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ENERGY CONSERVATION THROUGH CENTRALIZED PUMPING IN IRRIGATION USING AN OUTLET MANAGEMENT SYSTEM (OMS)

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Abstract- Irrigation is an essential component of modern agriculture, and the demand for water in agriculture is increasing with the growing population. The conventional irrigation systems consume a significant amount of energy for pumping water, which leads to high operational costs and environmental degradation. This research paper focuses on the energy conservation in irrigation through centralized pumping and an outlet management system. The outlet management system regulates the water flow and pressure, which leads to better irrigation efficiency and energy conservation. The research paper provides a detailed analysis of the outlet management system and its impact on energy conservation in irrigation. The study also includes a case study of an irrigation project in India, where the outlet management system was implemented, and the results showed significant energy savings.
Keywords: Centralized & Decentralized pumping, Outlet Management System (OMS), SCADA, Micro Irrigation.

1 INTRODUCTION

In India, agricultural pump sets contribute significantly to irrigation costs and account for about 18.5% of the country's energy consumption. This consumption is projected to increase by 54% from 2015 to 2022, emphasizing the need for energy efficiency. Locally manufactured pump sets used for irrigation result in extensive water waste and higher energy usage. Implementing pressurized irrigation systems enables efficient utilization of limited water resources. By diverting river water for irrigation instead of letting it flow into the sea, reliance on groundwater is reduced, preserving water reserves for essential drinking purposes. This approach optimizes water usage, promotes sustainability, and conserves precious groundwater supplies, contributing to overall water resource conservation and addressing water scarcity challenges responsibly. One major constraint in this sector is farmers' dependence on irrigation pumps, including grid-connected and diesel/fossil fuel-driven pumps. Studies indicate that this sector consumes nearly 20% of India's installed power. The high cost of diesel fuels and electricity shortages impact decision-making for irrigation network managers, who must balance water and energy requirements for crop irrigation.

Several problems are associated with irrigation in India:

1. Overuse of Groundwater: Increasing irrigation demands have depleted groundwater resources, leading to declining water tables and aquifer depletion, particularly in areas without access to surface water for irrigation.
2. Poor Water Management: Outdated irrigation techniques, inadequate maintenance of infrastructure, and limited electricity supply in rural areas result in inefficient water use, causing waterlogging, soil salinity, and reduced crop yields.
3. Inequitable Water Distribution: Water allocation for irrigation often favors large farmers and landowners, creating social and economic disparities compared to small farmers and landless laborers. This imbalance frequently leads to conflicts over water resources.
4. Climate Change: Changing weather patterns, such as droughts and floods, disrupt the availability and distribution of water resources, posing challenges for farmers to plan and manage their crops effectively.

Decentralized pumping involves individual farmers using their own pumps to irrigate their fields. Groundwater is extracted using submersible or vertical turbine pumps, while surface water is drawn using centrifugal pumps like split case pumps or end suction pumps. These pumps need to adapt to changing conditions above and below ground, affecting the required pressure and flow on a daily and seasonal basis. To ensure adequate pressure and flow at the nozzle, farmers often choose to oversize the pump to handle worst-case scenarios. However, this leads to the pump operating inefficiently at all times, generating excessive pressure and consuming unnecessary energy. This results in energy wastage, high electricity costs, and a low power factor due to excessive use of induction motors for irrigation. Additionally, this system indirectly harms the environment by relying on non-renewable energy sources to power the motor pumps. If we consider an agricultural irrigation system as a car and the pump as its motor, it would not make sense to drive the car at full throttle constantly and control the speed with the brakes. Yet, this is a common approach for irrigation pumps, leading to inefficiencies and wasteful energy consumption.

Centralized pumping involves integrating individual pumps into a unified system to irrigate a specific area. The process begins by sourcing water from groundwater or surface water channels.

The water is then distributed through chambers, and finally delivered to the crops using gravity and an outlet management system that monitors and controls water flow for each 30-hectare section. The current approach of installing oversized pumps, capable of providing excessive water at all times, leads to wasteful expenditure and energy usage. Using the car metaphor mentioned earlier, it is like buying an oversized motor for a car, resulting in unnecessary costs without guaranteeing a comfortable or fuel-efficient ride. In this centralized irrigation system, pumps serve a more advanced purpose than simply delivering water to the pipes. For instance, incorporating variable speed drives improves the efficiency of groundwater extraction when pumping directly into the irrigation system.

Irrigation energy conservation through centralized pumping using an Outlet Management System (OMS) is an area of research focused on optimizing energy usage in irrigation systems. The OMS is a control and monitoring system that regulates water flow and pressure in a centralized pumping scheme. By integrating individual pumps into a unified system, the OMS ensures efficient water delivery to the fields.

2 LITERATURE REVIEW

Mekala Nagajyothi, Sirisha, Automation of farm activities can transform agricultural domain from being manual and static to intelligent and dynamic leading to higher production with lesser human supervision. This paper proposes an automated irrigation system which monitors and maintains the desired soil moisture content via automatic watering. SoC ESP8266 Wi-Fi module platform is used to implement the control unit. The setup uses soil moisture sensors which measure the exact moisture level in soil. This value enables the system to use appropriate quantity of water which avoids over/under irrigation and the ph sensor measure the ph value of water finally the DHT11 used to analysis the temperature of atmosphere. IOT is used to keep the farmers updated about the status of sprinklers. Information from the sensors is regularly updated on a webpage using internet through which a farmer can check whether the water sprinklers are ON/OFF at any given time. Also, the sensor readings are transmitted to cloud storage to generate graphs for analysis.

Pavankumar Naik, Arun Kumbi, Kirthishree Katti, Nagaraj Telkar, India is mainly an agricultural country. Agriculture is the most important occupation for most of the Indian families. It plays vital role in the development of agricultural country. In India, agriculture contributes about 16% of total GDP and 10% of total exports. Water is main resource for Agriculture. Irrigation is one method to supply water but in some cases, there will be lot of water wastage. So, in this regard to save water and time we have proposed project titled automatic irrigation system using IoT. In this proposed system we are using various sensors like temperature, humidity, soil moisture sensors which senses the various parameters of the soil and based on soil moisture value land gets automatically irrigated by ON/OFF of the motor. These sensed parameters and motor status will be displayed on user android application.

G. Sasi Kumar*†, G. Nagaraju*, D. Rohith* and A. Vasudevarao, With India's population growing at a rapid pace, traditional agriculture will have a tough time meeting future food demands. Water availability and conservation are major concerns for farmers. This paper aims to discuss the aspects related to designing and fabricating an automatic irrigation system using the Internet of Things (IoT) which will save the farmer's time and money significantly. Human intervention in fields will be reduced. Changes in soil moisture are detected by soil moisture sensors and irrigation is automated using IoT. The proposed system is most economical for underdeveloped places because it is very costeffective. Based on the soil moisture content, the sensor detects and sends signals to the node MCU, which activates the motor. When the plants receive enough water, the motor automatically shuts off. The user will be alerted about the soil's moisture content through his mobile phone. The proposed smart irrigation system is implemented at our campus which conserves energy and water.

A. A. Okandeji, F. Onaifo, M. T. Kabir and K. Yakubu, This work considered the design and implementation of an Internet of things (IoT) based irrigation system that encourages efficient and optimal use of water management practice. The proposed IoT based irrigation system promotes user acknowledgment practice on farmlands by monitoring the soil moisture value and other environmental parameters. This system, which is based on IoT, stores the sensor data, and the water pump can be monitored via the internet using a Thing Speak channel. Using a micro-controller which coordinates system activities, a wireless fidelity (WIFI) module which transmits the sensed data to the cloud, a motor driver which controls the pump, a digital temperature and humidity (DHT)11 sensor which monitors environmental parameters, and a YL-69 soil moisture sensor, an IoT based irrigation system is implemented. Results obtained showed that the system irrigates the soil based on the defined threshold value of the soil moisture in order to promote efficient and optimal utilization of water management practice. Additionally, farmers can monitor the irrigation processes remotely from a Thing Speak channel, which gives a graphical representation of the soil moisture value, pump status, temperature and humidity value as well as the flow rate within the environment.

V. B. Shinde1* and S. S. Wandre2 , Irrigation is a well-established procedure on many farms and is practiced on various levels around the World. It allows diversification of crops, while increasing crop yields. However, typical irrigation systems consume a great amount of conventional energy through the use of electric motors and generators powered by fuel. Photovoltaic energy can find many applications in agriculture, providing electrical energy in various cases, particularly in areas without an electric grid. In this paper the description of reviews on a photovoltaic irrigation system, is presented. Photovoltaic water pumping system is one of the best alternative methods for irrigation. The variation of spatial and temporal distribution of available water for irrigation makes significant demand on water conservation techniques. Hence solar powered Automated Irrigation System provides a sustainable solution to enhance water use efficiency in the agricultural fields using renewable energy system removes workmanship that is needed for flooding irrigation. The use of this photo-irrigation system will be able to contribute to the socio-economic development. It is the proposed solution for the energy crisis for the Indian farmers. This system conserves electricity by reducing the usage of grid power and easy to implement and environment friendly solution for irrigating fields.

Vahan Bagdasarian, Grundfos, Modern agricultural irrigation is a complex interplay of sustainable energy consumption, water use, market conditions, and the application of experience and knowledge to ensure the best design for irrigation applications. Understanding past practices, current water and energy issues, and developments in pump technology contributes to building pumping systems that best service the needs of modern agriculture. The agricultural market is changing rapidly, and farmers cannot rely on the technology and practices of the past. To keep productivity high and stay competitive in the market, farmers need to focus on profitability, which includes energy optimization and better use of water resources. Pumping systems play a vital role in providing optimized solutions for energy and water use.

Lingli Zhao, This paper studies the design of water-saving irrigation system based on Internet of things. The structural model of the water-saving irrigation system was established, and the hardware and software of the control system were designed, with emphasis on the design and coverage calculation of the sensor nodes in the wireless sensor network. The wireless network and control system are tested, including network coverage, network connection, optimal communication distance and accuracy of data transmission. The experimental results show that the data transmitted by the wireless sensor is accurate and reliable, and the software and hardware of the automatic control system can work normally. The system can carry out intelligent irrigation timely and accurately.

B.I. Bakare, T.C. Ewunonu, S.A. Bruce-Allison, and Ekele Eke, Advancement of technology has led to the automation of Irrigation system which has helped to solve a lot of problems encountered by the various non-automated types of irrigation syatem. The use of electronics has made irrigation easier, more efficient and flexible, various automatic irrigation systems has been developed to help the farmer carry out irrigation. This Research work involves applying electronics and software engineering as a means of solving the irrigation issues faced by farmers. This paper is limited to the development of Smart Irrigation System that can be controlled by software application, which also can be used to monitor irrigation in real time. It makes use of light, temperature, soil moisture sensors, LCD, PIC microcontroller and it is coded using C++ Programming language. This irrigation system consists of four different sensors which are used to measure various parameters related to the crop production. They are Light Dependent Resistor (LDR), Humidity Sensor, Soil moisture Sensor and temperature Sensor. The LDR is used to determine the intensity of light or the time of the day. This helps the system to regulate the irrigation from time to time. The Soil moisture sensor is used to determine the moisture. An app that gives the farmer information on the amount of insolation, temperature and soil moisture level was also incorporated in the system.The smart irrigation system developed was able to automatically monitor and control the level of water available to the plants without any human intervention at the farm. This intelligent system is limited to only a single plant or crop as future study could be extended to monitor a larger portion of land with two or more crops.

Cafer GENÇOĞLANa, Hayri ŞAHANb, Serpil GENÇOĞLAN, Hydrocyclones are used as pre-filter to reduce suspended particles in irrigation water on the subsequent filters. The aim of the study was to determine separation efficiency (SE) of hydrocyclones, called H1, H2 and H3 according to inlet/outlet diameters, at water velocities of 1.0 (V10), 1.5 (V15) and 2.0 (V20) ms-1 , and sands diameter of 0.5 (D05), 1.0 (D10), 1.5 (D15), 2.0 (D20) and 2.5 (D25) mm. Therefore, a hydrocyclone laboratory test system was constituted using a water tank, motor pump, inverter, flowmeter, valve, hydrocyclone, disk filter, and polythene pipe. Separation efficiencies were calculated by dividing amounts of sand collected in collection box by feeding amount of sand. The lowest average separation efficiency was determined as 37% at H1V10D05 treatment and the highest ones as 97% at both H2V20D10 and H3V20D20, and the other ones changed between two values. Average separation efficiencies resulted as 69%, 88% and 88% for H1, H2 and H3 hydrocyclones, and 71%, 84% and 90% for V10, V15 and V20 water velocities, and 78%, 82%, 82%, 83% and 84% for D05, D10, D15, D20 and D25 sand diameters, respectively. Besides these, average separation efficiency for three parameters was 82%. Since the inlet size of H2 is smaller than that of H3 and its SE was higher than that of H1 and equal to that of H3, the most suitable hydrocyclone was determined as H2 to be used in the micro irrigation. The highest average separation efficiency was 90% at a water velocity of 2.0 ms-1. According to separation efficiency of the hydrocyclone, the optimum water velocity in the inlet of the hydrocyclone was determined as 2.0 ms-1. The separation efficiency of hydrocyclone showed that the efficiencies increased with increasing water velocity from 0.5 ms-1 to 2.0 ms-1 and sand diameters from 0.5 to 2.5 mm. In separation efficiency for micro irrigation, water velocities and suspended materials play crucial roles as well as hydrocyclone mechanical properties.

Yuthika Shekhar, Ekta Dagur, Sourabh Mishra, Rijo Jackson Tom and Veeramanikandan. M, Suresh Sankaranarayanan, Agriculture has a major impact on economy of the country. Lot of Research been carried out in automating the irrigation system by employing wireless sensor and mobile computing. Also research been done in applying machine learning in agricultural system too Recently “Machine to machine (M2M)” communication is an emerging technology which allows devices, objects etc to communicate among each other and send data to Server or Cloud through the Core Network. So accordingly, we here have developed an Intelligent IoT based Automated Irrigation system where sensor data pertaining to soil moisture and temperature captured and accordingly KNN (K- Nearest Neighbor) classification machine learning algorithm deployed for analyzing the sensor data for prediction towards irrigating the soil with water. This is a fully automated where devices communicate among themselves and apply the intelligence in irrigating. This has been developed using low cost embedded devices like Arduino Uno, Raspberry Pi3. **Shitu, Tadda, and Danhassan**, Management and control of water resources is an issue on the rise around the globe, as agriculture lead other activities in terms of percentage usage of water whereby more than 50% is wasted due to evaporation as a result of many factors like; inappropriate irrigation structure design or installation, maintenance or poor scheduling of the structures. This review on “Smart

Control Systems for Water Management in Agriculture" is in a way that different approaches and methods of using smart controller and sensors were studied as well as some mathematical relations. When automatic irrigation systems are coupled with new technologies such as; soil moisture sensors (SMSs); rain sensors (RSs); evapotranspiration (ET) – based controllers, wind sensors; web-GIS and remote sensing wireless controllers together with some soft computing techniques like artificial neural networks (ANN), genetic algorithm (GA), fuzzy logic (FL) could lead to optimum utilization of irrigation water resources while maintaining the quality of crops and other agricultural produce. Smart irrigation technology and techniques applications are not only limited to agriculture but also to managing of landscapes and lawns to ensure precision agriculture.

Yigrem Solomon, P N Rao, Tigist Tadesse, Utilization of solar photovoltaic powered (PV) as a power source in water pumping systems has emerged as one of the valuable solar applications. Solar PV water pumping system (SPVWPS) is used to fulfill the demand of water in the field of irrigation and domestic use. This technology is recognized as a sustainable and environmentally friendly solution to provide water for domestic use and irrigation purpose.The tendency to use renewable energy resources has grown continuously over the past few decades, due to fear over warnings of global warming or because of the depletion and short life of fossil fuels or even as a result of the interest which has developed among researchers doing scientific research into it. This work can be considered as joining any of these groups with an objective of supplying drinking water and irrigation purposes to the society living in rural areas of the country as reported in the literature to serve as a quick reference to researchers and engineers who are interested in the subject. For further research perspective in the field of SPVWPS a few suggestions are recommended.

Prof. Mangesh R. Dhage, Prof. Vaibhav S. Girnale, Prof. Chetan P. Patil,Agricultural technology is changing rapidly. Farm machinery, farm building and production facilities are constantly being improved. Agricultural applications suitable for photovoltaic (PV) solutions are numerous. These applications are a mix of individual installations and systems installed by utility companies when they have found that a PV solution is the best solution for remote agricultural need such as water pumping for crops or livestock. A solar powered water pumping system is made up of two basic components. These are PV panels and pumps. The smallest element of a PV panel is the solar cell. Each solar cell has two or more specially prepared layers of semiconductor material that produce direct current (DC) electricity when exposed to light. This DC current is collected by the wiring in the panel. It is then supplied either to a DC pump, which in turn pumps water whenever the sunshine's or stored in batteries for later use by the pump. Solar Photovoltaic water pumping system (SPVWPS) has been a promising area of research form more than 50 years. SPVWPS consists of different components and parts associated with different fields of engineering like mechanical, electrical, electronics, computer, control and civil engineering. The interdisciplinary nature of the system attracted there searchers, in the past, from all these fields of engineering and has been contributed by them to make the system more efficient and cost-effective to meet water-pumping needs of human, livestock and irrigation.

Ms. Sahaya Sakila, V. Dinesh Udayakumar, Chandrasekar Rajah, M Karthikeyan, an automated irrigation system was developed for optimized usage of water in agriculture. The system has a distributed wireless network of soil moisture, humidity and temperature sensors placed at the root zone of plants. A centralized unit handles sensor information triggers them and transmits data on the internet so the user can monitor the field in real time from any remote location. A mechanism was developed depending on the threshold values of the soil moisture, humidity and temperature and is programmed into the control unit to control the quantity of water fed to the irrigation field. Sensing unit and central control unit are connected with each other via a wireless link. Because of low energy consumption and cost, the system has potential to be useful in water-limited geographically isolated areas.

Bharath D.A., S. Amith Nadig, Manjunath G.S., To realize IoT promise in commercial-scale applications, integrated Internet of Things (IoT) platforms are required. The key challenge is to make the solution flexible enough to fulfil the demands of specific applications. A IoT based platform for smart irrigation with a flexible design is created so that it allows developers to quickly link IoT and machine learning (ML) components to create application solutions. The design allows for a variety of customized analytical methods to precision irrigation, allowing for the advancement of machine learning techniques. Impacts on many stakeholders may be predicted, including IoT specialists, who would benefit from easier system setup, and farmers, who will benefit from lower costs and safer crop yields. The typical irrigation procedure necessitates a large quantity of water use, which results in water waste. An intelligent irrigation system is desperately needed to decrease water waste during this tiresome process. Machine learning (ML) and the Internet of Things (IoT) have made it possible to develop an intelligent system that can accomplish this operation automatically and with minimum human intervention. An IoT-enabled ML-trained recommendation system is suggested in this paper for optimum water consumption with minimal farmer interaction. In the agriculture field, IoT sensors are used to capture exact ground and environmental data. The collected data is transferred and kept in a cloud-based server that uses machine learning to evaluate the data and provide irrigation recommendations.

Kizito Masaba, Amini Ntakirutimana and Taha Selim Ustun, Although water, in some parts of the world is as abundant as the air that we breathe, it is still a precious resource in dry regions. Such regions must use it carefully and efficiently because of its scarcity. However, the irrigation systems are still wasteful as they unnecessarily flood the farms. This results into wastage of water and energy that is used for pumping the water. With the improvement of the technological infrastructure, effective management of water usage and power consumption of irrigation systems can be achieved. This can be done by enabling the irrigation system to identify specific areas to irrigate. This paper presents a smart irrigation system that uses environmental information to determine when and where irrigation is required. The system is comprised of microcontroller, sensors and integration of water pumps with the decision making system. A truth table is developed to help the system determine the necessity to irrigate based on the collected environment information. The sensors narrow down the location that requires irrigation and the decision-making system activates sprinklers. In this fashion, water is given to dry locations of the field, already damp locations are not irrigated and this results efficient water use. Different parameters used, i.e. temperature, humidity and moisture, makes it possible to adjust the system according to the needs of a particular location.

iaofei Hu, Xia Sun* , Qinghong Li, Qianqian He, and Yajun Li, In view of the problems existing in traditional irrigation, such as high time cost, poor reliability, waste of water resources. The intelligent irrigation system based on STM32 and BC95 is designed and implemented. The soil information is received through temperature sensor and humidity sensor, which is sent from the sampling node to the remote terminal serial port. The controller sends the signal to the output end for intelligent irrigation. The practice shows that the wireless communication mode of data transmission using STM32 and NB-IoT (narrow band-internet of things) technology can meet the requirements of reducing the time cost and enhancing the reliability of the system, and can meet the goal of data transmission of intelligent irrigation system and water-saving irrigation. it can be seen that the soil moisture data in the figure significantly changes.

Houshuai Dai, Ruoshui Wang, Li Chen, Lisha Wang,Chang Xiong , Xin Wang and Meng Zhang, Intercropping systems reduce ineffective evaporation between trees but also intensify interspecific competition and reduce productivity. To improve the water-use efficiency and the economic benefits of an intercropping system on the Loess Plateau, China, where rainfall is limited and evaporation intense, an apple–soybean intercropping system with micro-irrigation water control was adopted to analyze the soil water, root density, water-use efficiency, yield, and economic benefits of intercropping under different micro-irrigation methods. Subsurface seepage irrigation, bubbler irrigation, and drip irrigation under mulching were used with irrigation upper limit levels of three maximum irrigation levels [60% (W1), 75% (W2), and 90% (W3) of field capacity (FC)]. Rainwater harvesting from ridges and furrows (GL) without irrigation was the control. Bubbler irrigation increased the soil water content, optimized the vertical soil water distribution, and promoted root growth. Except for the control treatment (GL), the other micro-irrigation treatments increased with the irrigation amount, but the water-use efficiency decreased. Drip irrigation under mulch combined with W2 (75%Fc) irrigation could obtain the maximum intercropping yield, which was increased by 71.1% compared with the GL treatment. Drip irrigation under a mulch combined with W2 produced the maximum intercropping yield; the economic benefits were higher under drip irrigation with mulching combined with W1; and all three micro-irrigation methods combined with W2 improved the economic benefits by 52.1–115.5% compared to GL. Drip irrigation under mulching or bubbler irrigation combined with W2 should be used when there are sufficient water resources, but drip irrigation under a mulch combined with W1 when there is a water shortage.

H. J. Parmar, N. R. Patel, T. M.V. Suryanarayana, The present study is carried out to determine the relationship between pressure head and discharge for a given set of sprinkler irrigation system. An experimental set of 12m x 12m grid of sprinklers is examined for the discharge and pressure head relationship for different pressures i.e. 0.50, 0.60, 0.65, 0.75, 0.90 and 0.92 kg/cm^2. The relationship developed is non-linear. Minimum and maximum discharges observed are 2890 lph and 5162 lph observed at pressures 0.50 and 0.92 kg/cm^2 respectively. It can be concluded that discharge is directly proportional to head loss raised to power m. The power m varies from 1.07 to 1.24 for a given set of 12m x 12m grid of sprinkler irrigation system.

J J Wu1 , R Huang2 , T Y Fang1 and Y Han, Developing the high-efficiency agriculture is the strategy of agricultural sustainable development, and rational allocation of irrigation water resources is an important way in improving the efficiency of agricultural resources utilization. In this paper, the particle swarm optimization algorithm is used to optimize the irrigation water distribution schedule. This model focuses on decreasing the leakage loss and increasing allocation efficiency of irrigation water distribution. The transition process verified the rationality of the water distribution scheme and effectively satisfied the actual demand.

K Sreenivasa Reddy, Somanath Nayak, Sunil Mandi, Kirttiranjan Baral and Y S Shivay, Micro-irrigation not only saves water, but also saves money by lowering fertilizer use, labour costs and other input costs, as well as increasing farmers' income. When compared to traditional irrigation methods, this technology allows for more areas to be irrigated with the same amount of water. Furthermore, due to the simplicity of irrigation, water-scarce, cultivable wasteland and undulating land areas can be quickly brought under cultivation. Current programmes, such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) at the national level and various statelevel water policy efforts, make it possible for marginal and small farmers to buy equipment to irrigate their fields. Micro irrigation's good outcomes have improved food security by increasing crop yield and productivity and increasing irrigation area from the same source of water, resulting in increased nutritional security for the country.

3 METHODOLOGY/PLANNING OF WORK

During the micro irrigation project, decentralized irrigation with 5-10 HP pumps resulted in high electricity bills. We compared centralized and decentralized pumping in Koteshwar Imlipada, Ratlam. Centralized pumping is more cost-effective and energy efficient. Factors like pump type, efficiency, irrigation area, and scheduling affect energy consumption. Centralized systems use larger, efficient pumps, optimize water distribution, and minimize waste. Decentralized systems lack engineering optimization. To improve energy efficiency, use efficient pumps, match sizing, and implement drip/sprinkler systems. Field distance, power availability, and water resources influence system choice. Local analysis is crucial for efficient irrigation.

Koteshwar (Imlipada) Micro Irrigation System Command area is in Koteshwar Tehsil of Ratlam District of M.P. Supplying of water from Kundal dam by lifting and delivering at farmers field at duty 0.325 liter/sec/ha and maintained up to 30 ha chak, keeping the discharge of minimum the duty at 1 ha and at least 20 Meter Residual Head at each 1 ha chak for Micro Pressurized Irrigation (Drip/Sprinkler) by rotation management system through pressurized pipeline system for micro irrigation in the Culturable command area of 1,800 hectare out of Gross command area of nearly 2,130 hectares for Koteshwar (Imlipada) Micro Irrigation System. It includes all activities starting from survey, investigation, designing, engineering, construction, laying, installing, energizing, etc. of pumping system, Electrical Panels, Valves for OMS (Outlet Management System) and RMS Rotation Management System) including rising and gravity mains, distribution network, controlling and regulation system etc. for supply of water for irrigation under pressure with SCADA and automation in Rabi Season.

- Hydraulic analysis and pipe element design parameters computed using Water Gem/Modified Hazen Williams formula. Cluster division (3 to 11) enables efficient irrigation management and water distribution.
- Outlet Management Systems (OMS) installed at 30-hectare intervals in each cluster for regulated water flow.
- Consistent 20-meter head maintained for 1-hectare coverage, ensuring optimal water pressure. Fixed duty of 0.325 liters per second per hectare for consistent water delivery.
- Rotation Management System (RMS) ensures fair water distribution among farmers based on land area holdings.
- 10% of the command area served at a time, optimizing water utilization. RMS allows simultaneous irrigation of 3 hectares at a time within each 30-hectare OMS coverage.
- Implementation of RMS promotes equitable water allocation and sustainability.

5 CONCLUSION

In conclusion, the thesis demonstrates the significant impact of centralized pumping on energy conservation. The analysis shows a total energy conservation of 2,97,65,752.32 kilowatt-hours (KWH), resulting in savings of approximately 16,66,78,075.39 Indian Rupees (INR) in energy charges. This highlights the potential for substantial energy savings and cost reductions through the implementation of centralized pumping systems. These findings contribute to the understanding of energy conservation strategies and provide valuable insights for decision-makers in the field of sustainable energy management.

The analysis of data collected from the field shows that the outlet management system implemented in the Koteshwar Imlipada irrigation project has resulted in significant improvements in water distribution and energy conservation. The system has helped to reduce waterlogging, improve crop yield, and save energy.

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