INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,
BENGALURU

EVALUATION OF RKVY PROJECTS
OF
UNIVERSITY OF AGRICULTURAL SCIENCES,
BENGALURU

"ESTABLISHMENT OF WATER TECHNOLOGY CENTER FOR CAUVERY COMMAND"

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ESTABLISHMENT OF WATER TECHNOLOGY CENTER FOR CAUVERY COMMAND

EXECUTIVE SUMMARY

India is an agrarian society and the agricultural sector accounts for 18% of India's gross domestic product (GDP) while providing employment to 50% of the country's workforce. India initiated its own Green Revolution programme in the field of plant breeding, irrigation development and financing of agrochemicals after 1960. The Green Revolution had several benefits, such as increase in production due to the use of high-yielding varieties of seeds, crop genetic improvements and irrigation, which led to widespread poverty reduction. However, the unabated adoption of unsustainable agricultural techniques and practices (high dependence on chemical fertilizers and pesticides) by farmers to produce more had an adverse impact on the environment. There were reports of loss of soil fertility, deteriorating state of water resources, pollution of groundwater and increase of salinity in groundwater.

Irrigation is one of the important inputs of scientific crop production. Water is a critical input into agriculture in nearly all its aspects having a determining effect on the eventual yield. Good seeds and fertilizers fail to achieve their full potential if plants are not optimally watered. The availability of adequate, timely and assured supply of water is an important determinant of agricultural productivity. Irrigation, in addition to raising productivity and cropping intensity, will also facilitate shifts in cropping patterns. Irrigated agriculture contributes to about 40 percent of the global food production from an estimated 20 percent of agricultural land, or about 300 million ha globally.

From about 16.9 percent of net irrigated area we have reached a figure of 40 percent. There are in all 119 major and 176 medium irrigation projects in the country. The efforts of the Governments have yielded rich dividends and nearly 65.6 % of the ultimate irrigation potential has been developed. From 22.6 million hectares of irrigation potential in 1950, today more than 90 million hectares of land have been brought under irrigation through major and medium (31.50 million hectares) and minor irrigation projects (57.96 million hectares). The ultimate irrigation potential of India is estimated as 139.95 million hectares including 56.00 million hectares by major and medium projects and 81.05 million hectares by minor irrigation projects comprising 17.40 million hectares by surface minor irrigation projects, 64.05 million hectares by ground water irrigation projects.

India with 17 percent of the world population has merely 4 percent of the world fresh water resources. It has a very low per capita water availability which puts it in the category of waterstressed nation. The average annual water availability in India is estimated to be 1869 billion cubic meters (BCM). However, due to hydrological, topographic and other constraints, the utilizable water is expected to be about 1123 BCM, out of which 690 BCM is from surface water and 433 BCM from replenishable groundwater.

The burgeoning world population and ever-increasing need of water is likely to cause water scarcity in the coming decades. India with a high population growth and millions of mouths to feed has immense pressure on agriculture. Even after seven decades of independence agriculture in India is primarily dependent on monsoons (INCID, 1994 and Narayanamoorthy, 1997). Farmers in India can play an active role in adopting efficient irrigation practices minimizing the wastage of water to a great extent. A large proportion of farmers in India falls in the small and marginal category (Narayanamoorthy, 1999 and 2005). All this background gives a very critical picture of the future of agriculture in India unless some radical agricultural practices are introduced to raise the production.

Water scarcity has many negative impacts on the environment, including lakes, rivers, wetlands, and other fresh water resources. Additionally, water overuse can cause water shortage, often occurs in areas of irrigation agriculture, and harms the environment in several ways including increased salinity, nutrient pollution, and the degradation and loss of flood plains and wetlands. Furthermore, water shortage makes flow management in the rehabilitation of urban streams problematic. Owing to poor water resource management system and climate change India faces a persistent water shortage. As per OECD environmental outlook 2050, India would face severe water constrains by 2050. Indian agriculture accounts for 90% water use due to fast track ground water depletion and poor irrigation systems.

As a result of climate change the country has been witnessing drought and flood at the same time, which has impacted agriculture productivity. About 40 million ha of the country is flood prone and every year about 8 million ha is affected by floods. The waterlogged area in the country is about 11.6 million ha.

Droughts have severe impacts on economy, society and environment affecting crops, irrigation, livestock, wildlife, soil, health problems, public safety ultimately leading to severe loss to human life. The period between 1950 and 1989 had 10 drought years, while there have been 5 droughts in the last 16 years (since 2000). According to meteorologists the frequency is set to increase between 2020 and 2049 (Collison, A. et al., 2000). Indian agriculture is crucially dependent on the local climate: favorable southwest summer monsoon is critical in securing water for irrigating crops. In some parts of India, the lack of monsoons results in water shortages, resulting in below-average crop yields.

Droughts mean less water availability for agriculture than usual. Increased groundwater use during droughts can help overcome such critical periods. However, the resulting groundwater overuse and quality deterioration mean there is also less groundwater available for agriculture than before, thereby causing even more pressure on agricultural production.

India is not a water rich country and is further challenged due to negative impact of climate change; enormous wastage owing partly to poor management and distorted water pricing policies. India receives an average of 4,000 billion cubic meters of precipitation every year (Vibha Dhawan, 2017). However, only 48% of it is used in India's surface and groundwater bodies. A dearth of storage procedure, lack of adequate infrastructure, inappropriate water management has created a situation where only 18-20% of the water is actually used. India's annual rainfall is around 1183 mm, out of which 75% is received in a short span of four months during monsoon (July to September). This result in run offs during monsoon and calls for irrigation investments for rest of the year. The population of India is likely to be 1.6 billion by 2050, resulting in increased demand for water, food and energy. This calls for infrastructure expansion and improved resource utilization.

At present, irrigation consumes about 84 %of total available water. Industrial and domestic sectors consume about 12 and 4 %of total available water, respectively. With irrigation predicted to remain the dominant user of water, "per drop more crop" is an imperative. The efficiency of water use must improve to expand area under irrigation while also conserving water. Irrigation infrastructure in India has seen substantial expansion over the years. The total irrigation potential created (IPC) has increased to 113 million ha at the end of the 11th Plan. The scope for further expansion of irrigation infrastructure on a large scale is limited. Over the years, there has been significant shift in the sources of irrigation. The share of canal in net irrigated area has declined from 39.8 % in 1950-51 to 23.6 % in 2012-13. Alongside, the share of groundwater sources has increased from 28.7 % to a whopping 62.4 % during the same period. This expansion reflects the reliability and higher irrigation efficiency of 70–80% in groundwater irrigation compared with 25-45% in canal irrigation. While proving to be a valuable source of irrigation expansion, injudicious utilization of groundwater through the explosion of tube wells has raised several sustainability issues (Vibha Dhawan, 2017).

Given the numerous challenges and the large share of water withdrawn for agriculture, irrigation and drainage, management has to address emerging climatic, technical, economic and organizational aspects through a holistic and integrated approach. In addition, increasing the surface water storage and its use has to be optimized by improving efficiency of delivery, increasing productivity and expanding irrigated area without withdrawing additional water. Measures need to be adopted in order to do this.

Some of these measures are to conserve, reuse and recycle water; to adopt improved water management and agronomical practices including water saving micro irrigation technologies such as drip irrigation, sprinkler irrigation, etc.; to reclaim degraded land; and to promote participatory irrigation management.

Different approaches have been put forward for using water efficiently, some are listed below.

1. The method of irrigation followed in the country is flood irrigation, which results in a lot of water loss. Greater efficiency in irrigation were achieved through:
    - Proper designing of irrigation system for reducing water conveyance loss.
    - Adoptions of water saving technologies such as sprinkler and drip irrigation systems have proven extremely effective in not just water conservation but also leading to higher yields.
    - New agronomic practices like raised bed planting, ridge-furrow method of sowing, sub-surface irrigation, and precision farming which offer a vast scope for economizing water use.

In this context, the Indian government has tried to inculcate new policies and schemes to improve agricultural productivity, while simultaneously increasing water use efficiency. The Indian government introduces schemes as commendable effort to increase irrigated area. One example is the launching of ~ USD 7,5 billion “Pradhan Mantri Krishi Sinchai Yojana (PMKSY)”. This scheme provides a sound framework for the expansion and effective water use in irrigation. The impact of this scheme can be greatly enhanced, however, by restoring the original flexibility of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in asset creation. Despite these efforts, still a specialized solution is required in chronically water stressed areas where measures implemented until now were ineffective.

2. Water productivity can be improved by adopting the concept of multiple water use, which is beyond the conventional sectoral barriers of the productive sectors. There is scope for increasing income through crop diversification and integration of fish, poultry and other enterprises in the farming system. The multiple water use approach can generate more income benefits, and decrease vulnerability by allowing more diversified livelihood strategies and increasing the sustainability of ecosystems.
3. Emphasis should be given on water resources conservation through watershed development in suitable areas and development of micro-water structures for rainwater harvesting. The promotion of water conservation efforts has direct implications for water resources availability, groundwater recharge, and socio-economic conditions of the population.

4. The effective water management is critically linked with the performance of local level water institutions. Therefore, institutional restructuring in favor of participatory irrigation management and water users associations (WUAs) needs to be strengthened.

Karnataka, one of India's most water scarce states, has a major challenge at hand. Its agricultural and economic growth aspirations will lead to an estimated 60 per cent increase in water demand by 2030. Karnataka will be unable to meet this demand unless it focuses on a state-driven comprehensive transformation of its water and agriculture sectors.

With agriculture accounting for 80 per cent of water use in the state, water efficiency in agriculture is a critical lever not just in meeting Karnataka's aspirations for agricultural growth, but also making water available for other sectors. Further, given that agriculture accounts for 61 per cent of employment in Karnataka, improving agricultural productivity will be essential to improve farmer income.

More ever the water management research in Karnataka remained confined to agricultural universities, institutes and research stations. The agricultural scientists of those organizations did not have much opportunity to interact with irrigation engineers and farmers in tackling on-farm water management problems. This has created a gap between the available research findings and their utilization for improving the design and operation of irrigation systems. In addition, optimum irrigation schedules for different arable or irrigated dry (ID) crops and cropping system, including intercropping, besides, seasonal water requirements, irrigation requirements and consumptive water use, progressive and peak consumptive water use rates, crop factors and soil moisture extraction patterns of different crops have been worked out for a limited number of crops. Moreover, some experiments have been conducted to evaluate different irrigation methods aiming at uniform application of required water depth to have better control of applied water to match the soil moisture deficit in the root zone before each irrigation in order to obtain higher efficiencies of water application and use.

The spatial and temporal adjustments between source/ supply and utility of water as a resource led to its scarcity in the place and time it is most needed. In recent years, its scarcity has not only jeopardized the agricultural production but also upset rural, urban and industrial development. Managing the water resources through scientific basis and organizing its developmental programmes including recycling and reuse has been a prioritized agenda at this juncture. A long term planning of water resource management for soil-water-crop in relation with weather modeling and remote sensing in Karnataka is absolutely necessary to achieve higher productivity without hampering the soil fertility. Hence, water efficient cropping systems, through crop diversification and integrated farming systems, location specific crops and cropping system models through farmer's participatory approach is the need of an hour.

To ensure that Karnataka has the water required to meet its economic growth aspirations, the state should embark on a comprehensive transformation of its water and agriculture sectors. The first step in such a transformation is to envision the end-state. Karnataka can set itself a vision of becoming the most progressive state in India in the areas of agriculture and water use. This will help unlock the potential to increase farmer income by 50 per cent by 2020 and by 100 per cent by 2030, thus improving the living standards of the large farmer community in the state.

Achieving this vision requires a state-driven transformation in water and agriculture, with private sector involvement in select areas. The transformation should leverage innovative but proven technologies in irrigation, agriculture and project execution, particularly focused on rice and sugarcane. The vision can encompass several focus areas: enabling agriculture to grow at an annual rate of 4 per cent; ensuring adequate service levels; allocating irrigation water equitably to all; and ensuring sufficient water is available for basic human needs, growth of industry.

Both surface and ground water resource management pose diverse and complicated challenges such as i) Ways and means to economize the water use, ii) Methods to conserve the water and develop water resources, iii) Strategies for economical and sustainable water use, iv) Water management research and related issues and v) Methods to fix, revise and rationalize water rates. In general, the over exploitation of underground resources, wastage of surface water, poor knowledge of water resource management; lack of policy initiatives and participatory approach indicate an obscure and insecure future, if proper strategies are not adopted to address these issues in holistic approach.

Keeping the above in view, the project, "**ESTABLISHMENT OF WATER TECHNOLOGY CENTER FOR CAUVERY COMMAND"** was taken up by University of Agricultural Sciences, Bengaluru with Rashtriya Krishi Vikas Yojana funding. The project was implemented from 2013-14 to 2018-19. The details of the project are as under:

1.	**Title of Project**	:	**"ESTABLISHMENT OF WATER TECHNOLOGY CENTER FOR CAUVERY COMMAND"**
2.	**Nodal officer and Principal Investigator**	:	**Dr. C. Ramachandra, Professor of Agronomy,** Zonal Agricultural Research Station, VC Farm, Mandya, UAS, GKVK, Bengaluru

3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	**Zonal Agricultural Research Station, VC Farm, Mandya**
4.	**Date of commencement of Project**	**:**	2013-14
5.	**Approved date of completion**	**:**	2018-19
6.	**Actual date of completion**	**:**	2018-19
7.	**Project cost**	**:**	Rs. 200 lakhs

The objectives of the project are as follows:

a. To conduct, co-ordinate and promote applied water research through multi-disciplinary approach.

b. To collect, collate and disseminate information relating to available water resources and water management research and effective utilization of water.

c. To function as a nodal agency for planning, programming and policy making in the management of water at all levels.

d. To act as a nerve-centre in organizing training programs, workshops, at grass root/command area based and state, national level seminars and to conduct short courses to acquire broad understanding of all aspects of water technology and management.

The focus of Evaluation is:

i. To evaluate the usefulness of various applied water research studies taken up through multi-disciplinary approach.

ii. To evaluate the relevance of information collected relating to available water resources and water management research and effective utilization of water.

iii. To evaluate the impact of organizing training programs, workshops, at grass root/command area based and state, national level seminars and to conduct short courses to acquire broad understanding of all aspects of water technology and management.

FINDINGS AND DISCUSSION

Research on water management

The Centre has conducted 15 applied research studies on various crops and cropping systems. In most of the studies, the effect of various irrigation management practices and nutrition on crops was evaluated. The results were mostly confined to assessing the effect on yield of crops and in some cases on water use efficiency and water productivity. In most experiments conducted, the parameters like irrigation methods and nutrition were combined. As a result, the singular effect of irrigation management practices on crop yield could not be independently assessed. In most studies, the economics of the various treatments have not been assessed.

The studies have brought to sharp focus the advantages of System of Rice Intensification (SRI), Mechanized system of rice cultivation and Aerobic method of rice cultivation over traditional practices and a large number of farmers in the command area have started adopting these practices. The studies have also revealed that the drip fertigation and sprinkler irrigation methods area not ideally suited in rice cultivation.

While studies have been conducted on use of micro irrigation techniques in various crops, there is need to understand the water use pattern in various planting geometry such as paired row planting, wider rows etc. The focus of these studies should have been on water saving without affecting the crop yields.

The need for application of micro nutrients has been demonstrated in some studies.

The studies on characterization of water availability and management in the canal command area have not been able to bring out measured needed to solve the problems faced by tail end farmers.

No appreciable benefit appears to have accrued from the study on applications of Remote Sensing and Geographical Information System for Soil Fertility Mapping of V C Farm, Mandya, Karnataka. Its relevance to the project needs to be elaborated.

A detailed study of the Cauvery command area pertaining to the available water resources, storage capacity of reservoirs, command area of the reservoirs, area of crops cultivated, irrigation potential created and present usage, cropping systems and their water use efficiency, soil types has been made and issues relating to water productivity have been collected. The information gathered has been comprehensive and gives a holistic view of the command area. The present scenario of the command area, reasons for poor water productivity and approaches to improve water use efficiency have been well detailed.

The centre has organized 38 training programmes/ workshops/ seminars/ brainstorming sessions/ world water day to educate the farmers on importance of water and adopting of water saving technologies for enhancing Water Use Efficiency in field crops. Around 4734 farmers have participated and benefitted from the programmes.

Large scale demonstration programmes have been conducted in farmers' fields in the command area to show case the advantages of methods of improved irrigation management practices. The large scale adoption of SRI, DSR, Mechanized rice cultivation and aerobic rice method by farmers is the culmination of the efforts of the scientists. The demonstrations have also been successful to help educate the farmers on use of water saving irrigation techniques like subsurface drip irrigation and sensor based drip irrigation. The feedback received from farmers has exemplified the efforts made by the scientists in educating the farmers.

REFLECTIONS AND CONCLUSIONS

1. The results of the research studies were mostly confined to assessing the effect on yield of crops and in some cases on water use efficiency and water productivity.
2. The singular effect of irrigation management practices on crop yield could not be independently assessed.
3. In most studies, the economics of the various treatments have not been assessed.
4. The studies have brought to sharp focus the advantages of System of Rice Intensification (SRI), Mechanized system of rice cultivation and Aerobic method of rice cultivation over traditional practices and a large number of farmers in the command area have started adopting these practices.
5. The studies have also revealed that the drip fertigation and sprinkler irrigation methods area not ideally suited in rice cultivation. Drip fertigation in aerobic / direct seeded rice is ideal under tail end areas and water scarcity situation. Hence this technology may be popularized through extensive demonstration and educating farmers on adoption of drip irrigation with an objective of considerable saving water besides improving soil health.
6. There is need to understand the water use pattern in various planting geometry such as paired row planting, wider rows etc.
7. The focus of the studies should have been on water saving without affecting the crop yields.
8. The studies on characterization of water availability and management in the canal command area have not been able to bring out measured needed to solve the problems faced by tail end farmers.
9. The relevance to the project study on applications of Remote Sensing and Geographical Information System for Soil Fertility Mapping needs to be elaborated. A case study was conducted at Zonal Agricultural Research Stations to know the physiography and soil types for adoption of micro irrigation under various soil textures in order to improve the water use efficiency. The results are yet to be compiled.
10. The information gathered in the study of the Cauvery command area pertaining to the available water resources, storage capacity of reservoirs, command area of the

reservoirs, area of crops cultivated, irrigation potential created and present usage, cropping systems and their water use efficiency and soil types has been comprehensive and gives a holistic view of the command area. The present scenario of the command area, reasons for poor water productivity and approaches to improve water use efficiency have been well detailed.

11. The demonstrations and training programmes have comprehensively influenced the farmers to adopt new methods of irrigation management methods and techniques.
12. The project has not been able to conclusively demonstrate to the farmers the need for crop diversification. However, on station research and demonstration focused on crop diversifications viz., ragi, maize, leguminous crops like red gram, cow pea, avare and vegetable crops were conducted by involving scientists of crop improvement, protection and production team.

ACTION POINTS

a. The project has been meticulously planned and well executed. The integration of research projects with demonstration farms and training and education platforms for farmers is a novel idea which has borne exemplified results worth emulating.
b. The Water Technology Centre is only one of its kind in the entire State. There is need to establish similar water technology centres in other command areas to study the problems in irrigation management methods and techniques in those areas.
c. There is need to design research studies to evaluate the various irrigation management methods to determine their effect on water use pattern, water use efficiency, water savings and economics of the use of the method.
d. The impact of irrigation management techniques like drip, subsurface irrigation on soil characteristics and soil microflora needs to be evaluated.
e. There is need to design demonstrations to educate the farmers, especially tail end farmers, on crop diversification.
f. There is need to draw a calendar of training programmes to educate the farmers in the command area on water saving techniques.
g. Although, some government line departments were involved in the project, the convergence of line departments is necessary for better implementation of similar projects.
h. One of the objectives of the project was that the Water Technology Centre should act as a nerve-centre in organizing training programs, workshops, at grass root/command area based and state, national level seminars and to conduct short courses to acquire broad understanding of all aspects of water technology and management. This objective has only been partially achieved. There is need to

identify the Water Technology Centre as a policy making agency with regard to irrigation management practices.