Role of Water Resources in Agricultural Development

Surender*

Research Scholar, Department of Geography, M.D. University, Rohtak

Abstract – The use of water resources for agricultural purposes, Agricultural water resource, main body of regional water resources, was affected by multiple factors (e.g. landform, climate, precipitation and water system). The water requirement will vary depending upon the crop cultivated in that area. The controller considers different parameters such as types of crop in that area, temperature, humidity, and wind speed while estimating the requirement of water. A case study shows that the optimal irrigation schedule can achieve water saving and production increment compared with the conventional irrigation schedule in which the whole field is fully irrigated. These measures mentioned above optimize disposition of agricultural water resources after the earthquake via source, transportation, irrigation, conservation and use of agricultural waters. Additionally, they could increase efficiency of utilization, reduce negative impacts to environments, and ensure durative of agricultural production.

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INTRODUCTION

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. Adequate availability of water is important for animal husbandry as well. Fisheries are, of course, directly dependent on water resources. India accounts for about 17% of the world's population but only 4% of the world fresh water resources. Distribution of these water resources across the vast expanse of the country is also uneven. The increasing demands on water resources by India's burgeoning population and diminishing quality of existing water resources because of pollution and the additional requirements of serving India's spiraling industrial and agricultural growth have led to a situation where the consumption of water is rapidly increasing while the supply of fresh water remains more or less constant[1]. Surveys conducted by the Tata Institute of Social Sciences (TISS) showed most of urban cities are water deficient. Nearly 40% of water demand in urban India is met by ground water. As a result ground water tables in most cities are falling at alarming rate of 2-3 meters per year.1 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. The water transformation plays an important role in thenrational allocation and avoiding overexploitation of resources. The south to North water diversion project overcomes the water scarcity of China and it is the largest water diversion in the world[2]. A survey was conducted to identify various issues such as the project cost, overruns, and delays. Poor water management along with water scarcity is lowering the performance of small-scale irrigation scheme in Ethiopia. In order to overcome this problem, several group discussion, and survey has been made. Further measurement has been taken to verify formers perception.

INDIA'S AGRICULTURE SECTOR

India ranks 2nd world wide in farm output. Agriculture and allied sectors like forestry and fisheries accounted 13.7% of the GDP (Gross Domestic Production) in 2013, and employed 50% of the workforce. The irrigation infrastructure includes a network of canals from rivers, ground water, well based systems, tanks and other rain water harvesting products for agriculture activities. Today ground system is the largest, covering – 160 million ha of cultivated land in India with 39 million ha irrigated by ground water, 22 million ha by irrigated canals and about two third of cultivation in India is still depending on monsoon.

"*The earth, the land and the water are not an inheritance from our forefathers but on loan from our children. So, we have to handover to them at least as it was handed over to us.*"

- Mahatama Gandhi2

India is the world's largest producer of fresh fruits and vegetables, milk, major spices, various crops such as jute, staples such as millets and castor oil seed. It is also the second largest producer of wheat and rice. The average size of the around 138 million farms was around 1.15 ha in 2010/11 and average size of large-scale farmers' farms (170.000) is around 37 ha in 2016 (BMEL India country report 2016). Agricultural extension has only one extension worker per 800-1000 farmers and degree of mechanization reaches less than 50% (BMEL India country report 2016). Indicators of water stress and scarcity are generally used to reflect the overall water availability in a country or a region. As per the international norms, a country is classified as water stressed and water scarce if per capita water availability goes below 1700 m3 and 1000 m3, respectively. With 1544 m3 per capita water availability, India is already a water-stressed country and is moving towards turning into water scarce[3].

ECONOMIC CHARACTERISTICS OF WATER

Water provides goods (e.g. drinking-water, irrigation water) and services (e.g. hydroelectricity generation, recreation and amenity) that are utilized by agriculture, industry and households. Provision of many of these goods and services is interrelated, determined by the quantity and quality of available water. Management and allocation of water entails consideration of its unique characteristics as a resource. These are discussed in brief below.

Water used for irrigation can be pumped from reserves of groundwater, or abstracted from rivers or bodies of stored surface water. It is applied to crops by flooding, via channels, as a spray or drips from nozzles. Crops also obtain water from precipitation. Water infiltrates into the soil, evaporates, or runs off as surface water. Of the water that infiltrates the soil, some is taken up by plants (and later lost through transpiration) and some percolates more deeply, recharging groundwater. This water can be polluted with agrochemicals (fertilizers, herbicides and pesticides), with salts leached from the soil and with effluent from animal waste. However, pollution can be attenuated as the water moves through the ground by processes that include sorption, ion exchange, filtration, precipitation and biodegradation. Aquifers can also be sources of pollution. Pollutants can be released into groundwater from pockets of contaminants or natural materials (e.g. sources of fluoride) within the aquifer. When river levels are low and groundwater levels are high, groundwater can recharge the levels of surface water, which creates a two-way linkage between resources of surface and groundwater.

It is not easy to control or prevent water use. Many uses of water involve the withdrawal of water from the hydrological system (known as 'extractive' or 'off-stream' use). Typically, only a small proportion of the water withdrawn is consumed. Water consumption is exclusive in its use. Consumed water is retained in plants, animals, or industrial products, so it is not available for other uses. However, most of the water withdrawn is not consumed and it returns to the water system for reuse at a later time and a different location. Water in return flows can reenter the surface water system further downstream, can percolate into aquifers, or evaporate, returning to the hydrological system in gaseous form. Therefore, water withdrawals are not exclusive within a broad perspective on water use, but only within a narrow location- and time-specific context. Water can also be used in-stream without removal from the hydrological system (e.g. in hydroelectric power generation or boating). Such uses generally entail little or no consumption of water but do affect the location and time at which water is available for consumption by other uses (Young, 1996).

Water is a 'bulky' resource. This means that its economic value per unit weight or volume tends to be relatively low. Therefore, its conveyance entails a high cost per unit of volume and is often not economically viable over long distances unless a high marginal value can be obtained. The costs of abstraction, storage and any conveyance tend to be high relative to the low economic value that is placed on the use of an additional unit of water. This can create values for water that are location specific (Young, 1996). A further characteristic of water is that the quantity of supply cannot be readily specified; it is determined by various processes: the flow of water; evaporation from the surface; and percolation into the ground. In the case of surface water, supply is determined largely by the climate. Consequently, the quantity supplied is variable and can be unreliable. This can preclude certain uses of water (e.g. the development of water-dependent industries) and affect the value of water in some uses (e.g. irrigation). The quality of water (i.e. the nature and concentrations of pollutants) can exclude certain uses (e.g. drinking-water for household use), but have no impact on others (e.g. hydroelectric power generation).

Characteristics of demand for water for irrigation relate to quantity, location, timing and quality. Irrigation generally requires large volumes of water, which can be low in quality. This is in contrast to household use of water, for example, which requires low quantities of water of high quality. The large volumes of water required for irrigation usually have to be transported over some distance to the field. For surface water, canals and pipes can enable conveyance; in the case of groundwater, extraction is provided via tubewells. In terms of timing, demand for irrigation water can extend through the growing season and, where adequate supplies are available, extend into the dry season for multiple cropping. Peak demand for irrigation water does not usually coincide with peak flows of surface water. This creates the need for storage capacity, which naturally occurring waterbodies (lakes, wetlands and aquifers) or specially constructed dams may provide. Although the quality of water required for irrigation is low, high levels of salinity preclude its use for irrigation, and contaminated supplies can reduce the quality of produce (e.g. contamination of horticultural produce with pathogens in polluted water supplies). Agriculture is implicated in issues that concern water quality. Leaching of effluent from animal wastes, especially from intensive livestock production, can pose a serious water pollution risk. Both return flows of irrigation water and precipitation runoff from arable land can pollute surface water with nutrients, herbicides, pesticides, salts leached from the soil, and sediment.

WATER AVAILABLE FOR AGRICULTURAL PRODUCTION

Available water

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. The Northern Ganga River Basin has abundant water resources, whereas the Southern River Basin has few, but with high levels of pollution in ground water and surface water. Increase in population and changing lifestyles has increased demand for water (largely for irrigation) in both urban and rural areas. India has 18% of world population, having 4% of world's fresh water, out of which 80% is used in agriculture. India receives an average of 4,000 billion cubic meters of precipitation every year. 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[3].

Water availability in different regions of India

The availability and demand for water resources in India show sizeable variations from one region to another. There is an inefficient and inequitable use of and distribution of water. Nearly 90% of the India population lives in areas with some form of water stress or food production deficit. Ground water has been relatively abundant in most parts of India. However, in some regions, it is becoming one of the most serious resource issues. Conditions of poor water quality and water stress in India are shown in Figures 1a and 1b

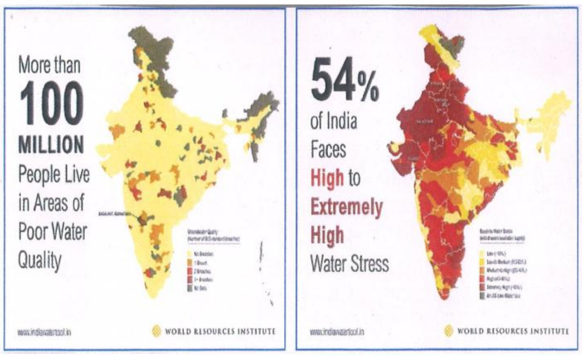

Fig: 1a & 1b

WATER AND AGRICULTURE

Groundwater and surface water use for agriculture

Although overall development of groundwater (groundwater draft as a proportion of the total availability) is 62%, there exists wide regional variability. Over-dependence on groundwater beyond sustainable level use has resulted into significant decline in the groundwater table, especially in northwest India. The Central Groundwater Board has categorised 16.2 % of the total assessment units: Blocks, Mandals or Talukas7 numbering 6607 as 'Over-exploited'. It has categorized an additional 14% as either at 'critical' or 'semi-critical' stage. Most of the over-exploited blocks are in northwest region of the country. The unsustainable groundwater use necessitates demand management and supply augmentation measures for improved water use efficiency in agriculture sector. On the other hand, Eastern region, where groundwater utilization is on a limited scale, offer greater scope for harnessing the benefits of groundwater usage to improve crop yields. Linkage of Canals (use of surface water): building storage reservoirs on rivers and connecting them to other parts of the country can impose reduction in regional imbalances and provide lot of benefits by way of additional irrigation, domestic and industrial water supply, hydropower generation, navigational facilities etc.

Groundwater utilization for irrigation

Globally, about 40% of irrigation water is supplied from groundwater and in India it is expected to be over 50%. The common pool nature of groundwater and the difficulty of observing it directly make this resource difficult to monitor and regulate, especially in developing countries. Groundwater resources are being depleted because of unsustainable extraction levels that exceed natural recharge rates. In India, groundwater irrigation covers more than half of the total irrigated area (around 42 million ha).8 Indian authorities collaborate at central, state and local level. The Central Water Commission has the objective of promoting integrated and sustainable development and management of India's water resources by using state of art technology and competency coordinating all stake holders. They are working on reserviour monitoring system, real time water quality monitoring, flood forecast, river basin management, watershed development, rejuvenation of major issues etc[4]. The Central Ground Water Board has been setup to develop and disseminate technologies for monitoring and implementing policies for scientific sustainable development and management of ground water resources including exploitation, assessment, conservation, augmentation, protection from pollution and strategy based on economic and ecological efficiency and equality. Central Water Commission and Central Ground Water Board have formulated "General Guidelines for Water Audit and Water Conservation". These guidelines have been circulated to all the state governments and concerned central ministries and other utilities for framing their own specific guidelines.

Some of the state governments such as Punjab (Northern India) offer free electricity for pumping ground water. States such as Gujrat and Maharashtra (Western India) offer high subsidy for solar pumps. For increasing water usage efficiency high subsidy has been given on water sprinklers/ drip irrigation systems. Several regions in the country face acute water stress chronically. These include districts of South and North Interior Karnataka (Southern India); Rayalseema in Andhra Pradesh (Southeastern coast of India); Vidarbha and Marathwada in Maharashtra (Western India); Western Rajasthan and Bundelkhand region of Uttar Pradesh (Northern India) and Madhya Pradesh (Central India). Low and erratic rainfall for consecutive years in these districts have rendered water-harvesting structures devoid of water and the conservation measures almost unviable. The water storage in reservoirs has depleted leading to scarcity of drinking water. The moisture index in majority of these districts in the range of -85 to -50%, denoting that natural precipitation is highly inadequate to support the arable cropping. States with the highest dependency on ground water for irrigation include Punjab (79% of the area irrigated is by tube-wells and wells), Uttar Pradesh (80%) and Uttarakhand (67%). Local governance in India has been formed under the Panchayati Raj system (PRC) in 1992. The Panchayati Raj system is a three-tier system with elected bodies at the village, taluk and district levels. The central and state government policies have put forward varying schemes to promote irrigation and water use efficiencies. The over enthusiasm of some of the state government is resulted in distorting water prices resulted in over exploitation of water. Various functions related to the development of agriculture as important one including decision related to irrigation services are taken by them at local level.

IRRIGATION IN INDIA

Intensity of irrigation

Since India is a country with an important agricultural sector, and over 55% of population is dependent on agriculture, many state governments are offering incentives to ensure availability of water for irrigation purposes, such as: State government of Punjab (Northern India) are offering free electricity for ground water pumping. Moreover, states of Gujarat and Maharashtra (Western India) offer high subsidy for solar pumps. Variations in irrigation intensity are due to among others varied geographical conditions in different parts of the country. Rugged mountains, sandy deserts and rocky terrains deep aquifers from which extracting water becomes an expensive proposition tend to have very poor irrigation facilities. Fertile alluvial plains with perennial rivers and potable groundwater as well as areas of less than 125 cm of annual precipitation are by far, the areas of high percentage of irrigation. The highest intensity of irrigation exists in the Kashmir Valley, large parts of the states of Punjab (Northern India) and Haryana, the Ganga-Yamuna Doab of the state of Uttar Pradesh (Northern India), Western part of the South Bihar (Eastern India) Plain, Birbhum, West Bengal (Eastern India), Lakhimpur, Assam (Northeastern, the Godavari Krishna Deltas and Chengalpattu district), Tamil Nadu (Southern India). The intensity of irrigation in these areas is above 60% and in some parts of Punjab (Northern India) it exceeds 75%. Dry areas of Ladakh district in Jammu and Kashmir and Lahul and Spiti district in Himachal Pradesh (Northern India) cannot raise crops without irrigation[5].

Groundwater-based irrigation

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) from major, medium and minor irrigation schemes has increased from 22.6 million ha during pre-plan period to 113 million ha at the end of the 11th Plan. Because this irrigation potential represents 81% of India's ultimate irrigation potential estimated at 140 million ha, 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.

Water use efficiency

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 (approx.) ~ 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)15 in asset creation. Despite these efforts, still a specialized solution is required in chronically water stressed areas where measures implemented until now were ineffective.

Specialized solutions are required in chronically water stressed areas where the normal measures may not be effective. Connecting highly water stressed areas with perennial water sources through linking of rivers or water grids is one such option. The value added agri-horti-pastoral agro-forestry systems and alternative sources of livelihoods are required in these districts. These districts could be ideal candidates for prioritized intervention of watershed plus activities (water conservation along with livelihood support activities) under the recently launched PMKSY and convergence with MGNREGA. As previously noted, priority must be given to the completion of on-going irrigation projects over initiation of new ones through strengthening of programs such as Command Area Development Programme (CADP)16 and Accelerated Irrigation Benefits Programme (AIBP)17. Promotion of alternative planting methods such as a system of rice production intensification and direct seeded rice can lead to water saving and productivity increases.

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.

5. National Water Policy is emphasizing the concept of Participatory Irrigation Management and WUA through active involvement of people in execution of irrigation project. According to the latest data available, 56,539 WUA manage 13.16 million ha of irrigated land. It will be useful to evaluate the effectiveness of this participatory approach.

TECHNOLOGIES RELATED TO WATER USE EFFICIENCY

Various government subsidy programs are attempting to boost adoption of more efficient technologies, with varying degree of success. Part of the logic behind this subsidy program is the hope that the adoption of water saving technologies can reduce groundwater extraction and stabilize water tables. However, groundwater is seldom regulated or even priced in India, and electricity used for pumping is heavily subsidized and often priced at a flat tariff. Recently, the state of Madhya Pradesh (Central India) has introduced a programme on raised bed planting of soybean. Planting of soybean on ridges has helped conserve water and raise productivity. Micro irrigation via sprinklers and drips has helped bring dramatic change in several pockets of the country especially in undulating topography and sand dunes areas where no other methods of irrigation can work.[6]

LITERATURE SURVEY

M. Abuzar et.al. [2013] Irrigation has a significant impact on water resources. It is therefore important that objective assessments of the use of irrigation water are undertaken on a regular basis. Current affordable remote sensing technologies provide an opportunity to assess and monitor water use at farm and regional scales. This study demonstrates the use of satellitebased estimates of evapotranspiration (ET) and NDVI in irrigation performance indicators that relate crop water use to crop water requirement in an irrigation region of Australia. A modified energy balance algorithm was used to derive ET estimates using Landsat-7 ETM+ data. Results show a consistent trend of slightly over-supply of crop water as compared to actual requirement at both field and farm scales during the peak irrigation season in 2011-12.. [7]

SHIVAM AGARWAL et.al. [2013] In this paper one of the application of Arduino mega 2560 board and ultrasonic sensors for social modernization of embedded technology is presented. ireless path following system in irrigation process of land is proposed as per the requirement of land. The sensors are used to detect the motion and soil moisture level of land. The objective is to build an autonomous, self-calibrating advance robot embedded with sensors and actuators that can be used for irrigation operation of agriculture. It is the primary way for production of crops with the operations like ploughing, seeding, irrigation, manuring, weeding. The robot is a composition of three main parts: electric circuit, mechanical design and algorithm. With the development of technology, automation is channelized with the process to facilitate the irrigation to increase the yield of crops and conservation of water resource and time. Row motion and alignment serve important role for smooth control of irrigation in the field and information is send to the user through coded output on any output device. In this paper the main focus is for irrigation.[8]

Chellaswamy C et.al. [2018] Water plays an important role in our day to day life in various fields. Introduction of new methods to solve the waterrelated problems includes adaptive management, remote sensing with the new concepts such as water security, global integration of information, etc. In this paper, we present an Internet of Things (IoT) based dam water management system (IoT-DWM) for reducing the wastage of water. The proposed IoT-DWM consists of various parts such as field sensing section, IoT network section, and dam control section, etc. The real data can be observed through different sensors placed in the agriculture area and updated it in the cloud. The dam controller receives the real data of the particular area and estimates the water requirement. The water requirement will vary depending upon the crop cultivated in that area. The controller considers different parameters such as types of crop in that area, temperature, humidity, and wind speed while estimating the requirement of water. The simulation result shows that the proposed IoT-DWM provides better results, save water in a considerable amount and leads to reduced water scarcity[9].

Dan Bai et.al. [2012] To meet the demand of crops irrigation water, theoptimal planning model of the field water saving irrigation, in which minimum incremental annual cost of field water aving irrigation engineering is the objective function, has been established based on types of ater resource, agricultural utilizable water yield, crop planting structure, status of water saving rrigation and feasibility of each water saving irrigation technology. To use the model, the injiang Hetian region optimal plan of water saving irrigation that includes optimal development scale of water saving irrigation for each crop in the region has been put forward in 2020. The model provides a scientific basis for reasonable planning of water saving irrigation and optimal llocation of water and land resources in region[10].

Diego Guidotti et.al. [2019] Technology-based solutions warrant to guide farmers and agronomists towards more efficient use of irrigation water. Indeed, wise irrigation practices are urgently required to overcome the increasing shortage of water resources due to the impact of climate change and the competition for water resources with other activities. With the aim of moving from traditional water management to advanced precision irrigation, we designed the Agricolus® platform. Here, we describe the approach used in building the platform, which integrates a set of different IT tools: sensors, farm management system, mathematical models, remotely sensed indices and decision support system. Agricolus will provide the final user with an easy-to-use integrated interface to properly assess the irrigation requirement and to finely schedule the water supply[11].

Qassem H. Jalut et.al. [2018] The impacts of using different water qualities conjunctively on soil hydraulic properties and root water uptake are vital for proper water management at the field level. Different scenarios were used to simulate water and solute transport in the root zone (within 100 cm) below ground surface in two farm field in Diyala governorate namely Al-Khuyls and Al-Hashmyat farm fields. The following scenarios were used: freshwater all season long, groundwater all season long, freshwater-groundwater all season long, and freshwaterfreshwater-groundwater all season long. It has been found that the hydraulic properties between (pressure head-water content, and pressure head-hydraulic conductivity) have no significantchange throughout the course of the irrigation season. A significant change has been found in root water uptake, water content and pressure head in two fields.[12]

YanJianget.al. [2013] The urbanization with increasing water demands and exploitation of groundwater are aggravating in recent years. Dwindling water supply and rapid expansion of irrigated agriculture have important implications for northern China's agricultural sector. Water scarcity and irrigation costs that increase with water use have motivated farmers and communities to adopt the water saving technologies in agricultural sector. Surface pipe system has being used popularly with relatively individual low fixed costs input and highly movable or divisible. In addition, underground pipe systems tend to be more recently adopted by communities or groups of households rather than household based or traditional water saving technologies. We seek to establish a set of first order facts about the role of this two water saving technology, and to increase awareness of pass trends and current status. So our efforts on this survey and research has focused on the economics and adoption these two types of water savings technologies with three specific objectives: (1) to illustrate progress in adoption rate over the past several decades, (2) to identifY the characteristics of technologies that have most popular and farmers' perspectives of technology traits, (3) to examine the determinants to promote or hold back the technologies adoption and diffusion. We find that, despite the growing use of the two of watersaving technologies in recent years, the extent of adoption is still low and there is still considerable room for the two kinds of technologies to be expanded in fitture.[13]

Jingling Li,et.al. [2011] In order to improve the use efficiency of nitrogen fertilizer and decrease the loss of nitrogen fertilizer, a twodimensional mathematical model on soil water movement and nitrogen transformation was set up by integrating the basic equation of soil water and nitrogen transport with characteristics of water and nitrogen transport in soil under water storage pit irrigation, and solved numerically by finite volume method. The model verification results showed that good agreement was obtained between simulated and measured values of soil water contents, ammonium concentrations and nitrate concentrations. It indicated that the mathematic model was correct and solving the model with finite volume method was feasible, the mathematical model can be satisfactorily used to describe the soil water and nitrogen transport properties under water storage pit irrigation.[14]

James Montgomery et.al. [2018] The use of water resources for agricultural purposes, particularly in arid and semi-arid regions, is a matter of increasing concern across the world. Optimisation techniques can play an important role in improving the allocation of land todifferent crops, based on a utility function (such as net revenue) and the water resources needed to support these. Recent work proposed a model formulation for an agricultural region in the Murrumbidgee Irrigation Area of the Murray-Darling River basin in Australia, and found that the well-known NSGA-II technique could produce sensible crop mixes while preservingground and surface water for environmental purposes. In the present study we apply Differential Evolution using two different solution representations, one of which explores the restricted space in which no land is left fallow. The results improve on those of the prior NSGA-II and demonstrate that a combination of solution representations allows Differential Evolution to more thoroughly explore the multiobjective space of profit versus environment.[15]

Sfiso H Nkosi, et.al. [2018] Adequate Irrigation improves food security crisis, maintains parks and sport-fields in good condition. The city of Cape Town in South Africa is currently experiencing water scarcity due to lack of rainfall. This has been affecting all living beings and plants. So, an Automated Irrigation and Water Level Management System is proposed using Raspberry Pi. The main objective of the project is to try minimizing the human intervention (gardeners) and try improving the usage of water during irrigation, also prevent water storage from drying out and overflowing. This is done by providing a system that will solely operate automatically. The proposed System will also help in reducing municipality water bills, save energy, improve the irrigation method for farmers (commercial and residential). This is because irrigation will only take place when it is needed. A webserver is developed using node red dashboard which gives access to the user to check all the process information of the system. Through the webserver one can access information such as soil status (dry nor wet), water level status, temperature & humidity status and email notification. Android smart phone or laptop can be used to access this information (display purpose) from the dashboard, they just must be connected to the same network as the system.[16]

Priyanka Padalalu, et.al. [2017] Water scarcity has been a big issue for agriculture. This proposed idea is beneficial to the farmers to irrigate the farms efficiently using an automated irrigation system based on soil temperature, moisture and pH. Respective sensors are used to find the soil water content level and based on thismicrocontroller drives the servo motor and pump. Irrigation status is updated to the database using PC. This technique works by installing sensors in the field to monitor the soil temperature, moisture and type of soil, which transmits the data to the microcontroller for estimation of accurate quantity of water as per the requirements. The collected data is updated from time to time to the server and can be accessed via an Android app. The subsequent watering of plants can be controlled using the aforementioned app. Depending upon the type of soil and crop, the fertilizers are suggested by applying Naïve Bayes algorithm on the database. The estimated amount of rain is predicted using weather forecasting using Web scraper and the crops are watered accordingly, i.e., is a heavy rainfall is predicted then the system will automatically reduce the water supplied to the crops.[17]

Yuan-feng Qiuet.al. [2013] This paper will use the straight line to describe the irrigation scheduling parameters, percent of deficit, application efficiency and coefficient of variation by simple mathematical model. Moreover, this paper uses the cost of water, price of yield, uniformity of the drip irrigation system, crop response to water application and environmental concerns of pollution and contamination to determine the optimal irrigation schedule. A case study shows that the optimal irrigation schedule can achieve water saving and production increment compared with the conventional irrigation schedule in which the whole field is fully irrigated.[18]

Vijay hari ram et.al. [2015] indian agriculture is diverse; ranging from impoverished farm villages to developed farms utilizing modern agricultural technologies.Facility agriculture area in China is expanding, and is leading the world. However, its ecosystem control technology and system is still immature, with low level of intelligence.Promoting application of modern information technology in agriculture will solve a series of problems facing by farmers. Lack of exact information and communication leadsto the loss in production.Our paper is designed to overcome these problems. This regulator provides an intelligent monitoring platform framework and system structure for facility agriculture ecosystem based on IOT.This will be a catalyst for the transition from traditional farming to modern farming. This also provides opportunity for creating new technology and service development in IOT (internet of things) farming application. The Internet Of Things makes everything connected. Over 50 years since independence, India has made immense progress towards food productivity. The Indian population has tripled , but food grain production more than quadrupled[1]: there has thus been a substantial increase in available food grain per ca-pita. Modern agriculture practices have a great promise for the economic development of a nation. So we have brought-in an innovative project for the welfare of farmers and also for the farms. There are no day or night restrictions. This is helpful at any time.[19]

Mohamad Shukri Bin Zainal Abidin et.al. [2015] Subsurface micro irrigation techniques such as capillary irrigation has long been proven to provide higher water saving for cultivation. Advancement of the capillary irrigation system has been made by using a high capillarity fibrous medium to transfer water directly to the rooting zone of plant. Wicking of water through the fibrous medium depends on the distance from a water source which known as water supply depth. The irrigation system is being managed by manipulating the water supply depth. However it is difficult to determine the optimum depth due to the dynamic water requirement which depends onthe plant growth stage and climatic change. In this study an adaptive method was introduced to manage the irrigation system based on water balance and energy balance model. Using the estimated data the optimum depth was determined by using fuzzy expert system. An experimental set-up was built using the fibrous-capillary irrigation system that allowed the change of water supply depth in real time. The optimum water supply depth obtained based on the adaptive method was analyzed based on water usage and plant yield which showed significant amount of water saving. The results suggested the feasibility of the waterand energy control model as an irrigation scheduling index for the fibrous-capillary irrigation system.[20]

Yang-ren Wang et.al. [2016] In the case that water resources cannot meet the irrigation water requirement, how to Irrigate according to the crop optimization irrigation time, maximize benefit of the limited water supply, is an important problem for agricultural sustainable development. So the concept of dynamic irrigation low limit was put forward. The dynamic irrigation low limit relates with crop growth and development time and water supply. When the water supply is small, the irrigation low limit should be reduced in order to make use of limited water supply in the drier later crop growth stage. On this basis the average soil moisture content of main root zone before irrigation under the optimal rrigation schedule is used as a irrigation low limit. By using statistical analysis method the relationship among irrigation low limit value, the corresponding irrigation time and water supply afterwards (The sum of the available irrigation water and rainfall), was determined. The method changed the traditional way to determine the irrigation lower limit solely based on field experiment and to a certain extent, enrich and improve thetheory of farmland irrigation. The irrigation prediction based on dynamic irrigation low limit provides key method to implement optimal irrigation schedule and dynamically correct irrigation plan under of limited irrigation.[21]

CONCLUSIONS

Presently, India is facing a decrease in available water resources that has implications on India's agriculture sector. Several regions in the country are experiencing water stress. If water use efficiency does not improve, the country could suffer under water scarcity in the next 1 to 2 decades. It is exceedingly important that the agriculture sector contributes to prevent the exacerbation of the situation by making best use of the available technologies and resources to increase water use efficiency. Improvement of policies, strategies and regulatory measures to prevent the water misuse should be taken into consideration. Awareness and orientation of water users in the agriculture sector to switch to more water efficient production methods can help the country against water scarcity. Moreover, enforcement of best practices can help present policy makers and planners to enhance governance structures to further understand key indicators that can assist in data-driven decision-making. These challenges can be better implicated, provided there are favorable policies and mechanisms that encourage the agriculture sector to increase water use efficiency.

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Corresponding Author

Surender*

Research Scholar, Department of Geography, M.D. University, Rohtak

sgulia410@gmail.com