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PV Based Automatic Irrigation System

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Abstract- **Pakistan is an agricultural country and requires an adequate supply of water for irrigation throughout the year. Water is one of the most precious natural resources and its effectual management is a main concern in various agricultural systems around the world. The major problem is the water accumulation by the wealthy farmers store water for their own fields and allow water to pass to other farmers after receiving the money. Secondly, most of the time water wastage occurs due to over watering, it is because there is very large area in the fields (in acres) that is very difficult for the famers to supervise all the area. Similarly, sometime there is inadequate water supply, which cause the damage of crops or results in lesser yield on some section of the field. This paper presents solution of the mentioned problems and increasing the hold of Indus River Systems Authority (IRSA) on the irrigation mechanism so that the required quantity of water can only be delivered at the specific time for each field (as per requiring output from sensors grounded in field). The presented system consists of implement of the sensors in each corner of the fields, when the sensor value (in voltage) goes to satisfied number it sends notification to IRSA and if the water level goes to danger level, it will automatically close the gate from where water is released. New water system with electrical control advancements can improve water utilization proficiency, compelling water sparing and diminishing the natural affects. The target of the presented system is to dodge wastage of water and enhance efficiency of irrigation by utilizing a PLC based irrigation framework with the assistance of soil dampness sensors. An automatic control system of gates helps to close or open the gates if the water level in soil reaches a critical value. The motivation behind this work was to create a self-administering water supply framework that works on utilization of a solitary model according to which; the water supply follows a pre-supplied timetable along-with the monitoring of the in-field conditions, prompting a sensible sparing in the measure of water supply. It should likewise be dependable and effectively deployable to work under cruel outside conditions without the requirement for oversight or customary checking. The deployed electronic system can be powered through solar energy. The developed mechanism can make farmers capable of fulfilling their irrigation needs besides the PV based generated extra electricity can be shared or sold to neighbors or water and power Development authority (WAPDA).**

Index Terms-- **Agriculture, Automated, Irrigation, Indus River System Authority (IRSA), Photovoltaic (PV), Water and Power Development Authority (WAPDA).**

I. INTRODUCTION

The fresh water scarcity is a global issue and lack of its availability emphasizes efficient and effective utilization of the available resource [1]–[4]. Similarly, the over-irrigation is also an important factor in destroying or affecting the health of growing crops [5]–[8]. Another major issue is possible riot occurring among farmers due to limited water supply for the irrigation purposes [9]–[13]. This accentuates the development and implementation of advance mechanisms to properly irrigate in-field crops that can provide sufficient yield to meet the necessary food demand [14]–[17]. Researchers have been working on developments of means to properly utilize the water supply for the irrigation of the crops that have been reviewed in the preceding sub-section of the paper.

A. BACKGROUND AND MOTIVATION

The authors in [18], discussed a programmed irrigation system that was proposed and actualized through various electric circuits. They accomplished this model through implementation of electric force and programmed control. The presented system had the limitation of not being suitable for large-scale implementation due to involvement of too many electric circuits. It was not possible to provide safeguarding the installed system at that level because you are dealing with uneducated people, if some error occurs, they would not be able to solve it.

Reference [19] presented the plan and usage of a mechanized shrewd framework for water system purposes. The requirement for unnecessary labor was sifted by means of presenting a robotized highlight for checking the status of the dirt, water siphoning necessities, and distinguishing shortcomings. The proposed ASSIS could be effectively introduced in gardens, rooftops and also for medium-scaled zones for planting crops. However, large-scale implementation was too complex, because of use of Arduino platform.

In reference [20], the authors proposed a wireless automatic system for monitoring of irrigation of the fields. They proposed a mechanism consisting of ZigBee, sensors and WIFI modules to monitor the irrigation of the fields. The principle thought of this is to see how information goes through a remote medium transmission utilizing remote sensor organization and checking framework. The presented water supply framework was automated by utilizing controllable boundary, for example, temperature, soil dampness and air moistness since they are the significant variables to be controlled in Precision Agricultures (PA). But issue of dependability is integral to Wireless Sensor Networks (WSNs). Hubs were battery-controlled, and interchanges are radio-based. Additionally, hubs in WSNs are inclined to disappointment because of the energy exhaustion, equipment disappointment, correspondence interface mistakes, malevolent assaults, and so forth.

The authors in [21], presented a Raspberry-pi embedded machine used for irrigation. They proposed a customized water supply framework for the agrarian landscapes. The developed system presented a robotized irrigation system, made to overhaul water use for provincial harvests. The developed system controlled the water motor precisely, screened the plant improvement using webcam and could similarly watch farm live on android mobiles internet connection. The entire system was proposed to be farmed by the Raspberry Pi that was powered by Linux working system.

In the paper [22], the Authors presented an automated residence water framework structure using a WSN and embedded Linux framework. It gives a web-based interface to the client so the client can control and screen the structure distantly. The framework corresponded with all scattered sensors in the domain through ZigBee. The objective of facilitator focused on the collection of the cutoff points like soil saturation and soil temperature remotely. Every sensor placed at the point consisted of soil dampness and soil temperature sensor and one ZigBee gathering contraption for correspondence with the organizer community point. Raspberry Pi stored the collected information in the enlightening record and investigated the put aside information.

The researchers in [23] reviewed various mechanisms of the existing developments and besides proposed a moderate and nonexclusive customized water supply framework. The reference [24] structure has simpler features arranged with the objective of insignificant exertion and effective with less power use using sensors for far away checking and controlling contraptions which are constrained by methods for SMS using a GSM module. A Bluetooth module is furthermore interfaced with the essential microcontroller chip". This Bluetooth module disposes of the usage costs by means of talking with the home hardware through Bluetooth while the utility is in an obliged scope of not many meters. The framework advises customer around any unusual circumstances like significantly less dampness substance and temperature rise, even grouping of CO2 through SMS from the GSM module or by method of Bluetooth module to the rancher's cell and developments are taken hence by means of the rancher. In fate, the rancher can be equipped for show and control the boundary by means of GSM and Bluetooth innovations.

In reference [25], the authors depicted venture proposed an installed framework for programmed water system for field, which has a remote sensor network for continuous infield detecting and controlling of a water system framework. This remote framework underpins the field which has both plain and inclines zones. An excess of watering makes ailments. This framework gives uniform and required degree of water for both plain and slant zones and hence it keeps away from the water flood at the incline regions which spares the plant and furthermore water. This framework has programming for constant in-field detecting and control of a water system framework. Field conditions were site-explicitly checked by in-field sensor stations dispersed over the field and afterward remotely communicated to a base station.

Reference [26], of the Author depicted a programmed water system framework depended on the most basic factor of this structure is RF module which is used to send and getting the message to the controller. This structure used three spots which give each other and flood paddy field regularly. The explanation behind our assignment is to modernizing agribusiness movement by programming parts and made the key portion for the system. The structure is progressing based and focuses the particular condition of paddy field. There is one central concentrate direct used which toward control different center point. The standard uttermost scopes of RF module are to pass the message to the center point and work the structure. The proposed model use ARM-LPC2148 which is totally chosen RF Module. This endeavor made creating field and development the improvement of food creation.

The Author in [27] depicted that the proposed framework utilizes sensors to screen the dirt dampness content which relies upon the valves of the framework which can get turned ON/OFF naturally. Soil dampness and temperature sensor will detect the state of the climate and will send a similar data to the microcontroller. The microcontroller makes a move contingent upon this sensor information. A similar data is given to Global System to Mobile Communication (GSM) which will impart this sign to clients portable as SMS (Short Message Service. The water system framework can be broadly utilized in farming grounds, modern mechanization, home gardens, and climate station. This can be useful in the advancement of agribusiness field. In future, it is conceivable to create video catching of absolute harvest condition by utilizing 5G (fifth Generation) innovation and this data will be sent to the closest climate station. This paper chiefly centers around planning a completely computerized trickle water system framework".

In reference [28], the authors proposed cushioned justification controller for convincing water framework subject to handle soil clamminess and availability of water. Cushy reason controller is arranged using crazy person guideline to turns on/off water framework motor subject to handle soil moistness level and well water level. MATLAB mechanical assembly is used to reenact feathery controller using mamdani model. Semantic variable for soil soddenness level and well water level is articulated. Investment extends for etymological variable are set and the structure is tried by varying sources of info. Results show that the proposed system is effective in flooding cultivating fields by considering openness of well water and field soil sogginess conditions.

Table I provides the analysis of the prominent research projects recently conducted related to the advanced irrigation mechanisms.

TABLE I COMPARISON OF KEY CONTRIBUTIONS WITH TIME

Years	Key contribution	Reference
2008,2012	A motorized water framework system has a scattered distant association of soil-moistness and temperature sensors put in the core zone of the plants.	[19], [23], [25]
2013,2015	System has a passed on distant association of soil-clamminess and temperature sensors set in the core zone of the plants and imparts data to a web application. It is assumed that using the advancement of ZigBee for a robotized water framework measure using distant sensor association.	[18], [20], [22], [26], [28]
2016	A shrewd water framework watching structure using raspberry pi. Raspberry-pi is the core of this structure. A robotized water framework system was made to propel water use for cultivating harvests.	[21], [27], [29]

This paper presents a mechanism to increase the agricultural efficiency of crops by providing them adequate amount of water that they need and overcome the late-night duties of farmers. Because in our sight most of the farmers deliver the water to their fields in night time (because of their shifts and most probably they distribute water in night time due to there is high temperature and overexposure of the sun during day time which evaporates the great amount of water), it gets too difficult for a farmer to awake at night time. The provided solution is going to be different because whatever work has been done yet is that they provide the control (automatic usage) to farmer, and if any error has been occurred farmer is not able to solve it. Since the control will be provided to IRSA, now ISRA is responsible for delivering the water to the field in specific amount and in specific time.

In this paper, a PV based programmed water supply framework is presented. The developed Automatic water supply framework is intended for guaranteeing the correct degree of water for irrigation of the crops throughout the year. In any event, when the ranchers are away, these programmed supply frameworks consistently guarantee the correct degree of water at the locales. Furthermore, it gives efficient water use productivity by observing soil dampness at ideal level. Since it works for every field, the interconnected system requires water level and field soil density of which each crop as it helps us to provide the tags on each sensor to differentiate the field's requirement.

After the initial introduction presented in section 1 of the paper, identified problems and presented solutions are discussed in section 2. The section 3 presents the proposed approach followed by the mathematical calculations of the system components presented in section 4. The section 5 discusses the simulation results followed by the conclusion in section 6. The references and appendix sections are presented at the end of the paper.

II. IDENTIFIED PROBLEMS AND TENTATIVE SOLUTIONS

Phase 1 of Problem Statement is that every crop has different water need such as wheat crop requires 15.6-17.8 (decade), rice crop requires 1100-1250 (mm), sugarcane crop requires 1500-2000 (mm), and onion crop requires 350-550 (mm).

Presented Solution: The presented paper solved the problem by sensing the soil moisture, while keeping the same tag for sensors in each field. These tags have fixed identified value of every crop. That's an easy way to improve irrigation in any field.

Phase 2 of Problem Statement is that most of the rich farmers steals the available water from the canals. They store water for their own fields and allow water to pass after receiving the money.

Presented Solution: The presented paper solved the problem that without permission of IRSA no one can use the canal water, IRSA can get the capability of delivering the water with specific amount in specific time for each field (as per requirement judged by the sensors grounded in field).

Phase 3 of Problem Statement is the issue of over-watering of the crops as most of the time a farmer cannot supervise all the area and that's how great amount of water wasted.

Presented Solution: The presented paper solved the problem by fixing the sensors in each corner of the monitored field, when the sensor value (in voltage) goes to satisfied number it send notification to IRSA and if IRSA doesn't replied or water level goes on danger level it will automatically close the gates.

Phase 4 of Problem Statement is that sometime there is inadequate water supply due to the unavailability of resource or stealing by some farmers, which cause the damage of crops on some section in the field.

Presented Solution: The presented paper solved the problem that those sensors grounded in the field sense the soil moisture, if it goes to the danger level it automatically opens the gates and let the water goes to the section of that field.

Phase 5 of Problem Statement is that in most areas there are riots between farmers due to distribution of water to their fields.

Presented Solution: The presented paper solved the problem by distributing the water with the manner of IRSA. Hence the farmers are not dealing with irrigation system so no riots were happening due to distribution of water.

III. PROPOSED APPROACH

This paper presents a helpful and simple computerization water system structure. By utilizing saturation sensor, the system will have water structure framework brilliant and electronic. Structure once introduced has no assistance cost and is certainly not difficult to utilize. In this work, a suitably build up a structure that can help in a robotized water system framework by investigating the soaked quality degree of the ground. The water structure ends up being a significant framework as it robotizes and facilitates the watering with no manual mediation. The fundamental applications for this undertaking are for ranchers and plant specialists who need more an ideal opportunity to water crops/plants.

The diagram given in Fig. 1 shows the functioning of the project as well as illustrations the tasks performed by different components to irrigate the crops. Automatic irrigation system is designed for certifying the appropriate level of water for growing up the crops all through the season with maximum per acre yield. For this reason, TIA PORTAL V13 was utilized for the desired output of the project. Totally Integrated Automation (TIA Portal) furnishes us with unhindered admittance to a total scope of digitalized automation administrations like, advanced arranging and incorporated designing to straightforward activity. The system is developed using ladder language for codding and linked it with the PLCSIM along-with a Human Machinery Interface (HMI) design. This variable rate computerized controlling methodology improves the general water system framework by decreasing the absolute expense and expands the creation of harvest yield. Hence, low cost, elective origin of power and variable rate mechanized activity are the key worries in the plan.

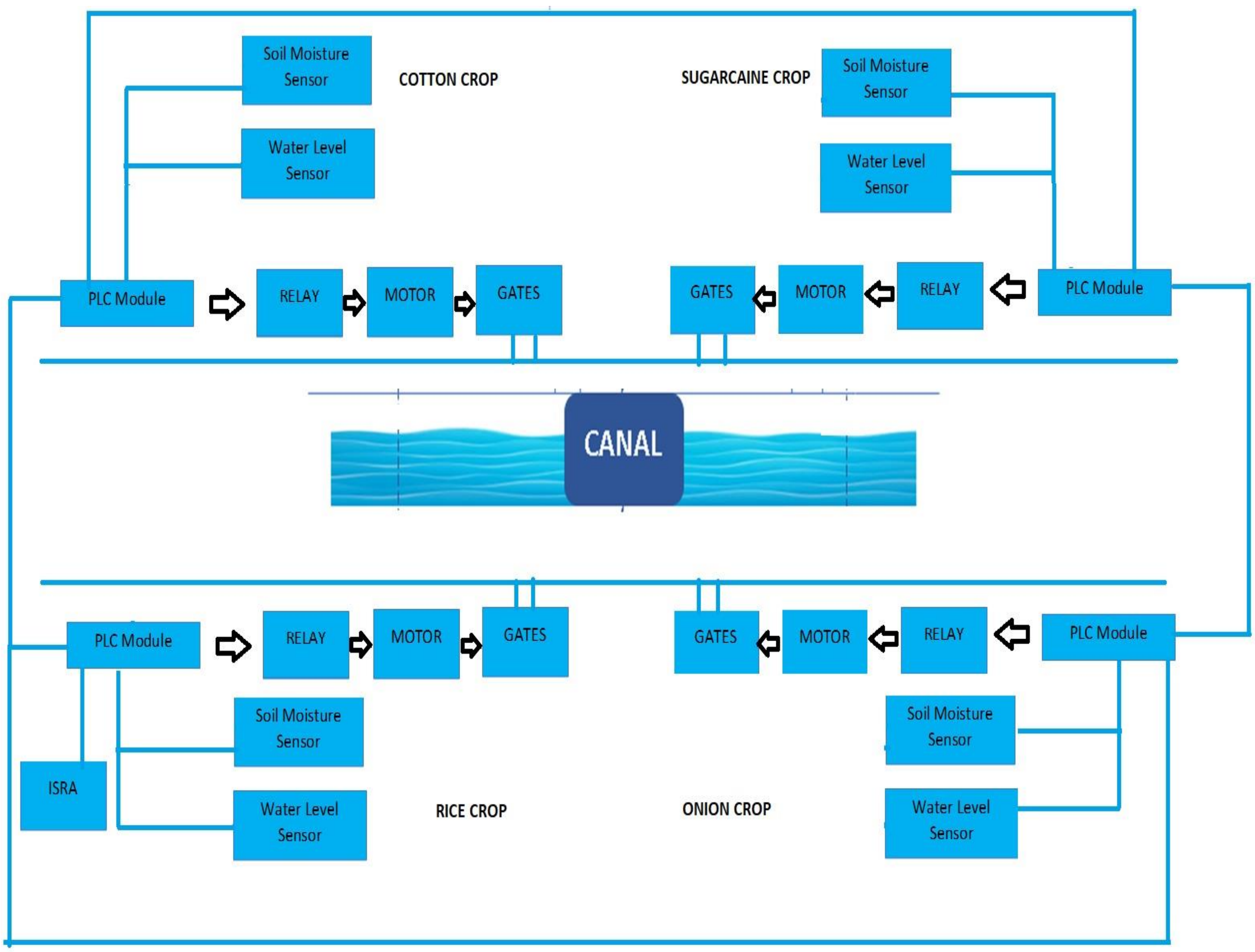


FIGURE 1. Schematic Diagram

The objective is to increase the per acre efficiency of crops by providing them efficient amount of water that they need and overcome the late-night duties of farmers and increase the quality and quantity of crops. By doing project save water and avoid riots between farmers. The mathematical modeling for the proposed system are given as follows

Wet soil + box = 1507g
Dry soil + box = 1250g
Box mass = 324g
Box size is 24cm in diameter, 7 cm tall.

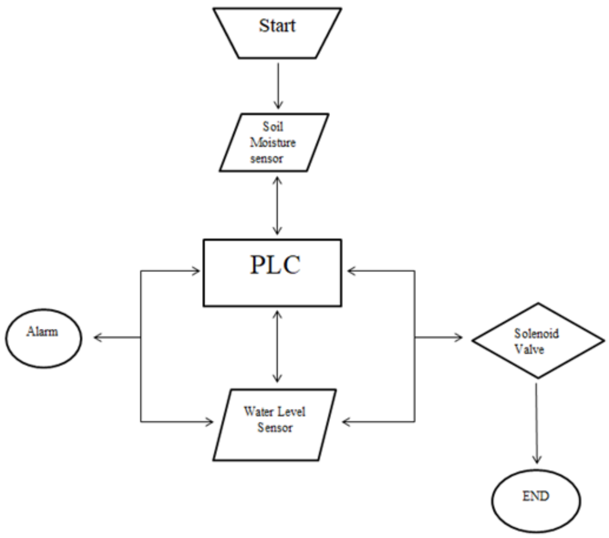


FIGURE 2. Proposed Algorithm

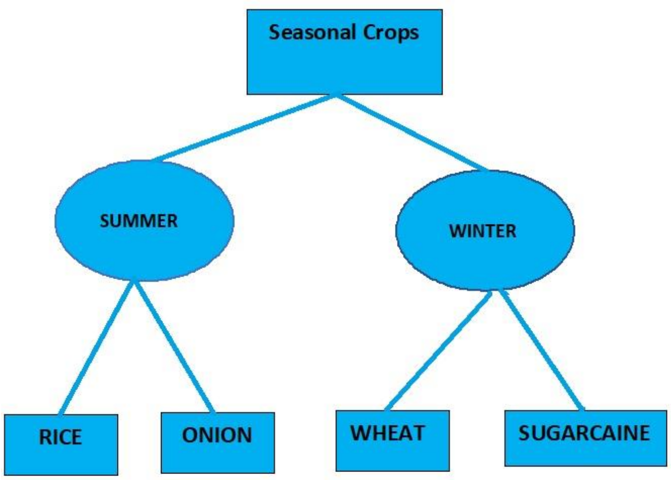


FIGURE 3. Seasonal Crops

IV. MATHEMATICAL CALCULATIONS

$$Volume = \begin{cases} \left(\pi \times r^2 \times h\right) \\ = 3.14 \times 144 \times 7 \end{cases} = 3165cm^3 \quad (1)$$

Samples displaces at 2500ml water

$$Bulk\ Density = \frac{Dry\ Soil}{Volume\ of\ Soil} = \frac{926}{3165} = 0.29\, g / cm^3 \quad (2)$$

$$Practical\ density = 0.58\ g/cm^3 \quad (3)$$

$$W = \frac{Mass\,Water}{Mass\,Solid} = \frac{1570 - 1250}{1250 - 324} = 0.27 \quad (4)$$

$$PV = \Theta = \frac{Volume\,Water}{Volume\,Total} = \frac{(1507 - 1250)}{3165} = 0.08\,cm^3 \quad (5)$$

Calibration of sensor:

The Table II shows the reading from the sensor:

TABLE II DATA OF CALIBRATION

"Θ" Volumetric content of water (cm3/ cm3)	**PLC value**	**Sensor reading (V)**
0.00	0	0
0.08	3	0.3
0.15	5	1
0.58	8	1.2
0.88	10	1.8

The specifications and features of the sensors are given as follows,

TABLE III SOIL MOISTURE SENSOR SPECIFICATIONS

Voltage required for operation:	3.3V to 5V DC
Current required for operation:	15mA
Output Digital can be	0 to 5V
Output Analog can be varies from	- 0V to 5V
Size of the PCB:	3.2cm x 1.4cm

A. BATTERY DESIGN

The mathematical formulations for designing of the battery are taken from [30], [31] and are used as follows:

Presently the required Back up Time of batteries in Hours = 3 Hours

12V x 100Ah = 120 Wh (6)

Presently for one Battery

120 Wh/82 W = 1.46 Hours (7)

In any case, our necessary Backup time is 3 Hours. Hence, 3/1.5 = 2

Two (2) batteries every one of 10Ah, 12V can be used,

TABLE IV DATA FOR BATTERY CALCULATION

Lithium Battery type	12V – 10Ah
Minimal capability	10Ah
Minimal voltage of battery	12 VDC
Operational discharge voltage	10.4 VDC
Operational charge voltage	14 VDC
Continuous charge current	50 A
Charging and discharging current	25 A

At that point the rating of batteries become Volts of battery-1 (V_1) + Volts of battery-2 (V_2) = 12V +12V = 24V while the current rating would be same i.e.10Ah.

That is the reason the interface of the batteries in equal, on the grounds that the Voltage of batteries (12 V) stays same, while its Ah (Ampere Hour) rating will be expanded. for example, the framework would become = 12V and 10Ah +10Ah = 20Ah.

Presently the Required Charging Current for these two batteries.

(Charging current ought to be 1/10 of batteries Ah)

Charging Time of battery = Battery Ah/Charging Current

B. REQUIRED NO. OF SOLAR PANELS

The design of solar PV supply system is done using the concepts shared in [32], [33] and are used as follows:

Presently there is a 4.5A straightforwardly associated burden to the boards Charge Controller. During the daylight, the sunlight based board gives 4.5A to the straightforwardly associated load + 2A to the battery charging for example sunlight based boards charge the battery just as give 4.5A.

TABLE V SOIL MOISTURE SENSOR SPECIFICATIONS

Components	Quantity	Watt Consumption	Total Watt
Relay	2	1.680 watt	2*1.680 = 3.36
PLC(FX 1N)	1	21 watt	1*21 = 21
Module (FX 2N-2AD)	1	1.2 watt	1*1.21 = 1.2
Soil Moisture sensor	2	0.075 watt	2*0.075 = 0.15
Water Level Sensor	2	0.1 watt	2*0.1 = 0.2
Solenoid valve	2	28 watt	2*28 = 56

Total Load (watt) = 3.36+21+1.2+0.15+0.2+56

$$= 81.91 \text{ W} \quad (8)$$

For this situation, the complete required current (2 A for Batteries Charging and 4.5 A for legitimately associated load)

For this situation above, complete required current in Amperes,

$$2A + 4.5A = 6.5A \quad (9)$$

Presently, I = 6.5 A, at that point required Power

$$P = V \times I = 12V \times 6.5A = 78 \text{ Watts} \quad (10)$$

The 78 W frameworks for the above clarified framework (This is for both Direct Load and Batteries Charging). Presently, the quantity of PV panels required are,

$$78/20W = 4 \text{ No's of Solar Panels} \quad (11)$$

In this way, 4 panels of 20W, 12V,1.5A ratings can be connected.

V. RESULTS AND DISCUSSION

In this section the simulation of PV Based irrigation system for different crops is discussed. Initially the wheat crop which is a winter season crop with the required range of irrigation (15.6-17.8mm). Similarly, the rice crop which is a summer season crop with the required range of irrigation (1100-1250mm). Similarly, the sugarcane crop, which is also a winter season crop with the required range of irrigation (150-200cm), and finally the onion crop, which is a summer season crop with the required range of irrigation (350-550mm). Hence the required range of irrigation of different crops, can be detected and fulfilled by use of sensors.

This section also provides the methodology of how each module works and the inter relation among the components is being discussed. The soil, operational mechanism, necessary sensors, and the governors are similar for all crops. However, the requirement of water for the irrigation purposes is different for the mentioned crops. All the crop fields are connected with the same PLC, having eight inputs and four outputs. Every output is connected with each governor of the particular field and every field is having the two inputs in the form of two sensors which are soil moisture and water level sensors.

The total number of components is presented in table 6 as follows,

TABLE 6 COMPONENT RATING OF RICE FIELD

Apparatuses	Quantity
Relay	2
PLC FX 1N-60MT	1
Module FX 2N – 2AD	1
Soil Moisture Sensor	2
Solenoid valve 24 Dc	2
Water Float/level sensor	2
Wires	<30
Battery 24V DC	1

The simulation diagram of the implemented circuit is given in figure 4,

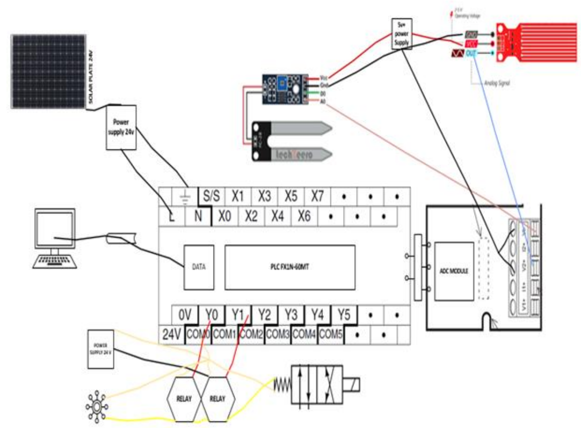
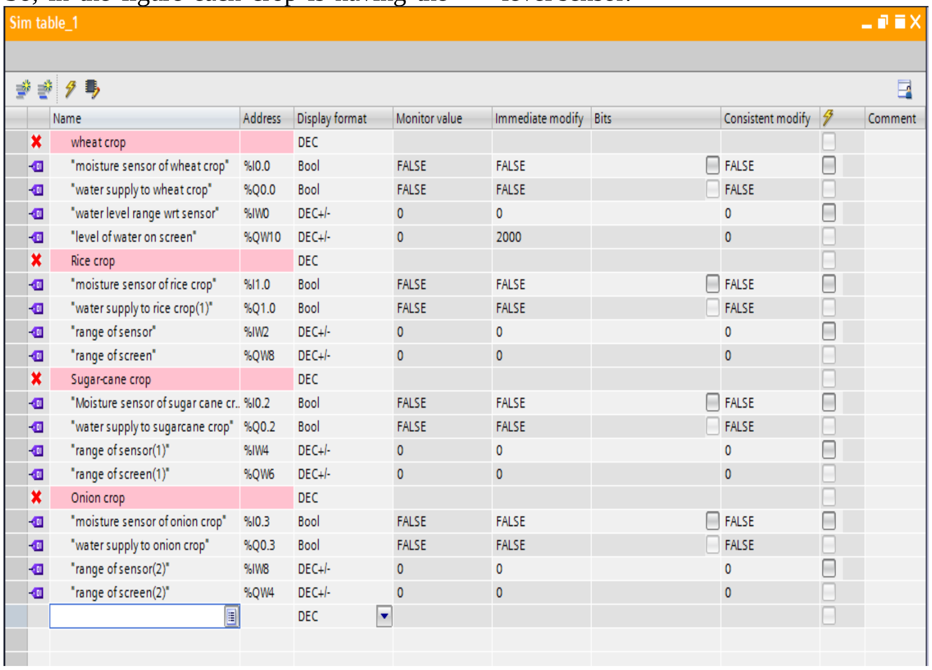


FIGURE 4. Circuit Diagram

Figure 4 shows the simulation diagram for the above mentioned four crops. So, in the figure each crop is having the soil moisture sensor, water supply (using governors), and a water level sensor.



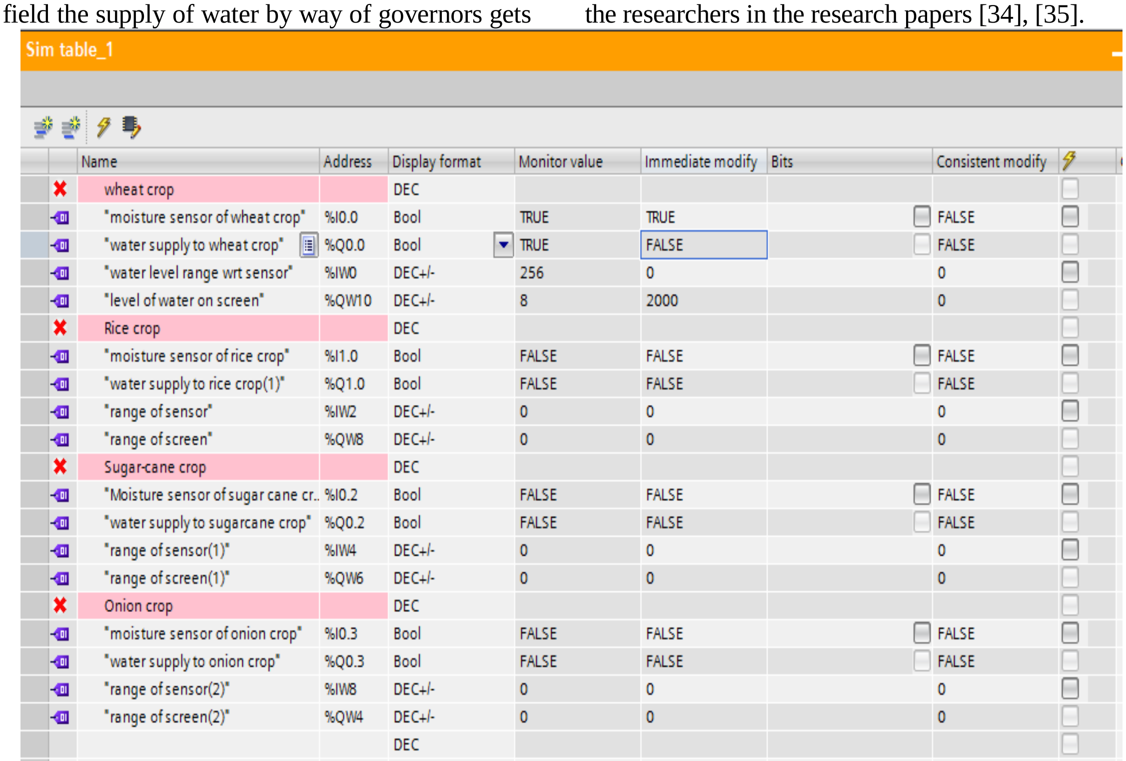
Sim table_1

Name	Address	Display format	Monitor value	Immediate modify	Bits	Consistent modify	Comment
wheat crop		DEC					
"moisture sensor of wheat crop"	%I0.0	Bool	FALSE	FALSE		FALSE	
"water supply to wheat crop"	%Q0.0	Bool	FALSE	FALSE		FALSE	
"water level range wrt sensor"	%IW0	DEC+/-	0	0		0	
"level of water on screen"	%QW10	DEC+/-	0	2000		0	
Rice crop		DEC					
"moisture sensor of rice crop"	%I1.0	Bool	FALSE	FALSE		FALSE	
"water supply to rice crop(1)"	%Q1.0	Bool	FALSE	FALSE		FALSE	
"range of sensor"	%IW2	DEC+/-	0	0		0	
"range of screen"	%QW8	DEC+/-	0	0		0	
Sugar-cane crop		DEC					
"Moisture sensor of sugar cane cr..	%I0.2	Bool	FALSE	FALSE		FALSE	
"water supply to sugarcane crop"	%Q0.2	Bool	FALSE	FALSE		FALSE	
"range of sensor(1)"	%IW4	DEC+/-	0	0		0	
"range of screen(1)"	%QW6	DEC+/-	0	0		0	
Onion crop		DEC					
"moisture sensor of onion crop"	%I0.3	Bool	FALSE	FALSE		FALSE	
"water supply to onion crop"	%Q0.3	Bool	FALSE	FALSE		FALSE	
"range of sensor(2)"	%IW8	DEC+/-	0	0		0	
"range of screen(2)"	%QW4	DEC+/-	0	0		0	
		DEC					

“

FIGURE 5 Simulation of all Crops

Figure 5 presents parameters and data of a wheat field, when soil moisture value gets true means that there is deficiency of water in wheat field the supply of water by way of governors gets started. To fulfill the need of water in wheat field, the range of water is fixed by the program which matches to the range fixed by the researchers in the research papers [34], [35].



Sim table_1

Name	Address	Display format	Monitor value	Immediate modify	Bits	Consistent modify
wheat crop		DEC				
"moisture sensor of wheat crop"	%I0.0	Bool	TRUE	TRUE		FALSE
"water supply to wheat crop"	%Q0.0	Bool	TRUE	FALSE		FALSE
"water level range wrt sensor"	%IW0	DEC+/-	256	0		0
"level of water on screen"	%QW10	DEC+/-	8	2000		0
Rice crop		DEC				
"moisture sensor of rice crop"	%I1.0	Bool	FALSE	FALSE		FALSE
"water supply to rice crop(1)"	%Q1.0	Bool	FALSE	FALSE		FALSE
"range of sensor"	%IW2	DEC+/-	0	0		0
"range of screen"	%QW8	DEC+/-	0	0		0
Sugar-cane crop		DEC				
"Moisture sensor of sugar cane cr..	%I0.2	Bool	FALSE	FALSE		FALSE
"water supply to sugarcane crop"	%Q0.2	Bool	FALSE	FALSE		FALSE
"range of sensor(1)"	%IW4	DEC+/-	0	0		0
"range of screen(1)"	%QW6	DEC+/-	0	0		0
Onion crop		DEC				
"moisture sensor of onion crop"	%I0.3	Bool	FALSE	FALSE		FALSE
"water supply to onion crop"	%Q0.3	Bool	FALSE	FALSE		FALSE
"range of sensor(2)"	%IW8	DEC+/-	0	0		0
"range of screen(2)"	%QW4	DEC+/-	0	0		0
		DEC				

FIGURE 5 Moisture Sensor goes True for Wheat Crop

The Fig. 6 shows the response, when the moisture sensor of wheat crop gets false, meaning that the soil gets enough water supplies but not enough to fulfill the need of wheat crop as can be seen that water supply by governors is still true. In this scenario, the supply is turned-off temporarily to check the response of the sensors, as the supply can be restarted if the crop still requires more water.

Sim table_1

Name	Address	Display format	Monitor value	Immediate modify	Bits	Consistent modify
wheat crop		DEC				
"moisture sensor of wheat crop"	%I0.0	Bool	FALSE	FALSE		FALSE
"water supply to wheat crop"	%Q0.0	Bool	TRUE	FALSE		FALSE
"water level range wrt sensor"	%IW0	DEC+/-	0	0		0
"level of water on screen"	%QW10	DEC+/-	0	2000		0
Rice crop		DEC				
"moisture sensor of rice crop"	%I1.0	Bool	FALSE	FALSE		FALSE
"water supply to rice crop(1)"	%Q1.0	Bool	FALSE	FALSE		FALSE
"range of sensor"	%IW2	DEC+/-	0	0		0
"range of screen"	%QW8	DEC+/-	0	0		0
Sugar-cane crop		DEC				
"Moisture sensor of sugar cane cr..	%I0.2	Bool	FALSE	FALSE		FALSE
"water supply to sugarcane crop"	%Q0.2	Bool	FALSE	FALSE		FALSE
"range of sensor(1)"	%IW4	DEC+/-	0	0		0
"range of screen(1)"	%QW6	DEC+/-	0	0		0
Onion crop		DEC				
"moisture sensor of onion crop"	%I0.3	Bool	FALSE	FALSE		FALSE
"water supply to onion crop"	%Q0.3	Bool	FALSE	FALSE		FALSE
"range of sensor(2)"	%IW8	DEC+/-	0	0		0
"range of screen(2)"	%QW4	DEC+/-	0	0		0
		DEC				

FIGURE 6 System Starts Watering the Wheat Crop

Sim table_1

Name	Address	Display format	Monitor value	Immediate modify	Bits	Consistent modify
Wheat crop		DEC				
"moisture sensor of wheat crop"	%I0.0	Bool	FALSE	FALSE		FALSE
"water supply to wheat crop"	%Q0.0	Bool	FALSE	FALSE		FALSE
"water level range wrt sensor"	%IW0	DEC+/-	29900	29900		0
"level of water on screen"	%QW10	DEC+/-	18	2000		0
Rice crop		DEC				
"moisture sensor of rice crop"	%I1.0	Bool	FALSE	FALSE		FALSE
"water supply to rice crop(1)"	%Q1.0	Bool	FALSE	FALSE		FALSE
"range of sensor"	%IW2	DEC+/-	0	0		0
"range of screen"	%QW8	DEC+/-	97	0		0
Sugar-cane crop		DEC				
"Moisture sensor of sugar cane cr..	%I0.2	Bool	TRUE	FALSE		FALSE
"water supply to sugarcane crop"	%Q0.2	Bool	TRUE	FALSE		FALSE
"range of sensor(1)"	%IW4	DEC+/-	0	0		0
"range of screen(1)"	%QW6	DEC+/-	0	0		0
Onion crop		DEC				
"moisture sensor of onion crop"	%I0.3	Bool	FALSE	FALSE		FALSE
"water supply to onion crop"	%Q0.3	Bool	TRUE	FALSE		FALSE
"range of sensor(2)"	%IW8	DEC+/-	0	0		0
"range of screen(2)"	%QW4	DEC+/-	0	0		0
		DEC				

FIGURE 7 Wheat Crop gets Enough Water

The Fig. 7 presents the scenario after the fulfillment of the required range of water in wheat field and the supply of water automatically gets turned off as the governor gets closed. Similarly, when there is again deficiency of water in wheat field again the moisture sensor gets true and water supply to the field

Figure 8 shows that the moisture sensor detects the volumetric water content and give the output in the form of voltages (0-4.2 V). This graph shows that voltages rise with the volumetric content of water. The two probes connected measure the (volumetric content) of water. The current passes through the soil and afterward the obtained resistance used to measure the moisture content value.

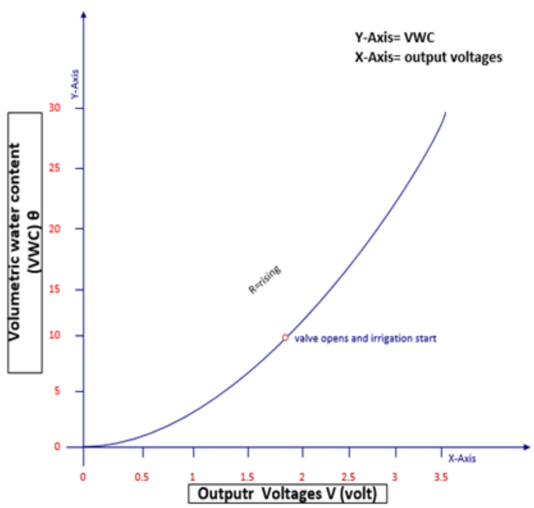


FIGURE 8 Moisture Sensor Voltages

The relationship between volumetric value of water and output voltages and PLC voltages is calibrated and given in Table VI.

TABLE VI COMPONENT RATING OF WHEAT FIELD

COMPONENTS	RATING	QUANTITY
PLC (S7-1200)	AC/DC/RLY	1
SOIL MOISTURE SENSOR	VH400	1
WATER LEVEL SENSOR	20MM	1

Figure 9 shows the voltages differ of sensors. On the other hand, it shows the required water level of every crop, as in the onion crop the water required from the moisture level of (0-0.3) and the level shows in PLC is in from (0-3). Similarly, with the other crops the water level defined by their voltage difference.

gets started by the way of governors. Now as can be seen there is value of water range is 18, hence the average value of water required for wheat field is from (15.6-17.8 mm) that's why the supply of governor goes close because the field gets enough water.

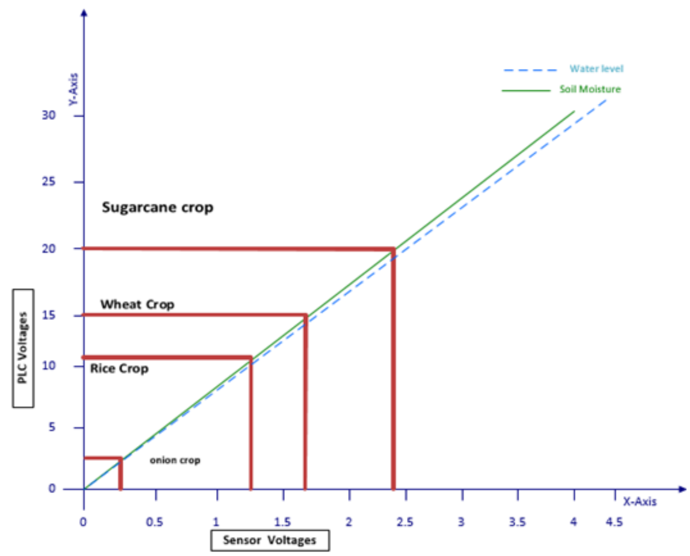


FIGURE 9 Optimal Level

The Tables VII, VIII and IX shows the rating of the components for Rice, Sugar-Cane and Onion fields.

TABLE VII COMPONENT RATING OF RICE FIELD

Components	Rating	Quantity
PLC (S7-1200)	AC/DC/RLY	1
Soil Moisture sensor	VH400	1
Water level sensor	1250mm	1

TABLE VIII COMPONENT RATING OF SUGAR-CANE FIELD

Components	Rating	Quantity
PLC (S7-1200)	AC/DC/RLY	1
Soil Moisture sensor	VH400	1
Water level sensor	200cm	1

TABLE IX COMPONENT RATING OF ONION FIELD

Components	Rating	Quantity
PLC (S7-1200)	AC/DC/RLY	1
Soil Moisture sensor	VH400	1
Water level sensor	550mm	1

Similarly, for all the other fields same procedure going to be happen like this wheat field every field is having the same soil moisture sensor but with different water level ranges and all the field are having same size of governor for the supply of water. But every field is connected with the same PLC which is having the eight inputs and four outputs. Every output is connected with each governor of each field and every field is having the two inputs in the form of two sensors which are soil moisture and water level sensor.

In the designing of human machinery interface (HMI), separate fields by season based like there are two winter season fields one is wheat and other is sugar-cane field and for the summer season there is rice and onion fields. Now if the click is on summer season field the graphics of rice and onion fields are shown. On the other side same as for winter season. Now by changes the ranges or bits on simulation can be seen the simple and common change on graphics (Fig. 10).

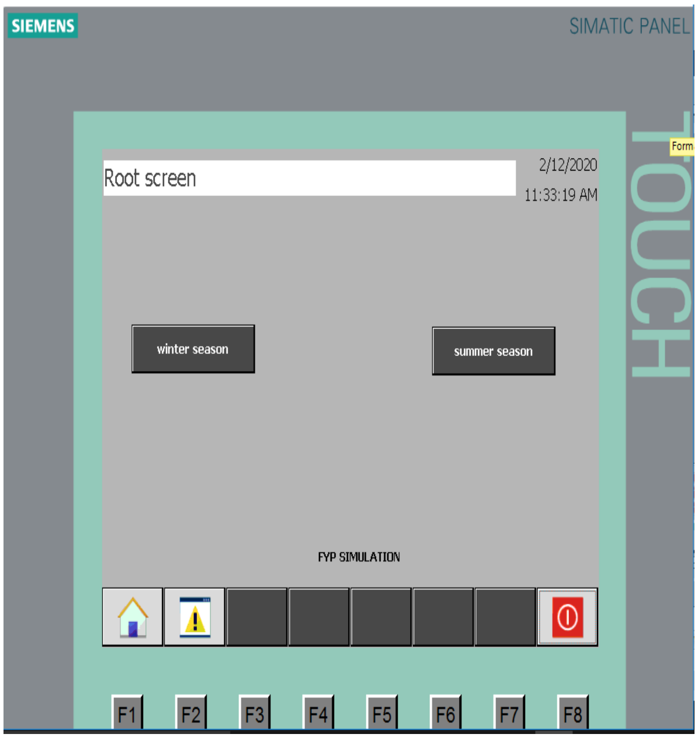


FIGURE 10 Graphical Results

As presented that the summer season HMI, as can be seen the upper field is onion field and, in the middle, there is canal and at lower end there is rice field. And with the both of field range meter is given. Now notice how it works as, the water increases on the field range of water at bar also increases according to the limits of every field (Fig. 11).

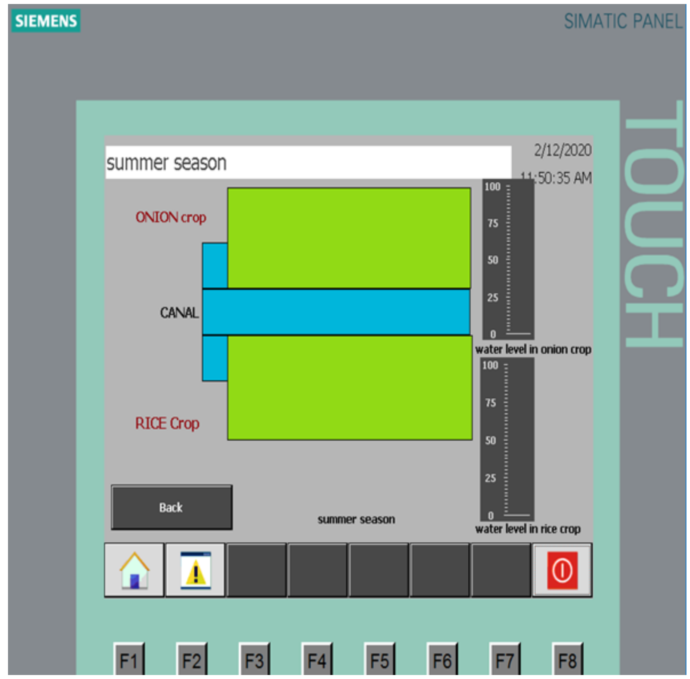


FIGURE 11: Graphical Results

VI. FINANCIAL BENEFITS

The aim of the project is to make innovation in the agricultural industry of Pakistan. By knowing the soil health, the agricultural yield of the country can be increased. With the help of soil moisture sensor, the quantities of water in the soil can be controlled and will improve the soil stability and results in better and improved production.

To materialize the presented product with the aim of business development, following resources are required:

- All the basic resources are required to start a business (i.e., Machinery, electronicequipment, a proper place etc.)
- Accessories.
- Human resources.
- Electricity (etc.)

The Table X presents the details of the initial investment for the development and deployment of the presented agricultural product.

TABLE X INITIAL BUDGET EXPENSES

Sr. No	Capital Nature Expenses	Amount (PKR)
1	Laptop (50,000 x 1)	50,000/-
2	Equipment (35,000 x 1)	35,000/-
3	**Revenue Nature Expenses**	**Amount (PKR)**
4	Internet (1800x 12)	21,600/-
5	Misc. Expenses (1,000 x 12)	12,000/-
6	Electricity (5,000 x 12)	60,000/-
7	Purchase of Raw Material (10,000 x 10)	100,000/-
8	**Total: Initial Expenses (Budgeted)**	**281,000/-**

The Table XI provides the statement of comprehensive income from business-oriented implementation of the intended product. However, following important points must be considered while calculating annual financial plan for five years.

- All expenses & revenue are estimated.
- Depreciation is provided on straight line method @10% on all Non-Current Assets.
- Commission shall be given @10% in the basis of profit earned every year.
- As the income in all years is less than the minimum prescribed limit as per “Income Tax Ordinance, 2001”. So, no provision for tax is calculated.
- Raw material contains sensors i.e., PLC, Water level Sensor, Soil Moisture Sensor, relays etc. and other electrical equipment which are required.
- Variable overhead vary with production depends on units produced in the year etc. electricity.

TABLE XI: STATEMENT OF COMPREHENSIVE INCOME (BUDGETED)

	Year-1	***Year-2***	***Year-3***	***Year-4***
Revenue	196,000/- (w-1)	250,000/- (w-2)	320,000/- (w-1)	400,000/- (w-1)
Production cost	(60,000) (w-2)	(80,000) (w-1)	(100,000)(w-2)	(150,000) (w-2)
Other Operating Expenses	(81,600) (w-3)	(100,000)	(120,000)	(120,000)
Depreciation	(6,000) (w-4)	(6,000)	(6,000)	(6,000)
Misc.	(4,000)	(6,000)	(8,000)	(8,000)
Marketing Expenses	(8,000)	(15,000)	(15,000)	(7,000)
Profit before Commission	38,400/-	43,000/-	71,000/-	109,000/-
Commission	(15,440) (w-5)	(17,400)(w-5)	(28,400) (w-3)	(35,000) (w-3)
Profit After Commission	**25,400/-**	**28,000/-**	**42,600/-**	**74,000/-**

In this section, the complete financial plan is described in detail for the development and implementation of the presented product. The product values and other features are also described in detail. The purpose is to make it easy for the reader to understand the economic value and social standing of this intended project.

VII. CONCLUSION

The PV Based Automatic Irrigation System is a proposed system that can be advantageous for the legislature and the ranchers. For the administration an answer for vitality emergency is proposed. By utilizing the programmed water supply framework, it enhances the utilization of water by diminishing wastage and lessens the human mediation for ranchers. The implementation of PV panels for providing electric supply to the installed circuits and for charging the batteries can also help in reducing the burden on the existing power system. It can also be helpful in overcoming the riots between the farmers which creates a peaceful environment in society. In any event, when the ranchers are away, the programmed water supply framework consistently guarantee the best possible degree of water for the crops. Thus, increasing the proficiency of water usage and keeping the soil dampness at ideal level. Despite the fact that there is a high capital investment required for the execution of the proposed system to be actualized, the general advantages are high and in since quite a while ago run this framework is conservative.

FUNDING STATEMENT

The authors declare they have no conflicts of interest to report regarding the present study.

CONFLICT OF INTEREST

The Authors declare that they have no conflicts of interest to report regarding the present study.

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