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Evaluating the use of Intelligent Irrigation Systems Based on the IoT in Winter Season of Vyas Municipality Ward No-1 and 13 of Nepal

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***Abstract:** Nepal's agricultural progress seems insufficient, particularly in its hilly regions where inadequate cultivation has led to a trend of people seeking employment overseas. This study investigates the contemporary agricultural landscape, focusing on irrigation management. Despite irrigation not covering all hilly areas, even in irrigated arable lands, efficient water management remains a challenge. Traditional methods result in water wastage, while modern techniques optimize water use, preventing agricultural issues caused by excess water. This research delves into the potential, difficulties, and prospects of IoT-based irrigation in Nepal's hilly regions. The primary aim is to assess the reality of IoT-driven irrigation in Nepal's hilly regions. The primary aim is to assess the reality of IoT-driven irrigation in the hilly area Vyas Municipality's ward no-1 and 13. Over a six-month test perod, around 95% of water wastage was curbed through IoT irrigation, as compared to manual methods. Pilot test demonstrated the positive impact of reduce water wastage on agriculture. Additionally, a 90-day comparative study of plant growth, weight, and development was conducted. analysis of challenges, benefits, and investments associated with modern irrigation technology in the hilly areas revealed IoT-based irrigation's significant potential and suitability. This research underscores its pivotal role in modernizing agriculture, enhancing farmer productivity, and stimulating higher yields.*

***Keyword:** Internet of Thing, Irrigation, SMART, Crops, Arable Land.*

1. INTRODUCTION

If the agricultural system cannot be managed in time and made attractive to all, we can all estimate the possibility of agricultural recession. In developed countries, there is work to manage the agricultural system. With the use of technology in agriculture, now the retention of smart in agriculture is slowly starting. A country like ours where there are various problems

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such as political problems, economic problems, geographical problems, problems of lack of attractiveness in the agricultural profession are causing decline in the agricultural system. In traditional farming system, people have to work hard. Similarly, we have to hear the news that some farmers have died due to various pesticides. It seems that the attraction of people in the agricultural profession is decreasing due to the fact that the production is much less than the effort and investment of the farmers.

IoT has the potential to revolutionize the agricultural industry by providing farmers with real-time information about their crops, soil and weather conditions. Some of the ways IoT is being used in agriculture include; IoT enabled irrigation system can be programmed to automatically adjust the amount of water delivered to crops based on real time soil moisture data. This ensures that crops receive the optimal amount of water, reducing water waste and improving crop yields. By using an IoT based irrigation system, farmers can optimize their use of water resources, reduce waste and increase crop yields. It can also provide real-time insights and alerts, allowing farmers to quickly identify and address potential problems. Overall, an IoT based irrigation system can help farmers to grow more food with fewer resources, leading to increased sustainability and profitability.

Farmers suffered a lot in the traditional farming system. Farmers were always ready in agricultural work without risking their lives. People's interest in agriculture started decreasing. Due to the declining interest of people in agriculture, at some point the crisis in agriculture will start. The main problems in agriculture are that production is much less than investment and labor. IoT in Agriculture If the use of the method can be made effective, there is a possibility of having a positive effect on agriculture.

Nepal is the fourth most vulnerable country with Global Hunger Index of 21.2 % scored indicating various risks and vulnerability. Impact of climate change seen on agriculture, forestry and fisheries. Nepal in a frontline of climate change as 42 districts classified as food insecure, 21 glacial lakes are potentially dangerous and Nearly 1.9 million people are highly climate vulnerable is dangerous statistical data for future Nepal. Change in rainfall pattern, temperature variation, unseasonal rain and long drought are some impacts on climate which ultimately impact on agriculture systems [1].

The main justification of this research is to find out whether proper agriculture has been produced in the arable land in the hilly areas of Nepal. If suitable agriculture is not being produced, advice on suitable agriculture should be given. In the same way, the amount of unnecessary water is being wasted in irrigation management and developing a technology that can only use the necessary water.

How effective will IoT based irrigation management be in water consumption on arable land of hilly area of Nepal? and to find effectiveness of Irrigation system based on IoT are the research question and main objective of the research respectively.

Paper review gives more motivate to research. It helps in making the framework and maturity of the research work. The papers reviewed above are excellent and all those papers were not directly tested in the important field of agriculture. Some reviewed papers are given.

This system is designed to reduce the need for manual labor and optimize water usage, resulting in increased crop productivity. To create this, system, an Arduino kit was used along with a moisture sensor and Wi-Fi module. The experimental setup is connected to a cloud framework, which allows for data acquisition. The collected data is then analyzed using cloud services, and

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appropriate recommendations are made. Typically, irrigation is carried out using traditional methods, such as stream flows from one end of a field to the other. However, this method may result in uneven moisture levels throughout the field. By utilizing a programmed watering system, the administration of the water system can be improved[2].
The solution is based on three main components: Smart Water Metering which collects real-time data and monitors water usage to promote conservation of the water-table via a Cloud-based IoT system; Renewable-Energy integration which reduces reliance on fossil fuels for water-table pumping and promotes energy-efficient agriculture; and Smart Irrigation which promotes healthy crop growth without harming the soil or water-table ecosystems. The solution has been tested in a real-world Smart Farm testbed and has shown to reduce water consumption by up to 71.8%. Additionally, the solution is open-source and can be easily adopted and adapted by other researchers to create a dedicated Cloud-based platform for water-table usage, particularly in arid and sub Saharan countries[3].
The Internet of Things refers to a network of interconnected devices that are capable of exchanging information over the internet and controlling operations without human intervention. In agriculture, there are numerous parameters that can be analyzed to improve crop yields, and the use of IoT devices can help modernize communication and information in smart farming. These parameters include soil type, soil moisture mineral nutrients, temperature, light, and oxygen, Sensors are used to detect these parameters and communicate the data to the cloud. The proposed system has been tested and implemented on the Thing Speak IoT cloud platform, which positive results[4].
When abnormal values are detected, an alert message is sent through a GSM module to indicate potential issues such as chemical spills, treatment plant malfunctions, or problems in supply pipes that cloud harm crops and soil quality. The data is stored in the cloud and an IoT server is connected to send messages to the government and provide remedial measures to address these issues, ultimately helping farmers improve their sales and business processes[5].
In the paper presented above, only the possibilities that can be used on arable land are presented. In the papers presented using only irrigation system but not comparative study, it was not possible to find a research paper that included all of them in one paper. In this paper completely validation and experimental analysis of arable land during six months.

2. MATERIALS AND METHODOLOGY

This study focuses on one major issues. Water consumption has been calculated using water pumps. In this system, using IoT, the soil moisture sensor is set to start the automatic pump if the moisture level is less than 40 percent. It includes IoT in water consumption. A comparative study of water consumption with IoT and manual use has been done.

Materials

- Arduino IDE 2.0
- Programming Language: C++
- IoT Requirement: Soil moisture sensor and Automatic water pump motor

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Soil Moisture Sensor on Arduino

When connecting the soil moisture sensor, only an Arduino board, a breadboard and a jumper were needed. In its connection, it was connected from A5 of the Arduino board and connected to the breadboard. Its connection was made based on the structure in the following table.

Table 1 (Composition of Soil Moisture Sensor)

Chip	LM393
PCB Size	30mm X 16mm
Probe Size	60mm X 20mm
Input Current	35mA
Output Signal	Both Analog and Digital
Operating Voltage	3.3V – 5V

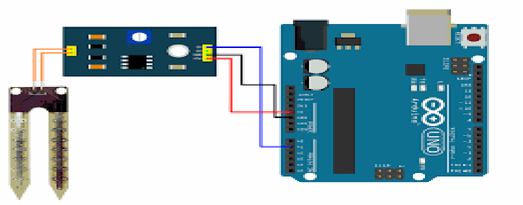

Figure-1 (Soil Moisture)

Water Pump Motor with 5 V relay

The motor used in this study is controlled by Arduino. In most agricultural systems, there is no water control during irrigation, so a lot of water is being wasted in unnecessary places. But irrigation according to this method will save water.

Table 2 (Features and Composition of Automatic Water Pump with Relay)

Name	Water Pump Moter
Color	White
Power Supply	8-12V
Electric Current	920mA
Max flow rate	800L/H
Fluid Temperature Range	0^0C to 60^0C
Noise	Lower than 35dB
Material	Plastic

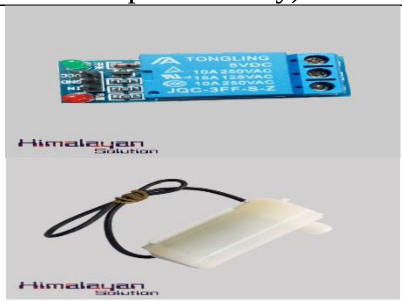

Figure: -2 (Water Pump with Relay)

Conceptual Framework

We have gathered the required components, flow these generate steps to create the automatic water pump system:

- Connect soil moisture sensor to the microcontroller according to its specifications. Typically, this involves connecting power (VCC and GND) and the sensor output (Analog or digital pin).
- Connect the relay module to the microcontroller. The relay module should have separate terminals for the power supply and the pump. Connect the power supply to the relay module, and the pump to the relay contacts.
- Write a program for the microcontroller to read the soil moisture sensor data and control the relay module based on the moisture level. Use the programming language supported by the microcontroller. The program should continuously monitor the soil moisture level and activate the water pump when it falls below 40%.

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- Upload the program to the microcontroller and ensure its functioning correctly.
- Place the soil moisture sensor in the desired location in the soil, preferably where it can accurately represent the moisture level of the area you want to irrigate.
- Connect the water pump to water source and position it in the appropriate location for irrigation.
- Connect the power supply to the microcontroller and the relay module.
- Test the system by observing the behavior of the water pump when the soil moisture level falls below 40%. The pump should automatically start irrigating and stop once the moisture level rises above the threshold.

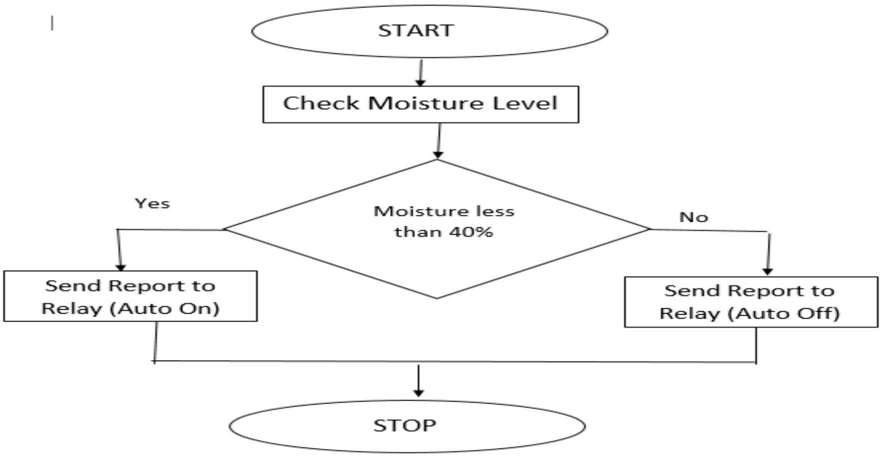

Figure: 3

Data

In this research, if the soil moisture level is less than 40 percent, the motor automatically pumps the water. In this way, when using IoT, water consumption is recorded. The record of water consumption is also collected by manual method using pipe according to the size of the pipe of the motor in use of IoT. The data collected in this way is used for comparative studies. In this data collection, at the same time, the data of water consumption has been collected through the use of IoT and manually.

Agricultural lands of 14 wards of Vyas municipality have been selected. Out of the 14 wards of Vyas municipality, 2 wards were selected by random sampling method, wards 1 and 13 were selected. Ward no 13, there are only monitoring of irrigation system. Ward no 1, there are only pilot test of irrigation system.

3. RESULT AND DISCUSSION

Irrigation is the artificial application of water to arable land to promote the growth of crops. it has been practiced for thousands of years and has played a crucial role in the development of agriculture. In ancient time, farmers used manual irrigation methods such as diverting water

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from rivers or streams to their fields using ditches and canals. Later, with the development of technology, irrigation systems evolved to become more sophisticated and efficient.
Modern irrigation system is designed to provide water to crops in a controlled manner, sprinkler system, drip irrigation, and center pivot irrigation. These systems use pumps and pipes to distribute water to crops, and sensors and controllers to regulate the amount and timing of water application.
The IoT-based irrigation system is more efficient and effective in terms of water usage and conservation compared to a manual irrigation system. it can save a significant amount of water and can be a better investment in the long turn. Based on the given data, the following conclusion can be drawn:

- The system being analyzed is IoT based and is used for saving water.
- The manual method of water conservation saves 8600 ml of water.
- The IoT based system saves 816391 ml of water.
- The percentage of water saved by the IoT-based system is more effective in saving water than the manual method, with a significant improvement of almost 95% in water conservation.

  The details result is given below.

Table 3 (IoT vs Manual Irrigation of ward no: 1)

Vyas Municipality Ward No: 1					
Date/ Time		**IoT based (ml)**	**Manual(ml)**	**Saving Water**	**Saving(%)**
September 17, 2022	7:00 AM	430	8600	8170	95.00
	1:00 PM	432	8600	8168	94.98
	6:00 PM	429	8600	8171	95.01
	9:00 PM	431	8600	8169	94.99
October 15, 2022	7:00 AM	450	8600	8150	94.77
	1:00 PM	449	8600	8151	94.78
	6:00 PM	451	8600	8149	94.76
	9:00 PM	445	8600	8155	94.83
November 12, 2022	7:00 AM	410	8600	8190	95.23
	1:00 PM	411	8600	8189	95.22
	6:00 PM	413	8600	8187	95.20
	9:00 PM	415	8600	8185	95.17
December 17, 2022	7:00 AM	400	8600	8200	95.35
	1:00 PM	401	8600	8199	95.34
	6:00 PM	402	8600	8198	95.33
	9:00 PM	400	8600	8200	95.35

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January 14, 2023	7:00 AM	401	8600	8199	95.34
	1:00 PM	399	8600	8201	95.36
	6:00 PM	398	8600	8202	95.37
	9:00 PM	402	8600	8198	95.33
February 11, 2023	7:00 AM	421	8600	8179	95.10
	1:00 PM	422	8600	8178	95.09
	6:00 PM	423	8600	8177	95.08
	9:00 PM	421	8600	8179	95.10
March 11, 2023	7:00 AM	455	8600	8145	94.71
	1:00 PM	456	8600	8144	94.70
	6:00 PM	457	8600	8143	94.69
	9:00 PM	459	8600	8141	94.66
April 8, 2023	7:00 AM	590	8600	8010	93.14
	1:00 PM	589	8600	8011	93.15
	6:00 PM	592	8600	8008	93.12
	9:00 PM	591	8600	8009	93.13
Maximum		603	8600	8270.00	96.16
Minimum		330	8600	7997	92.99
Average		436.09	8600.00	8163.91	94.93

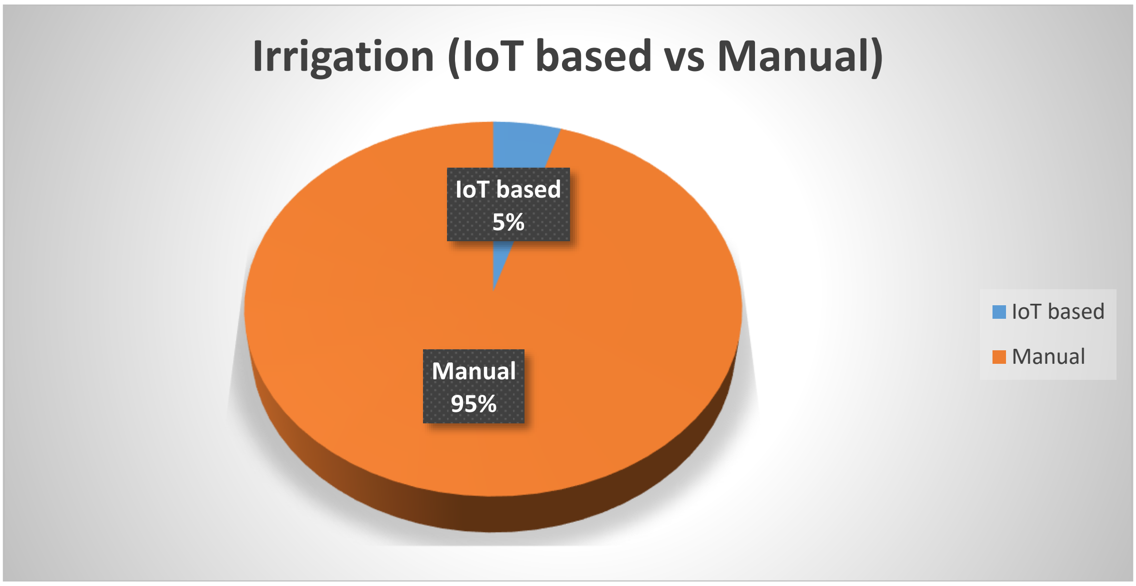

Figure: 4 (IoT vs manual irrigation)

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5.3.2 Pilot Test of IoT based and Manual Irrigation

The data shows that each of these crops has the same number of occurrences, which is 15. Without further context or additional data, it is challenging to perform a comprehensive result analysis.

Table 4 (Number of corps on Pilot test)

Crops	Number of crops
Carrot	15
Spinach	15
Garlic	15

Table 5 (Number of grown crops on Pilot test)

Crops	Total grown of crops (IoT)	Total grown of crops (IoT)
Carrot	15	13
Spinach	15	15
Garlic	14	13

Table 6 (Result analysis of Pilot Test)

Days	Crops	Grow		Height (CM)		Weight (G)	
		IoT	Manual	IoT	Manual	IoT	Manual
1st	Carrot	0	0	0	0	-	-
	Garlic	0	0	0	0	-	-
	Spinach	0	0	0	0	-	-
3rd	Carrot	3	1	0.5	0.2	-	-
	Garlic	2	0	0.1	0.1	-	-
	Spinach	4	2	0.3	0.3	-	-
7th	Carrot	14	9	2	1.2	-	-
	Garlic	14	8	3	2.1	-	-
	Spinach	15	9	1	0.2	-	-
10th	Carrot	15	13	2.5	1.9	-	-
	Garlic		13	5	3.4	-	-
	Spinach		15	1.8	0.9	-	-
15th	Carrot			6	4.2	-	-
	Garlic			7	4.9	-	-
	Spinach			5	2.7		-
20th	Carrot			8	6.1	26.1	19.2
	Garlic			9	7.3	13.2	8.2
	Spinach			8	6.4	13.7	11.1
30th	Carrot			11	9.1	29.8	20.1
	Garlic			13	8.9	15.3	12.1
	Spinach			11.5	8.2	19.2	14.2
40th	Carrot			16	12.2	38.4	23.5
	Garlic				10.1	18.2	14.2

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	Spinach			16.8	11.2	28.1	19.2
50th	Carrot			18	13.5	62.9	25.4
	Garlic			17	10.3	21.4	17.2
	Spinach			19.5	14.3	34.8	23.9
60th	Carrot			20	14	94.9	27.2
	Garlic			17	10.9	24.5	19.2
	Spinach			22.5	16.1	42.9	27.1
70th	Carrot			21	15	164.2	29.8
	Garlic			17.5	11.5	29.1	21.8
	Spinach			26.5	17.6	53.8	30.8
80th	Carrot			22	16	189	31.8
	Garlic			17.9	12	34.2	23.4
	Spinach			27.5	18.6	63.2	35.8
90th	Carrot			24	17.2	201.3	35.1
	Garlic			18	12.5	35.2	26.8
	Spinach			28	20.1	72.1	39.8

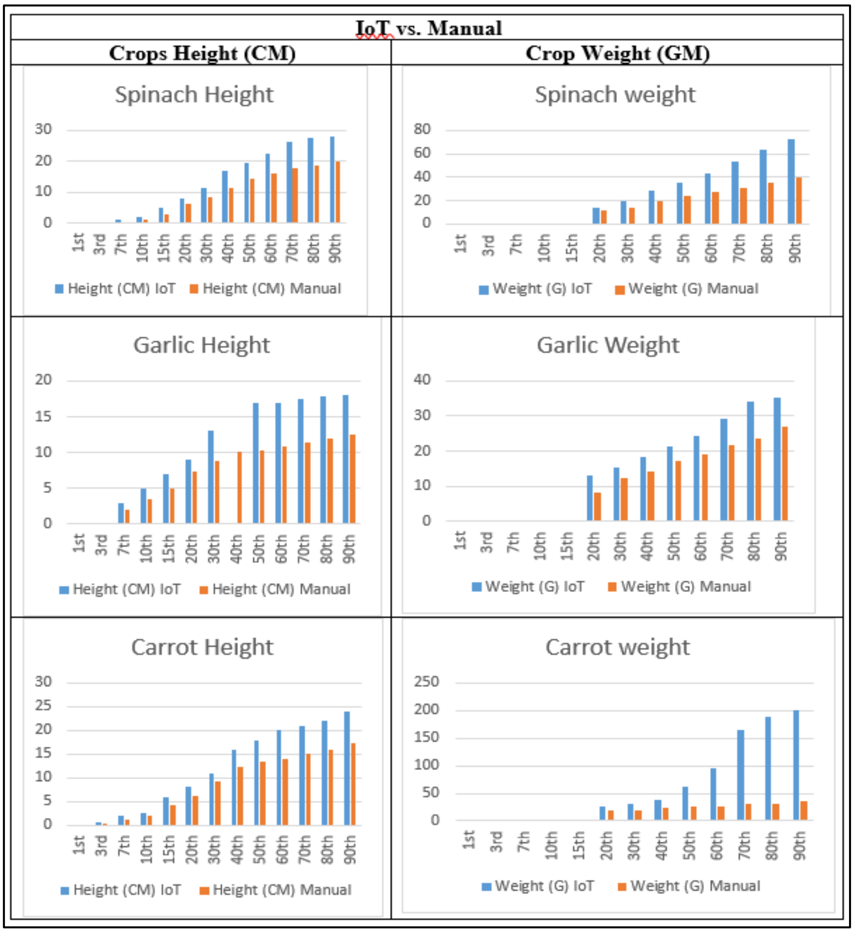

Figure: 5 (IoT vs. Manual)

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Comparing IoT-based irrigation system with manual irrigation systems in the hilly areas of Nepal, we can consider various factors that may impact their performance, efficiency, and suitability for the region.

Table 7 (Comparison IoT and Manual Irrigation)

Factors	IoT- based irrigation system	Manual- based irrigation system
Water Efficiency	Can use real-time data from weather stations and soil moisture sensors to optimize watering schedules.	Lack precision in water delivery, leading to potential wastage and uneven distribution of water.
Accessibility and Labor	Can be remotely monitored and controlled, reducing the need for physical presence.	Can be challenging for farmers to access manually.
Cost	Higher installation cost due to the need for sensors, controllers, and network infrastructure.	Generally more affordable in terms of setup but may have higher operational costs due to labor requirements.
Technology Dependence	In remote hilly areas of Nepal, reliable internet and power supply may not always be available, potentially affecting system performance.	Less dependent on technology and can function with manual labor alone.
Flexibility and Customization	Allow for precise control and customization of irrigation schedules based on specific crop needs and changing weather conditions.	May have limitations in adjusting water delivery based on real-time data.
Maintenance and Skill Requirements	Require regular maintenance, technical expertise, and troubleshooting skills to ensure proper functioning.	Might have less complexity in maintenance but rely heavily on the skill and knowledge of farmers for efficient irrigation management.
Environmental Impact	if optimized for water efficiency, can reduce water wastage and have a positive environmental impact.	May result in water wastage and potential soil erosion if not managed properly.
Adaptation and Training	Might require training and education for farmers to effectively use and benefit from the technology.	may be more familiar to farmers, requiring less training and adjustment.

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Both IoT-based and manual irrigation systems have their pros and cons. The choice depends on factors such as water availability, budget, technological infrastructure, and the willingness of farmers to adopt and adapt to new technologies. For hilly areas of Nepal, where accessibility, water conservation, and resource management are important considerations, properly implemented IoT-based irrigation systems have the potential to bring significant benefits in terms of water efficiency and crop yield.

Advantage of IoT based Irrigation System

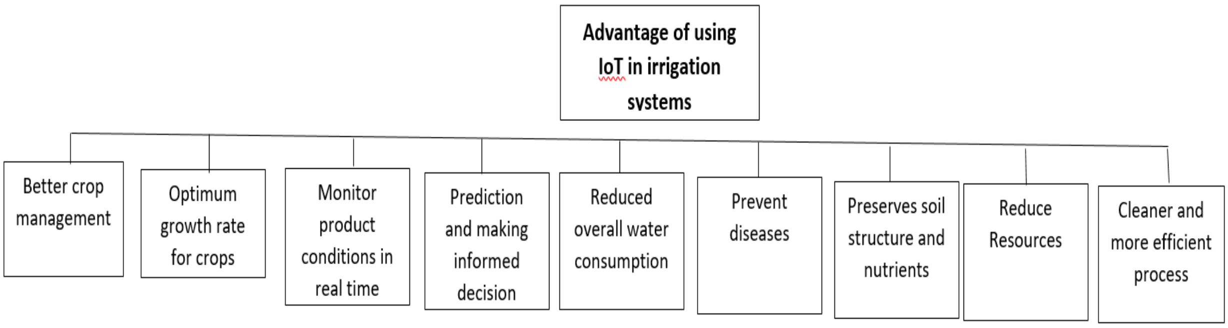

Figure -1

An Iot-based automatic irrigation system can bring numerous benefits to hilly areas of Nepal, where agriculture is a crucial livelihood for many communities Here are some of the key advantages:

- Water conservation: The hilly areas of Nepal often face water scarcity, making efficient water use essential. This helps conserve water by providing just the right amount needed for optimal plant growth.
- Increased crop yield: This can lead to higher crop yields and improved overall agricultural productivity in the region benefiting local farmers and communities.
- Reduced labor and operational costs: By automating the irrigation process, farmers can save time, effort, and labor costs, allowing them to focus on other essential farming tasks.
- Remote monitoring and control: Farmers can make timely adjustments to the irrigation schedule and respond to emergencies promptly, even from a distance.
- Improved livelihoods: Higher crop yields and reduced input costs can lead to improved economic conditions for farmers and their families. This, in turn can lead to better living standards and enhanced livelihoods for rural communities in the hilly areas of Nepal.

Issue and challenges of IoT based Irrigation System in Hilly area of Nepal

While IoT-based automatic irrigation systems offer significant benefits, they also face some challenges and issues, particularly when implemented in hilly areas of Nepal. Here are some key challenges:

- Internet connectivity: One of the primary challenges in hilly regions is the availability and reliability of internet connectivity.
- Power supply: Many hilly areas in Nepal may lack a stable and consistent power supply. IoT devices require electricity to function, and power outages or limited access to electricity

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can hinder the operation of automatic irrigation systems. Implementing alternative power sources like solar panels may be necessary, but it can add to the initial cos of setting up the system.

- Infrastructure limitations: The rugged and remote nature of hilly terrain can pose challenges in setting up the necessary infrastructure for IoT-based irrigation systems..
- Cost and affordability: Cost-effective solutions and government support may be needed to make these systems more accessible to farmers.
- Technical expertise and training: Farmers in hilly areas may not be familiar with IoT technology and its implementation. Providing sufficient technical training and support is crucial to ensure farmers can effectively use and maintain the irrigation systems.
- Adaptation to local conditions: Each agricultural region has its unique characteristics, and hilly areas in Nepal may have specific challenges that require customized solutions.
- Maintenance and support: In hilly areas, accessing remote farms for maintenance and troubleshooting can be challenging.
- Environmental impact: While IoT-based irrigation systems can promote water efficiency, the production and disposal of electronic components can have environmental.

Despite these challenges, the implementation of IoT-based automatic irrigation system in hilly areas of Nepal holds great potential to improve agricultural practices, boost crop yields, and enhance the resilience of farming communications to climate change impacts. Addressing these challenges will require collaboration between government agencies, technology providers, and local communities to create sustainable and effective solutions.

Possibilities of IoT based Irrigation System

An IoT-based automatic irrigation system in a hilly area of Nepal can offer several advantages and possibilities. Nepal's hilly terrain presents unique challenges for agriculture, and implementing smart irrigation solutions can significantly improve agricultural practices and water management. It is possible to invest in an IoT-based system in the hilly areas of Nepal. While hilly terrains may present some challenges, the benefits of such a system can outweigh the obstacles. Here are some factors to consider when investing in an IoT-based irrigation system for hilly areas:

- Adaptability: The IoT-based irrigation system should be designed and adapted to suit the specific topography, soil types, and climate of the hilly region. Local conditions need to be considered to ensure the system's effectiveness.
- Power supply: Hilly regions may have limited access to a stable power grid. it's essential to explore alternative power source, such as solar panels or battery backups, to ensure continuous operation of the IoT devices.
- Connectivity: Internet connectivity may be patchy or unreliable in remote hilly areas. Low-power wide-area network or satellite communication can be considered for data transmission in areas with limited internet access.
- Local expertise: Training and support for local farmers and communities are vital for successful implementation and long-term sustainability. Building local capacity and knowledge about the IoT system's operation and maintenance is crucial.

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- Cost considerations; While IoT-based irrigation system offer long-term benefit, the initial investment can be a barrier. It's important to assess the return on investment over the system's lifespan and explore funding opportunities or partnerships to make the investment feasible.
- Scalability: Consider the potential for scaling up the IoT irrigation system to cover larger areas or multiple communities. A scalable solution can attract more investment and support from various stakeholders.
- Environmental impact: Assess the potential environmental benefits of water conservation and reduced water wastage through the IoT-based system. Such benefits can attract support from environmental agencies and organizations.
- Government policies and support: Evaluate the regulator environment and government policies related to IoT and agricultural technology in Nepal. Supportive policies and incentives can encourage private and public investments in the area.
- Pilot projects: Consider starting with smaller pilot projects to test the effectiveness of the IoT-based irrigation system in a specific hilly area before scaling up to cover larger regions.

Investing in an IoT-based irrigation system in the hilly areas of Nepal can lead to sustainable agriculture, improved water management, and enhanced livelihoods for local farmers. It requires a thoughtful and context-specific approach, collaboration with local communities, and a long-term vision for success.

4. DISCUSSION

How effective will IoT based irrigation management be in water consumption on arable land of hilly area of Nepal?

An IoT-based irrigation management system can be very effective in reducing water consumption on arable land in hilly areas of Nepal. This is because IoT devices can provide real-time data on soil moisture levels, weather conditions, and other factors that affect irrigation needs.

Implementing an IoT-based irrigation system in hilly areas of Nepal can face several challenges:

- Power supply: One of the significant challenges for IoT-based irrigation system in the availability of a reliable power supply. In hilly areas of Nepal, there can be frequent power outages, which can disrupt the system's functioning. In such case, backup power supply, such as a solar panel or battery, would be necessary.
- Connectivity: IoT-based irrigation system requires a stable internet connection to function. However, hilly area in Nepal often have poor connectivity, which can result in data loss or delays. Then can affect the system's performance, leading to inefficient use of water and energy.
- Cost: Implementing an IoT-based irrigation system can be expensive, particularly in hilly areas of Nepal where the terrain can be challenging. The cost of the system could be a significant barrier to its adoption, particularly for some-scale farmers.
- Maintenance: maintenance of the IoT-based irrigation system can also be a challenge in hilly areas of Nepal due to the difficult terrain and limited availability of skilled technicians. This could result in longer downtime and decreased productivity.

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In addition, an IoT-based irrigation management system can help farmers to identify and address issues such as leaks, clogged nozzles, or other irrigation system malfunctions that can waste water. This can improve the overall efficiency of the irrigation system and further reduce water consumption. Furthermore, an IoT-based irrigation management system can help farmers to avoid over-irrigation, which can lead to soil erosion, nutrient loss, and other environmental issues. This can help to protect the local ecosystem and ensure the long-term sustainability of agricultural production in the region.
An IoT-based irrigation management system can be a highly effective tool for reducing water consumption on arable land in hilly areas of Nepal. By providing farmers with real-time data and insights, an IoT-based system can help to optimize irrigation scheduling, improve system efficiency, and conserve water resources, while maintaining crop productivity and profitability.

5. CONCLUSION

Examining Nepal's geographical context, there is an absence of documented exploration scholarly inquiry, and initial trials involving contemporary agricultural techniques. This scarcity of progress in Nepal's agricultural practices has led to diminished enthusiasm for agricultural enterprises. This investigation also encompasses insights for agricultural stakeholders. The conventional methods of agriculture, especially in irrigation, lead to unwarranted water wastage and insufficient water distribution in critical areas, ultimately causing a decrease in crop yield. Observing these multifaceted challenges prompted me to embark on comprehensive research driven by a curiosity about the efficacy of modern irrigation systems.
For this study, two sections of Vyas Municipality were chosen as the focal points for assessing an IoT-based irrigation system. To validate the findings, ward no-13 underwent testing over a six-month period, comparing the outcomes of wasteful water usage to the traditional method. This analysis revealed an astonishing 95% water wastage. Similarly, two experimental runs were conducted in ward no-1. Employing modern irrigation techniques exhibited the ability to shield plants from excessive moisture. Stakeholders responded positively to this approach, though challenges like a shortage of skilled technicians and other hindrances were acknowledged. The consensus was that governmental authorities should undertake broader testing in diverse locations and formulate a well-structured strategy, despite these hrudles.

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