.gov.in/Site/Upload/Pdf/TSP_scheme.pdf

46 https://pmksy.gov.in/MicroIrrigation/Archive/Guideline_MIF03082018.pdf

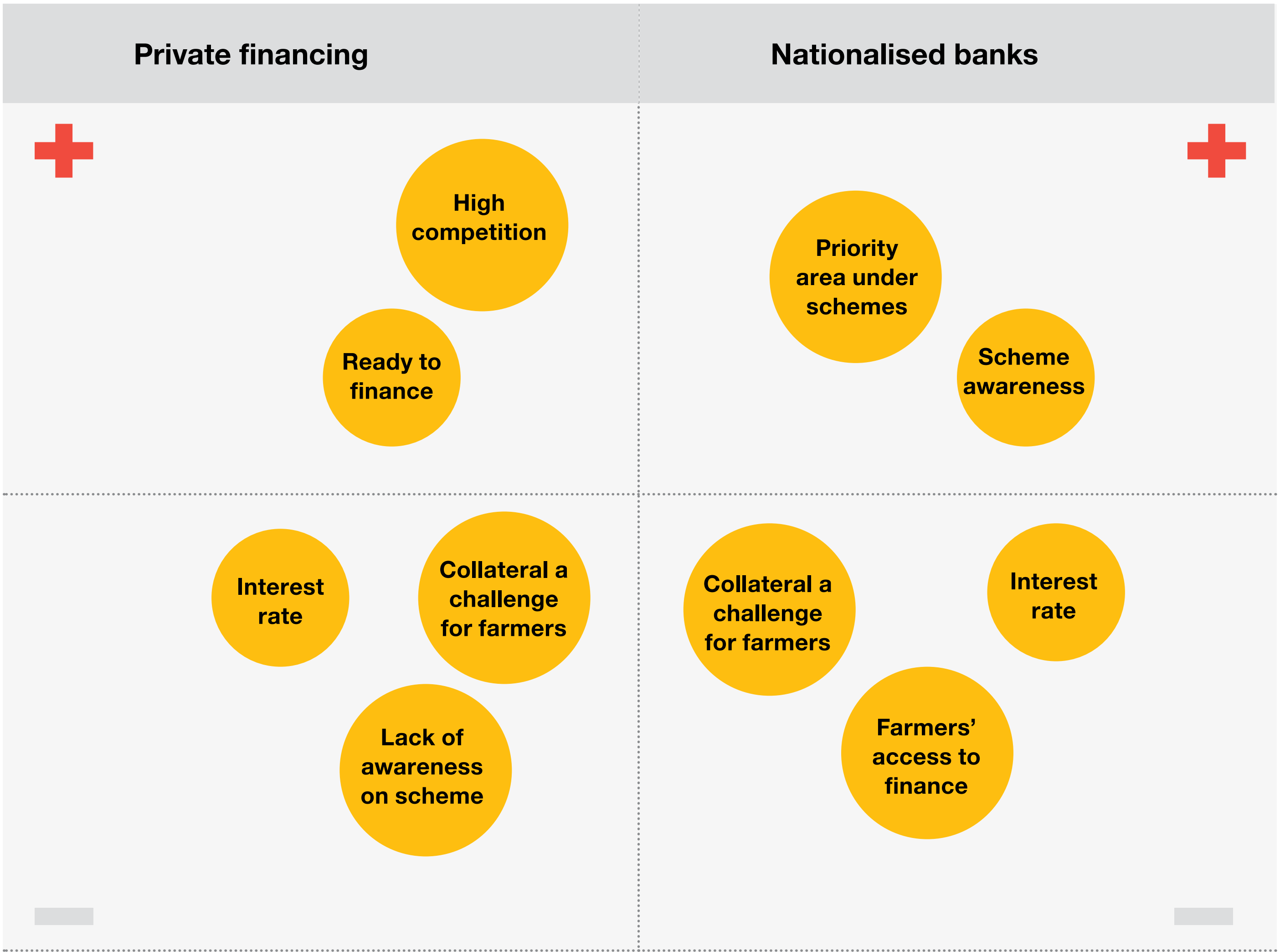
47 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1652644

Finance and adoption are two major areas of concern as far as successful implementation of micro-irrigation schemes in India is concerned. We discussed the concerns with stakeholders and beneficiaries and some key points that needs to be addressed going forward are analysed below.

Finance: Small and marginal farmers face the challenges of inadequate financing for installation of micro-irrigation services. Securing financing from banks by providing collaterals or paying interest on loans taken are additional challenges. While nationalised banks are aware of micro-irrigation schemes and prioritise them, most private banks lack information/awareness about such schemes even if they are willing to finance them.

Therefore, there is a need to enhance the awareness of both lending institutions and beneficiaries on the importance of financing micro-irrigation schemes that can be accessed by small and marginal farmers. Providing collateral-free loans could be one such option. Private banks may be encouraged to customise their interest rates basis the priority of schemes. KCCs may be strengthened to empower farmers in utilising them for financing his/her share of micro-irrigation installation. The Government could also consider bearing the GST charges to ease the financial burden of farmers.

Financing scenario for micro-irrigation schemes



Source: Stakeholder interactions and PwC analysis

Adoption of new technology by farmers: Farmers are often unaware and lack the knowledge of technology and methods required to adopt micro irrigation. They are also comfortable with older practices, which delays the implementation of new irrigation technologies. Live demonstrations to potential beneficiaries and arranging for exposure visits to view successful systems installed can play a major role in changing their mindsets. Providing users with technical knowledge can make them less reluctant towards adopting technology.

Effective implementation of initiatives: Challenges also exist in implementing initiatives and schemes, resulting in hindering the achievement of envisaged targets. Manual procedures, undecided timelines, lack of clarity about processes/ procedures from application to installation can cause delays. Many states have initiated online interventions but they are limited to partial processes. Implementation, subsidies and components depending on state demands lead to lack of uniformity and reduce the extent of coverage achieved. Some of the measures that state governments can take to ensure effective implementation of initiatives/schemes and maximise the results are suggested below:

- **Mission-mode implementation** should be considered for PDMC and the same can be achieved through establishing a special purpose vehicle (SPV). For example, the Government of Gujarat formed the Gujarat Green Revolution Company (GGRC), an SPV that promotes drip- and sprinkler-irrigation systems in the state.[48] The SPV aims to eliminate any confusion amongst farmers about the varying subsidy assistance norms implemented by multiple government departments, integrate all the varied funds available for effective expenditure and avoid undue delays in subsidy releases.
- The entire process of application to installation could be digitised to ease access and ensure smooth and timely completion of aligned tasks.
- **Timebound procedures** may be fixed at both front ends and back ends to avoid delays and bring transparency into systems. The schemes could be **operational around the year** rather than accepting registrations/enrolments for a certain period. These steps could enable farmers in benefiting in accordance with their cropping cycles.
- **Monitoring and evaluating** implementation and fund management should be undertaken rigorously by states to ensure adequate coverage and fulfilment of targets.
- **Convergence and integration** of schemes may result in better coverage and ensure sustainable management of water for agricultural use. Governments may decide to combine the cultivation of water-intensive crops mandatorily being grown with the help of micro-irrigation systems. For example, the Government of Maharashtra converged some schemes for the cultivation of sugarcane in the state. The Kusum Scheme for solar pumps by the Ministry of Renewable Energy (MNRE) may be converged with PDMC and micro-irrigation to avoid uncapped extraction of water.

Similarly, effective strategies can be implemented for sustainable use of water for irrigation:

- Bringing water to farmers' field **through 'Har Khet Ko Pani' and then converging it with PDMC under the PMKSY** for water-use efficiency through the implementation of micro-irrigation systems in the field.
- Micro-irrigation schemes may be converged with other national and state schemes to ensure effective adoption and implementation. For example, **Jal Jeevan Hariyali schemes in Bihar are being converged with other schemes by the Rural Development Department, Energy Department and Forest Department** for water conservation, use of solar energy and promoting plantation.[49]
- The National Rural Livelihood Mission, the Kusum Scheme of the MNRE, schemes of the Departments of Forest, Rural Development and Water Resources, etc., may be roped in for an integrated approach in increasing water-use efficiency for agriculture while addressing other issues simultaneously.

As issues of scarcity, access, depletion, contamination, equity and climate change plague the water sector continuously, the Central Government, state governments and other agencies have increased their investments in the sector. Several state governments have launched flagship programmes to address water-related issues in the last decade itself. Ensuring accountabilities and transparency and creating awareness to meet time-bound targets pertaining to sustainable water use in agriculture are the key priorities now.

A cadre of trained para-hydrogeologists with clear responsibilities and accountabilities needs to be created to work across programmes and schemes (to facilitate water balance and budgeting). This also demands a more refined and integrated approach in the form of collaboration, discussion and formulation of policies that are aligned with the latest resilient technologies to build a water-efficient and water-secure India.

48 *https://www.laudesfoundation.org/en/our-work/results-and-learning/drip-case-study.pdf*

49 *https://www.jaljeevanhariyali.bih.nic.in/JalJeevanHaryali/Default.aspx#*

4. Solutions for agricultural water management

The key to ensuring sustainability in agri-water management is ensuring a comprehensive and unified approach towards the diverse avenues – namely technology, cropping systems, governance institutions and policy frameworks. Partnership models that use modern technology are the main elements that demonstrate successful water-use management in agriculture. With the growing need for water-efficient agricultural practices, collaboration and partnership along with community participation is very important for integration of efforts and effective implementation of activities. A sustainable partnership model not only provides an opportunity to bring various stakeholders together but also helps in identifying best practices and start-ups to provide solutions. This section presents some strategies and examples of water-management solutions for the agriculture sector.

4.1. Diversification of cropping patterns

Crop diversification has a beneficial influence on ensuring water management, enhancing local food security and delivering a healthy and diverse diet. Selecting smart crop-diversification options in place of water-thirsty crop options such as paddy and sugarcane strengthens the economy and reduces the uncertainty associated with market vagaries and overuse of irrigation water. The looming water scarcity is already pushing for a paradigm shift to cultivation of crops that do not require much water. For example, Maharashtra has already moved to compulsory drip irrigation for sugarcane cultivation.

Policy interventions can play a major role in improving crop diversification and in resolving operational issues. Karnataka, Maharashtra and Gujarat have seen significant success in crop diversification. This is mainly due to their efforts in removing impediments in implementation of irrigation and crop-diversification schemes.[50]

Such interventions not only help in the sustainable use of available water in agricultural production but also provide opportunities for alternative livelihoods to local communities. The strategic initiative by the World Bank supported Tamil Nadu Irrigated Agriculture Modernization and Water-Bodies Restoration and Management Project is one of the successful examples of implementation of sustainable water-use management in promoting crop diversification in water-scarce areas. Such initiatives enable local farmers to avail crop- and livelihood-diversification opportunities.

50 https://www.downtoearth.org.in/news/agriculture/india-s-agrarian-distress-a-paradigm-shift-73529

Crop diversification: Operational concerns and interventions

Concern areas	Policy interventions
Profitability	Rainwater harvesting
Fertiliser response ratio	Micro irrigation
Soil health	Watershed
Price and yield risk	Crop diversification and precision farming
Minimum support price	Access to finance for technology adoption

Crop diversification through improvement in irrigation infrastructure in Chidambarapuram, Tamil Nadu[51]

This project enabled successful implementation of drip irrigation for crop diversification in Alankuppam, Anaimalai, Chidambarapuram, Ezhuthanivayal, Govindapuram, Mahibalanpatti and Perungudi villages in Tamil Nadu. Farmers reported an additional income of up to INR 60,000 in Mahibalanpatti village during the mango season. Micro irrigation has also been introduced in watermelon and muskmelon production in Alankuppam village.

Similar interventions can be implemented in the following ways to ensure appropriate selection of crops (that suit climatic conditions) by the adoption of smart agricultural practices and sustainable water use:

Impact

- System of rice intensification (SRI) resulted in an increase of paddy yield by 700–800 kg/ha
- Pulse yield increased to 130–150 kg/ha
- Micro-irrigation drip for bananas and sprinklers for vegetables (area increased from 53,901 ha to 65,220 ha)
- Fisherman cooperatives started fish culture

Results

- Increase in groundwater
- Crops based on water availability
- Smart practices – mulching and precision farming

Interventions

- Strengthening tank bunds
- Repairing two sluices
- Construction of recharge well

Cost incurred = INR 3.82 million

Source: World Bank and PwC Analysis

51 *https://ieg.worldbankgroup.org/sites/default/files/Data/reports/ppar_indiatamilnadu.pdf*

Crop diversification through a selection of crops – based on agro-climatic conditions, water consumption and productive capacity in terms of the economic returns of the water used in cultivation – can prove to be a boon for farmers. Mixed cropping and intercropping are other practices that can ensure complementary and efficient use of available input during cultivation. Techniques such as mulching, development of low water-consuming crops, direct-seeded rice (DSR) and the introduction of new and climate-resilient varieties of seeds can be adopted to enable the efficient use of water in the agriculture sector.

4.2. Technology as an enabler

Traditional methods of irrigation and uncapped usage of irrigation water lead to loss of freshwater. Adoption of modern and innovative technologies and methods is the answer to the growing need for smart use of water in agriculture. A smart irrigation system is a mix of usage of water and fertilisers based on soil types, climatic conditions and different stages of crop development, and the implementation of micro-irrigation techniques in a controlled manner through the use of sensors and controllers.

4.2.1. AI and satellite imaging

AI helps in data transfer without human interaction, as well as in crop-water management, pest control, precision farming and implementation of safety measures. Internet of things (IoT) helps in effective management of water in agriculture and increasing crop yield. It may also solve the issue of water use and increase the incomes of small and marginal farmers. The following is a depiction of the use of AI and satellites:

AI and satellite imaging

01 Water management	• Sensors based on soil moisture level • Sensors based on weather conditions • Assessing water requirement with the help of satellite imaging
02 Pest management	• Monitoring movement of pests/predators using sensors • Giving signals and helping in removing pests
03 Savings in electricity consumption	• Electricity consumption is controlled due to controlling systems and sensors • Cost of electricity reduction helps in increasing the income of farmers
02 Effective monitoring of crop development	• Crop is monitored at all stages of growth • Better yield is ensured

Using smart technology for sustainable agriculture – an example from Thailand

Key features

- Use of modern technology for fruits and vegetables (F&V) production with vertical farming system
- AI with smart control system
- IoT-based based technology to monitor farming systems using mobile devices
- Fully automated system for watering, lighting, nutrient adding and temperature control

Impact

- Infrastructure costs are almost half compared to conventional organic cultivation
- Harvesting time decreases from 45–50 days to 21–30 days and crop production doubles
- Defects decrease from 30–50% to 0.5–1%
- Water consumption is reduced by almost 99%
- Fertiliser costs are reduced by almost 80%

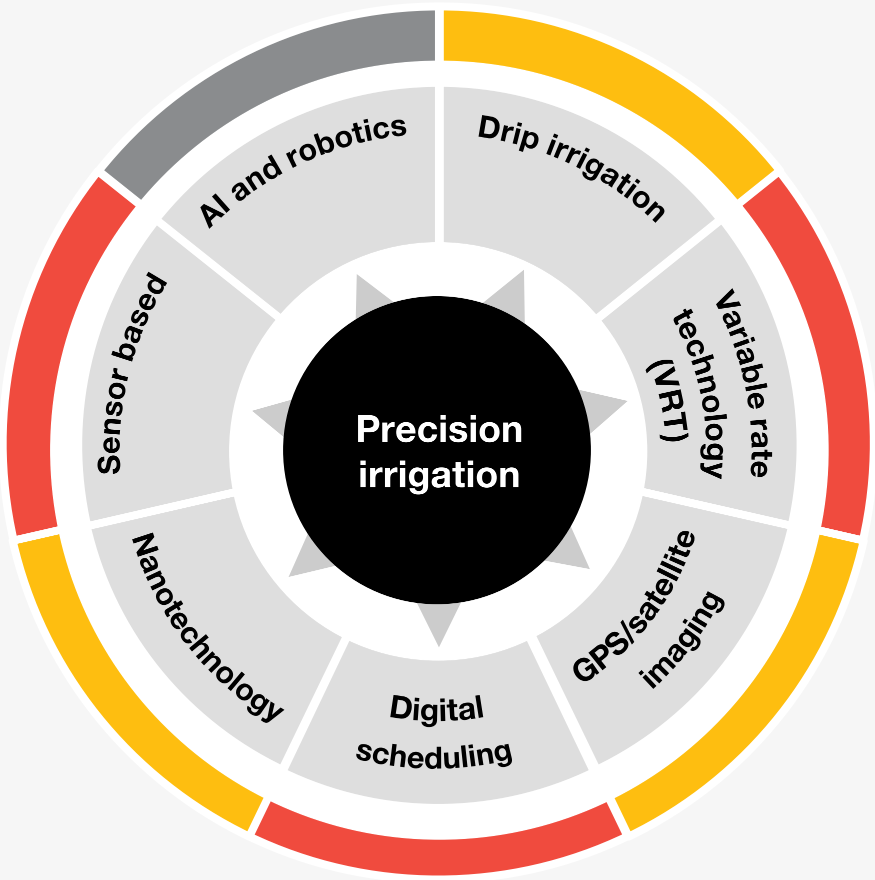
Source: MDPI

4.2.2. Precision irrigation

With the growing concern around water scarcity, modern irrigation methods that enable reduced use of water in irrigation are of prime importance . Precision irrigation methods are a possible solution for effective water usage, not only in water-scarce regions but also in areas where water is in abundance.

52 *N. G. Shah and Ipsita Das. (2012). Precision Irrigation: Sensor network-based irrigation, problems, perspectives and challenges of agricultural water management, Dr. Manish Kumar (Ed.)*
Martínez-Vilalta J, Piñol J. Drought-induced mortality and hydraulic architecture in pine populations of the NE Iberian Peninsula. Forest Ecology and Management. 2002; 161, 247–256

Precision irrigation



Drip irrigation is based on water-spray technique and controlled manually or automatedly. It helps in recharging groundwater and saving water during irrigation.

VRT is applied in mixing water, fertilisers and pesticides as per requirements across different locations in the field.

Global Positioning System (GPS)/satellite imaging based irrigation helps in irrigating fields based on moisture and weather conditions, and identifying crops and studying their water requirements.

Digital irrigation helps in determining the frequency and timing of water requirement. It helps in properly managing the entire irrigation cycle.

Nanotechnology-based irrigation can be a solution in water-deficient areas. Seeds can be treated with nanoparticles for better suitability in dry conditions.

Sensor-based methods help in controlling irrigation based on increase or decrease in outdoor temperatures. Such methods are also dependent on site specifications such as soil type and the rate of sprinklers' application to check watering run times or schedules.

AI and robotics help in irrigation water control, identification of water pooling and irrigation needs based on locations and weather conditions.

Source: PwC analysis

Building capacity to create a difference with every drop of water in Coimbatore, Tamil Nadu

Key features

- 90% of farmers unaware about the use of drip irrigation in Coimbatore
- Capacity building by International Water Management Institute and Tata Water Policy Research Programme along with local partners
- 1,000 farmers initially given training on using drip irrigation
- A water calculator was devised to assess water requirement and irrigation scheduling
- This model was upscaled in other districts and replicated even in Gujarat

Impact

- Banana farmers reduced the irrigation time from three hours to one-hour and 45 minutes
- Yield increased by two times
- Reduction in water requirement with usage almost reduced by 50%
- Shift from conventional irrigation to drip irrigation
- Consumption of fertilisers reduced
- More than 1,000 farmers were trained in effective implementation of drip irrigation

Source: International Water Management Institute (IWMI)

The use of modern technology is the need of the hour for implementation of effective measures in irrigation systems. This can be promoted through generation of awareness and capacity building of small and marginal farmers along with a supporting ecosystem.

Policy-level initiatives and effective implementation through the convergence of Government schemes is the key in using modern and innovative technologies in irrigation.

4.3. Promotion of participatory irrigation (PPI)

The participatory approach brings users, service providers and policymakers together. It helps in effective planning of policies and informed decision making for sustainable water-use management in agriculture. It is also very important in the management of available water resources to ensure a balance between irrigation needs and agricultural production. Farmers need to be included in such initiatives and lead interventions relating to PIM. Some of the key objectives of PIM are:[53]

- creating ownership for water usage, management and conservation
- improved service delivery by ensuring availability of technology and its maintenance services
- optimum utilisation and equity in water distribution
- collective responsibility and community participation
- stakeholder involvement
- accessibility to technology for innovations
- training and exposure
- effective monitoring and supervision.

Changing the lives of small and marginal farmers through water-efficient irrigation in Motihari, Bihar

JEEViKA is an autonomous body under Bihar's Rural Development Department that works with more than ten lakh self-help groups (SHGs) in the areas of institution and capacity building, social development, financial inclusion, livelihood, skills and jobs, and the Mahila Krishan Support Programme (MKSP).

The Madhuban block of East Champaran has undulated land due to this the area was under the grip of water logging during monsoon season and unequal distribution of water through flood irrigation practice from the last 10 years. The agricultural activities were getting affected, which resulted in local communities facing livelihood-related issues. Along with SHG members, JEEViKA took the responsibility to efficiently manage water usage for irrigation and provide small and marginal farmers the necessary infrastructure required for sustainable farming practices. The Government's collaboration with the JEEViKA group also ensured that the quality of life in these rural communities was improved. They were encouraged to adopt advanced technologies and institutional policies were implemented for sustainable usage of natural resources with water-efficient irrigation practices.

Key features

- Community farming of wheat, maize and mustard
- Capacity building of women and their skill development
- Financial input provided to farmers 90% from PMKSY and 10% from the JEEViKA group, including GST for micro irrigation)
- Convergence – borewell with submersible pump provided under the Community Handpump Scheme
- Package of practices to support farmers

Impact

- Uniform germination of crops
- Water-use efficiency at 75%
- Reduction in water requirement by the use of micro-irrigation systems such as mini sprinklers
- Shift from flood to micro irrigation
- Reduction in fertiliser consumption by 25–30%
- Women trained on micro-irrigation systems and technology

Source: Discussion with JEEViKA beneficiaries and PwC analysis

53 http://mowr.gov.in/sites/default/files/CADWM_Status_of_PIM_0.pd

4.3.1. Water-user associations/groups

PIM involves the participation of user farmers in various aspects of the management of existing or created water resources, including planning, design, construction, maintenance, financing and the adoption of new technologies. User farmers are generally grouped into a body or institution known as a water-user association (WUA) or a water-user group (WUG).[54]

The creation of WUAs or WUGs helps community-led initiatives targeted at the enablement of sustainable water use and management in agriculture. However, in order to effectively implement the micro-irrigation schemes of the Central Government and the state governments, the participation of local communities is very important. The creation of WUAs supports the active participation of communities and ensures required capacity building in user groups for enhanced implementation of projects and conservation of existing water resources. It also helps small and marginal farmers to optimise the cost of new technologies and adoption of modern irrigation systems. Moreover, WUAs keep regular checks on whether users are optimising available water resources for the betterment of their communities.

Structure

Project committee (PC)

- Presidents of DCs and WUAs are its members
- For major and medium irrigation
- Resolves disputes of DCs and WUAs

Distributary committee (DC)

- Presidents of WUAs constitutes DC members
- For all major irrigation systems
- Resolves disputes of WUAs

WUA

- User farmers are organised into WUAs with voting rights and non-users without voting rights
- For micro, minor, medium and major irrigation
- Resolves disputes between farmers

Source: Indian Institute of Management, Ahmedabad

54 https://www.iima.ac.in/c/document_library/4ParticipatoryIrrigation8f9a.pdf?uuid=a5eced82-3f75-4068-9aa1-57aef9de0876&groupId=62390

4.3.2. Farmer producer organisation led initiatives (FLIs)

A farmer producer organisation (FPO) can be a producer company, society, cooperative or any other legal entity that shares profits among its members. The main objective of an FPO is to increase the incomes of small and marginal farmers by enabling them to work in a collective manner. An FPO helps in the creation of economies of scale, common branding and marketing, thus creating improved income opportunities to its member farmers.[55]

There are around 86% small and marginal farmers in India with an average landholding size of less than 1.1 ha.[56] Most of them face challenges in accessing finance and technology, procuring high-quality seeds, using modern and innovative irrigation systems and marketing produce. The creation of FPOs will provide a launching pad for them to showcase their collective achievements and solve their problems. The Government plans to invest around INR 5,000 crore for the creation of FPOs in the next five years. It aims to set up at least one FPO in each block in India.[57]

The stage is set for FPOs to take a quantum leap ahead and contribute actively to the development of the Indian economy. Since their target group comprises farmers who do not market their produce, they can contribute by leading initiatives towards utilising water-efficient technologies for irrigation.

Bhungroo initiative in Gujarat: A one-stop solution for irrigation problems

The arid regions of Gujarat were plagued with issues including water scarcity, salinity of soil and waterlogging during the monsoon season. Bhumaikrupa Bhungroo Juth, an FPO initiative, has created and provided solutions that are effective and affordable, and help in solving irrigation-related problems in the region. Through this initiative, the collection of rainwater for nearly ten days helps farmers harvest 40 million litres of water (suitable for irrigation) and store it in underground aquifer reservoirs. This stored water enables them to have two cropping cycles during the monsoon and winter seasons.

Intervention	Construction of the Bhungroo underground aquifer reservoir – implemented in 14 villages in Samie and Hajri blocks of Gujarat's Patan district
Method	• Women's participation • Hand drilling of porous pipes in the soil from the lowest point of rainwater accumulation to a depth of around 110 feet
Results	• Frees land surface from waterlogging • Creates water lenses • Dilutes groundwater salinity • Controls desertification of the area • Enables availability of water for irrigation in two seasons • Increases income of farmers • Land ownership changes from man to woman, empowering women through the Bhungroo initiative • The initiative has received national and global awards, and accolades

Source: Small Farmers' Agri-Business Consortium

55 https://cab.rbi.org.in/docs/Special_Study/An%20Exploratory%20Study%20on%20Farmer%20Producer%20Organizations(FPOs)%20in%20Maharashtra.pdf

56 https://www.business-standard.com/article/economy-policy/modi-unveils-10-000-farmers-producer-organisations-to-boost-farm-income-120022900630_1.html

57 Ibid.

4.4. Encouraging the adoption of technology

The Central Government and the state governments have both implemented exemplary initiatives to promote the adoption of new technologies and methods in order to enable smart irrigation. However, their adoption does not come without challenges. Generating awareness among the target beneficiaries is of utmost importance. They need to be made aware why and how these new technologies are beneficial for them, the environment and in achieving sustainability of water resources. 'Seeing is believing' is a true adage in this case, as nothing propagates an agenda better than the target beneficiaries witnessing successful cases first hand. In this particular sphere, technology companies can play a major role by organising demonstrations, making exposure visits and disseminating the benefits of skill enhancement achieved by the implementation of new technologies such as micro irrigation.

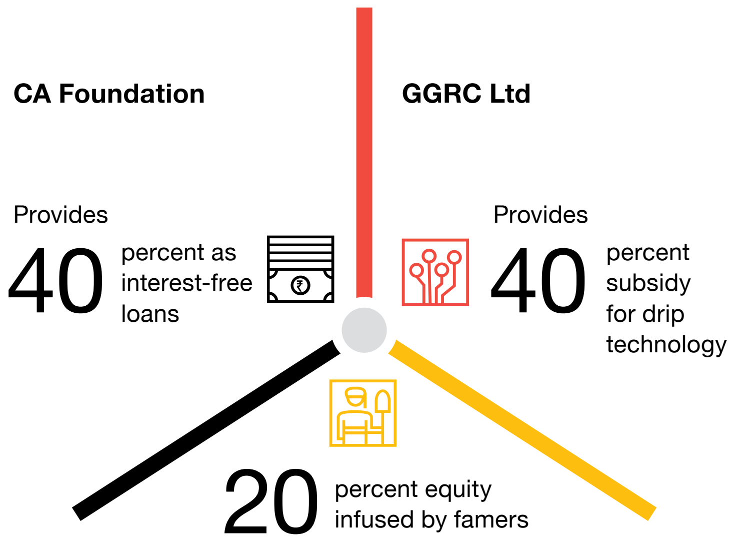
The following steps can be taken to address the major concerns of small and marginal farmers regarding their adoption of technologies to implement effective irrigation methods:

Areas	Challenges	Solutions
Landholding and documents	• Fragmented and small landholdings by farmers • Unavailability of land documents, viz. land possession certificates	• Digitising land records • Certification by local authorities for farmers without landholdings • Cluster-based approach and FPO interventions
Source of water and electricity	• Every farm does not have source water required for pressured water supply, a necessary requirement for micro irrigation • Non-existent electric feeders at farms as electricity provides better pressured water • Use of diesel-powered pumps lacks consistency in water flow	• Convergence among agriculture and irrigation schemes • Access to low-cost irrigation systems • Use of solar-powered irrigation systems
Awareness	• Small and marginal farmers lack awareness about the efficiency of micro-irrigation systems and costing • Farmers have not availed any formal training or been exposed to training institutions for live demonstrations • Exposure to successful farm interventions in the vicinity	• Organising information, education and communication (IEC) campaigns • Exposure visits and demonstrations for small and marginal farmers • Promoting community-based micro-irrigation systems
Access to finance	• Most nationalised banks provide financial support with at least 25% of the margin to be borne by individual farmers • Banking professionals need to be sensitised	• Awareness of banks and financial institutions (FIs) about irrigation schemes and sustainable water-use management • Convergence with other schemes • Inclusion of irrigation as an agenda in State Level Bankers' Committees • Timely release of subsidy to ensure the contribution of farmers in MI schemes

Source: PwC analysis

The Drip Pool Programme, Gujarat: Solving financial problems regarding the adoption of technology

The Gujarat Green Revolution Company (GGRC) Ltd is providing a subsidy of up to 40% and the remaining 60% is covered by contribution from farmers (20%) and community loans (40%) from a non-profit organisation. No interest is charged on the loan and it is disbursed through a simple process. It needs to be returned by farmers within 24 months in equal instalments.



It's a revolving fund, which provides interest-free loans to farmers and supports them in availing GGRC subsidy

Repayments are returned to the revolving fund and used to provide loans to other farmers

Thus, the money keeps circulating and the benefits of drip technology reach more farmers

Helps technology adoption for small and marginal farmers at affordable costs

Impact	Elaboration
Environmental impact	• Promotes micro-irrigation systems • Focuses on water-scarce crops such as cotton • Decreases need for water usage from 5,923 litres to 1,191 litres per kg
Agronomical impact	• Enables improved germination of seeds • Reduces mortality of seeds • Decreases the cost of seeds due to reduction in gap filling • Increases the cost efficiency of fertilisers • Enables an increased yield of cotton – 557 kg (for other farmers) and 692 kg (for project farmers)
Socioeconomic impact	• Increases net income of farmers • Ensures zero default in loan repayments
Institutional impact	• Leads to the creation of farmer interest groups (FIGs) and farmer producer companies (FPCs)

Source: Laudes Foundation

4.5. A new policy ecosystem to ensure sustainability

An enabling policy ecosystem would provide incentives to water users to improve their water-use efficiency and also help them make improvements in their existing irrigation practices as per regulatory measures recommended under policies. It would enable users to provide detailed information about their water usage, pricing and access to the latest technologies for efficient use of water in agriculture.

The policy ecosystem would encourage policymakers, the private sector and users to put in place a 'water stewardship' approach to enable efficient water usage in irrigation. For example, the efficiency of water usage would need to be measured but conventional meters could be too expensive for small and marginal farmers. Innovations in water technology and metrology would pave the way for low-cost water meters or other devices for measuring the volume of water usage so that these are affordable for smallholder farmers.

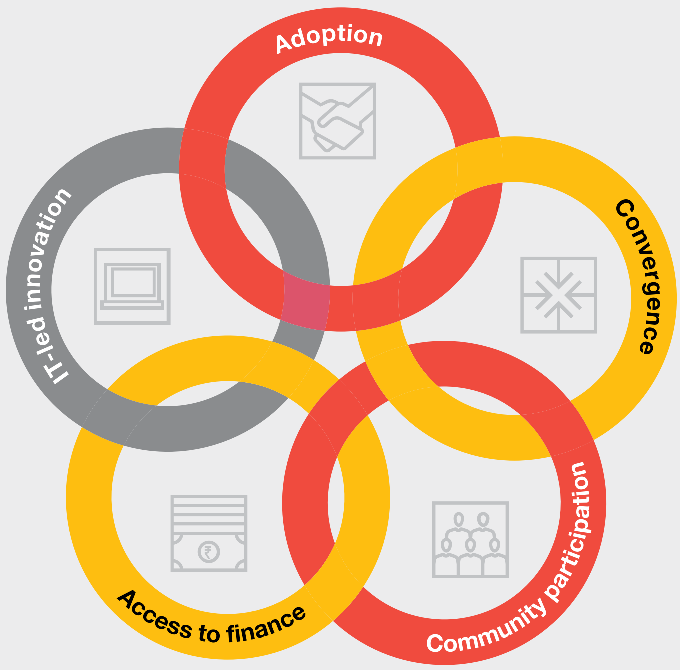
However, policymakers would need to create a system that is both reliable and transparent in assessing water supply and demand, and establish the 'water balance' in a river or a region. This system would enable the management of the link between the crop-water demand and supply at different stages of the agricultural process with appropriate technology and human interventions.[58]

58 *https://sustainabledevelopment.un.org/content/documents/16057HLPW_Water_Efficiency_Roadmap_final.pdf*

Creation of a new policy ecosystem

The initiatives by the GoI and the state governments to implement sustainable water-use management in agriculture is encouraging. There are several policies (discussed in previous sections of this report) that are being implemented and showing fair results. However, the existing challenges in current policies need to be addressed in an integrated manner for effective and fast results. The following holistic approach can increase the operational efficiency of ongoing government schemes:

New policy ecosystem: A unified approach



Adoption
Farmers will focus on reducing glitches and increasing the operational efficiency of micro irrigation schemes.

Convergence
Various policies on agriculture, climate change, forestry, water conservation, livelihood, skill development and women empowerment can be implemented in tandem and an integrated manner.

Community participation
Involvement of beneficiaries and their ownership are the keys to successfully implement any scheme, so participatory irrigation may be promoted in innovative ways.

Access to finance
In order to involve and help small and marginal landholders adopt irrigation systems, easy and low-interest financing options or creation of revolving funds will be crucial.

IT-led innovation
Latest and enabling IT technology shall act as catalysts in increasing operational efficiency through precision farming and water-efficient irrigation systems, and new IT interventions like AI, IoT, satellite imaging and drones may be utilised.

Source: Stakeholder interactions and PwC analysis

With convergence of interrelated schemes and policies (being executed by multiple departments) and sustainable water-use management in agriculture could reduce the impediments in the path of effective and efficient implementation of the Government's schemes and programmes. It would need the support of private players, non-governmental organisations (NGOs), institutions, training, etc. Convergence would help to create a synergy between all stakeholders.

A convergence framework would be beneficial in the creation of sustainable and efficient water usage in agriculture and also achieve other objectives:

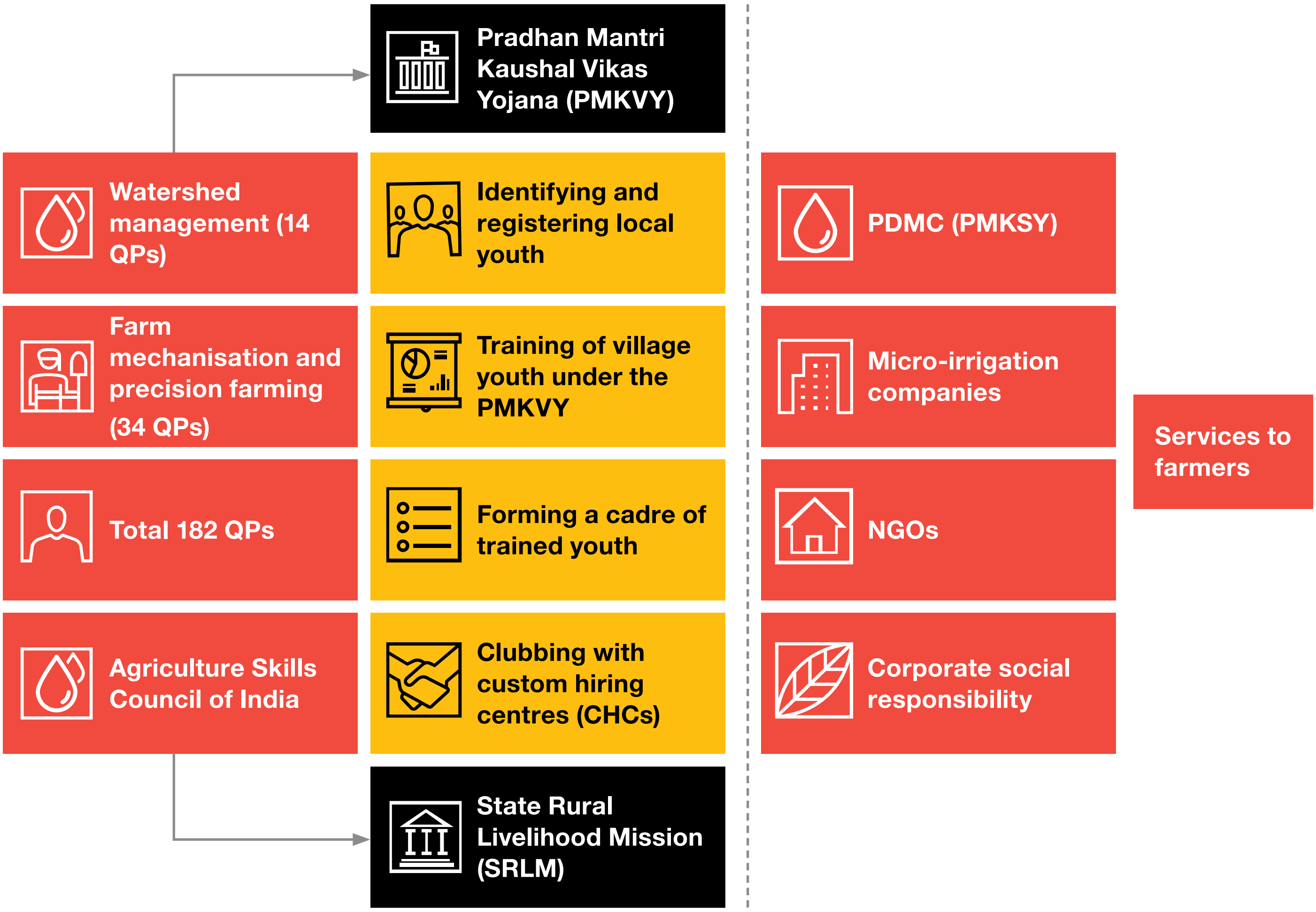
Department	Existing problems	How convergence would help
Water Resources Department	There is no convergence for micro-irrigation schemes yet, but there are instances of water structures being built in villages (not under micro-irrigation schemes).	Water conservation or resource-related structures would be created in regions, areas and villages and micro-irrigation enabled.
Forest and Environment Department	Plantation of trees and climate-related activities are being carried out in isolation.	There could be plantations in areas where water structures are created to stop soil erosion and ensure climate resilience.
Energy Department	There is no convergence between irrigation, forestry and renewable and non-renewable energy schemes.	It would ensure the utilisation of solar energy powered equipment and micro-irrigation systems to decrease the burden on non-renewable resources.
Skill Development	Services are limited and there are delays in repairing and maintenance of micro-irrigation systems at the village level, which hinder the adoption of facilities by small and marginal farmers.	It would enable skill training of village youth and create a cadre of trained and affordable people who could provide services for repair, maintenance and installation of micro-irrigation systems.

Source: PwC analysis

An illustrative convergence model for skill development to provide services for the enablement of micro irrigation

The Agriculture Skill Council of India (ASCI) was created under the Ministry of Skill Development and Entrepreneurship (MSDE) to build and upgrade the skills of farmers, agri-extension workers and youth engaged in agriculture and allied sectors. It has developed 182 qualification packs (QPs) to support agriculture and allied sectors. Farm mechanisation and precision farming (34 QPs) and watershed management (14 QPs) have also been identified as QPs. This indicates the seriousness of the Government to promote efficient irrigation practices and livelihoods for the youth.

The figure below depicts a model that could promote effective repair and maintenance services by training local unemployed youth, and thereby encourage the adoption of micro-irrigation by farmers and provide livelihood opportunities to the local youth.[59]



Source: Stakeholder interactions and PwC analysis

59 *https://asci-india.com/about-us.php*

Such a model could be adopted at the village level with the support of the local youth to provide affordable and timely services for the installation, repair and maintenance of micro-irrigation systems at farms. Convergence would help to bring in sustainable solutions for the adoption of modern technology by farmers and also resolve other issues faced by villages.

Community participation is important and would substantially upgrade the local socioeconomic condition of a targeted area and bring about mutual accountability, cost efficiency and sustainability. Engaging a community in planning, implementing and monitoring creates ownership, and also helps to ensure strategic convergence with other schemes and departments. Additionally, the local youth could be involved in these activities to enable holistic development of the area.

Community-based solar-powered micro irrigation in Punjab

Community-based solar-powered micro irrigation has been implemented in the Talwara and Hazipur blocks of Hoshiarpur district in Punjab. The key objectives of the projects include (a) land use and water and energy management, (b) the creation of a model for efficient irrigation, (c) science-based decision making, and (d) community participation for sustainable and efficient irrigation-water management. The project was implemented in around 1,200 farmer households. It costed INR 42.10 crore and was funded by the Remunerative Approach for Agriculture and Allied sector Rejuvenation (RKVY) which contributed INR 9.376 crore and NABARD which contributed INR 31.57 crore.

Existing problems

- Water-scarce area
- Undulating landscape with water being wasted due to runoff, resulting in soil erosion
- Unavailability of water for irrigation
- Problems pertaining to electricity

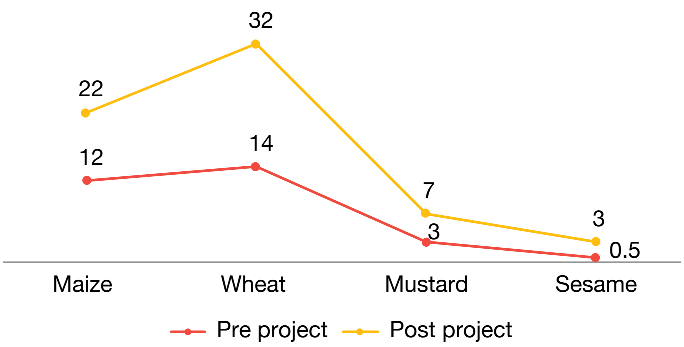
Interventions

- Community-led solar-powered and automated micro irrigation
- Livelihood training for the landless and women

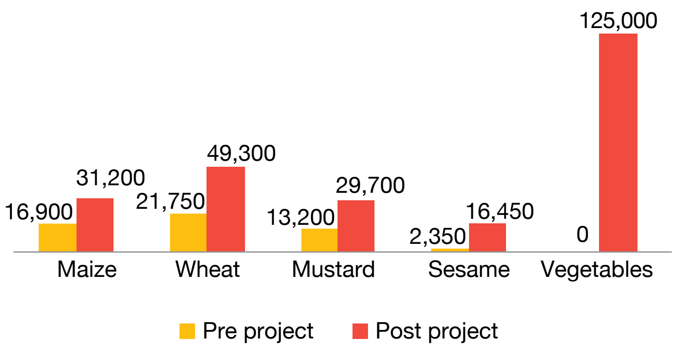
Impact

- Monocropping and diversification of crops
- Increased production
- Increased average income of farmers
- Creation of livelihood opportunities

Increase in production (in quintal/ha)



Change in average income (in INR)



Source: Department of Soil and Water Conservation, Government of Punjab, and PwC analysis

Similar intervention models in the policy ecosystem would help to bring about operational excellence and result in the success of community-led micro-irrigation systems. Active community participation along with enablement of the policy would result in more than the expected outcomes. Therefore, it is evident that a new policy ecosystem that would drive implementation of these initiatives would not only be practical but also result-oriented.

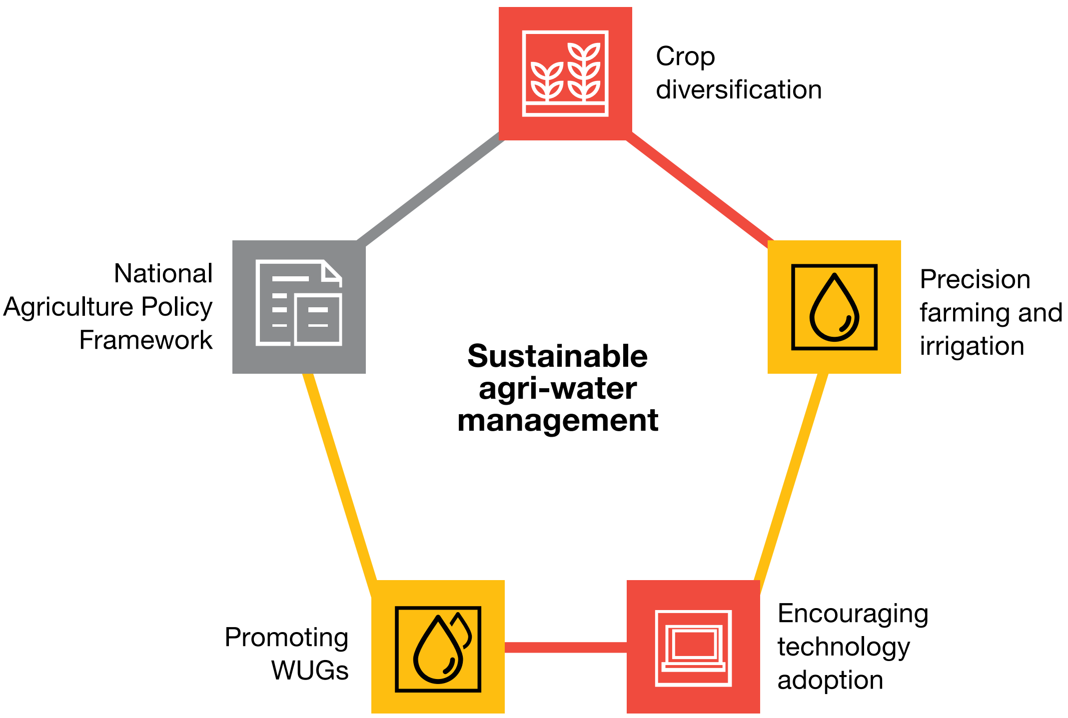
The new policy framework would devise mechanisms that will support a systemic change in the provision of access to institutional finance or revolving funds for effective implementation of irrigation policies. The interventions by corporates in providing interest-free loans to farmers to enable them to purchase new irrigation systems would boost the adoption of latest and modern irrigation systems.

The policy ecosystem needs to use information technology (IT) in a strategic manner and create solutions to ease accessibility for small and marginal farmers. Furthermore, capacity building of frontline workers and convergence with other schemes could also support the effective use of IT.

These practices provide a glimpse into how strategic interventions can lead to desired results. All that is required is a concerted effort to create an enabling ecosystem. The adoption of similar practices could be possible, but the policymakers would first need to replicate such enablers in the policy design so that the operational issues are minimised. It is evident that an integrated approach would be sustainable and effective, especially in the case of micro irrigation in which the role of the community is very important. Therefore, the participation of people, coupled with their adoption of technology, will result in effective and efficient outcomes in water-use management in agriculture.

5. Way forward

Water is an absolute imperative for the existence of life on earth and a common driver of various economic activities (agriculture, industry, etc.). Its sustainability is the need of the hour for India. Tackling water management in the agriculture sector is the key to doubling food production by 2050 and ensuring sustenance of this resource for future generations as well. The country is not far from facing a dire crisis resulting from overexploitation of its available water resources for agricultural production. There is a critical need to 'think smart' and adopt a holistic approach to resolve this looming issue.



Source: PwC analysis

Promoting crop diversification: Shifting cropping patterns in alignment with agro-climatic conditions in different regions in the country can lead to improved management of water usage in agriculture. Replacing water-intensive crops such as rice and sugarcane with ones that require less water (such as millets, pulses, etc.) can reduce water requirements for irrigation. Moreover, intercropping or mixed cropping can prove to be a beneficial for small and marginal farmers, and enable them to increase their produce (and consequently their returns) from the same field and inputs. Therefore, intelligent cropping practices that suit specific areas and the addition of available resources using smart irrigation technologies such as micro irrigation will result in a win-win situation for farmers as well as the Government.

Adoption of technology: Suitable adoption of technology in agricultural practices can play the key role of an enabler in the efficient use of water in agriculture. With the use of modern and innovative technologies such as AI and IoT, precision farming and irrigation can bring in proficiency and significantly reduce human interaction in irrigation systems. Precision farming and irrigation methods are solutions for effective water usage not only in water-scarce areas but also in regions where water is abundant. Drip irrigation has proven to be conducive for efficient irrigation and also resulted in increased production. Digital irrigation can help farmers manage the entire irrigation cycle on the basis of the frequency and timing of water required for crops. With the use of VRT a controlled supply can be ensured for fields and reduce overutilisation of water. The use of GPS or satellite imaging based irrigation can efficiently irrigate fields based on their moisture content and weather conditions. Other technological interventions such as nanotechnology-based irrigation, AI and robotics can help in irrigation-related water control, identification of water pooling and irrigation needs based on locations and weather conditions.

However, promoting the adoption of technology among farmers requires encouraging them to utilise programmes and incentives. The Government needs to package technology in affordable and encouraging schemes, and mobilise cultivators for the adoption of these options through rigorous extension and training programmes with demonstrations, with front-line demonstrations (FLDs) and exposure visits playing a major role. Awareness of banks and FIs on the importance of irrigation schemes and sustainable water-use management is crucial to put in place and propagate financing options for the ease of farmers. Convergence with other schemes and the creation of a package of incentives could ensure adoption and also ease access for beneficiaries. Furthermore, introducing subsidies for the adoption of solar-powered technology interventions can lead to input-related cost reduction in agricultural practices, including usage of electricity, and subsequently reduce greenhouse gas emissions. However, the adoption of technology by farmers needs adequate support through adequate handholding, follow-up in users' experience and maintenance-related support. This is an area where private players can play a significant role.

A participatory approach is critical in water-use management in agriculture to bring users, service providers and policymakers on a common platform. The creation of WUAs and WUGs or the management of irrigation systems by FLIs also need to be promoted to create community-led initiatives for sustainable and efficient water-use management in agriculture. This participatory approach can ensure capacity building of user groups for an improved implementation of projects and conservation of existing water resources. This will result in cost-optimisation of new technologies and initiation of modern irrigation and collective responsibility, and lead to the conservation of this fragile resource.

Sustainable water management in agriculture can be achieved by implementing an enabling policy ecosystem at the national level. A consistent and suitable policy framework can lead to effective and affordable technology interventions for smart water utilisation in agriculture, judicious distribution of usage rights and the establishment of institutions to ensure efficient management of different systems. Pricing of irrigation water is in practice in certain parts of the country but needs to be scaled up through PIM. Re-engineering of the Government's strategy for achievement of positive environmental externalities also needs to be seriously considered. And most importantly, the policy ecosystem should encourage policymakers, the private sector and users to adopt a 'water stewardship' approach to significantly enhance water-use efficiency in India.

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Contact us

Agriculture Division

Federation House, Tansen Marg
New Delhi-110001, India
agriculture@ficci.com
Ph: +91-11-23487415:
Fax: +91 11 2376 5333, 23721504

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Kaushal Jaiswal
Rivulis Irrigation India Pvt Ltd

Dr. Pankaj Kumar
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TAFE Ltd

Dr. Ajai Kumar
Corteva Agriscience

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DCM Shriram Ltd

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Corteva Agriscience

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Contact us

Ashok Varma

Partner and Head, Social Sector Advisory Practice
PwC India
ashok.varma@pwc.com

Shashi Kant Singh

Director, GRID
PwC India
shashi.k.singh@pwc.com

Acknowledgements

Authors

PwC

Guna Nand Shukla
Associate Director, Agriculture and Natural Resources, GRID
PwC India

Vishal Ranjan
Manager, Agriculture and Natural Resources, GRID
PwC India

Pooja Sharma
Manager, Agriculture and Natural Resources, GRID
PwC India

Md. Naved Aslam
Senior Associate, Agriculture and Natural Resources, GRID
PwC India

Vikas Ranjan
Senior Associate, Agriculture and Natural Resources, GRID
PwC India

Tejaswini Shirsat
Associate, Agriculture and Natural Resources, GRID
PwC India

Editorial support

Saptarshi Dutta

Dion D'Souza

Chandana Chandra

Design

Kirtika Saxena

Harshpal Singh

FICCI Project team

Jyoti Vij

Deputy Secretary General

Ruchira

Joint Director and Team Leader – Agriculture

Shikha Dutta

Assistant Director - Agriculture

Priya Ahuja

Research Associate - Agriculture

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