NRRI SMART TENSIOMETER
for Maximizing Water Productivity in Rice Cultivation

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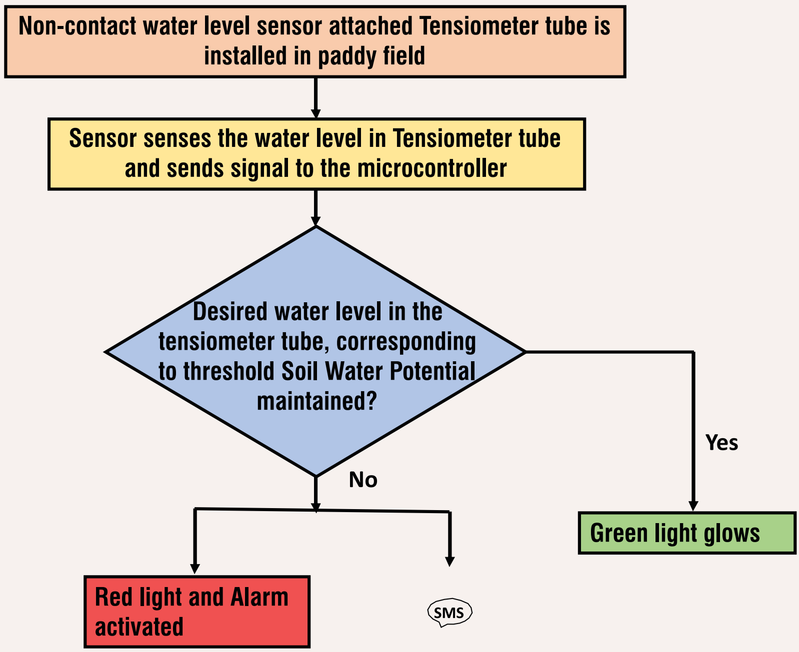
Rice cultivation frequently requires a significant amount of irrigation water. In conventional rice cultivation, farmers usually keep the fields consistently flooded from the transplanting phase until the rice crop reaches physiological maturity. However, it's widely recognized that sustained flooding isn't essential for achieving high yields in rice. After seedling establishment phase, rice plants can efficiently absorb water from the sub surface soil, even if there is no standing water in the field. Over the past few decades, addressing the issue of water scarcity has become more prominent in sustaining rice production. Hence, the advancement of innovative water-saving technologies is vital to aid rice farmers in coping with water shortages. An essential aspect of irrigation scheduling involves determining the optimal timing for irrigation. One method involves employing threshold soil water potential as measured by tensiometer to determine the appropriate timing for re-irrigation. Implementing such irrigation scheduling techniques can maximize water productivity by minimizing irrigation water input, as farmers often tend to over-irrigate the crop regardless of its actual water needs.

The regularly monitoring of the water level in tensiometer tubes situated in distant fields poses a significant challenge for farmers. Often, this monitoring task is not executed adequately, leading to over/under irrigation. To address the limitations of manual monitoring, ICAR – NRRI, Cuttack has developed smart tensiometer for enhancing irrigation precision in rice fields. In this system, a non- contact sensor is attached to the tensiometer tube to sense the water level inside the tube. The sensor is connected to the tensiometer tube at a height which corresponds to threshold soil water potential for maximising water productivity. The sensor is connected to a microcontroller and relay module and the entire setup operates using a 12V battery, which is recharged by a solar panel positioned on the upper part of the structure. Once the water level in the tensiometer tube falls below the desired threshold, the sensor sends a signal to the microcontroller, prompting it to activate both the red bulb and alarm. The illumination of the red bulb and the sounding of the alarm alert the farmer for the irrigation event. Furthermore, upon reaching the threshold level, the microcontroller and GSM modem also transmit an alert message to the farmer's mobile number registered with the system.

METHODOLOGY

This system is entirely automated and consists of sensing, control and communication module. The sensing unit is tasked with real time monitoring of water level in the tensiometer tube. The sensing module consists of a tensiometer tube and a non-contact sensor. With the help of an auger, the tensiometer tube is installed in the field at desired depth (root zone). Prior to installation, the porous ceramic cup of the tensiometer should be kept dipped overnight to ensure that they get fully water saturated and do not leak. The gap between the tube and hole is backfilled with soil slurry so that the tensiometer is firmly held in the soil. The tensiometer is allowed to equilibrate for about 24 hours before recording readings. After the installation of tensiometer tube, a non- contact sensor is connected to the tensiometer tube at a height which corresponds to threshold soil water potential for maximising water productivity. After some days of the irrigation event in the field, the soil surrounding the ceramic cup of the sensor begins to dry and there is an outflow of water from the tube through the ceramic cup, leading to a reduction in the water level within the tensiometer tube. The non-contact sensor is connected to the tensiometer tube at a height which corresponds to threshold soil water potential for

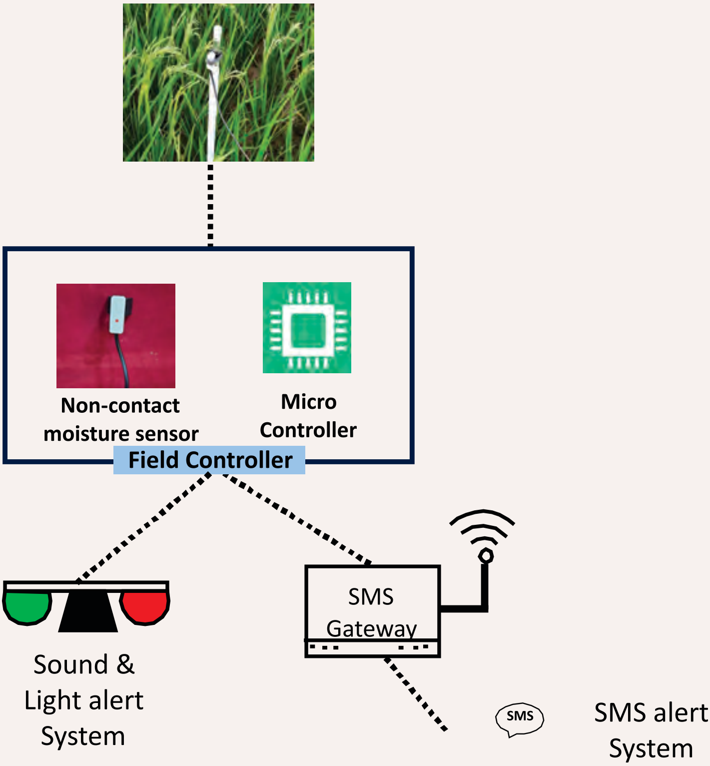


maximising water productivity. As soon as the water level in the tube enters the threshold height the sensor attached to the tube communicates a signal to the microcontroller.

The control module initiates a control action in response to signal sent by the sensor. Primarily, it comprises an Arduino ATmega328 microcontroller and a relay block module for receiving instructions from the Arduino ATmega328 microcontroller. Based on the signal received from the sensor, the microcontroller with the help of relay block controls the light and sound alert system. The green light remains illuminated until the water level in the tensiometer tube reaches the threshold level. As soon as the water level in the tube falls below the threshold level, the sensor sends a signal to the microcontroller to enable the red light and sound alert system. Under this situation, the microcontroller also sends a signal to activate the GSM communication system, prompting it to send an SMS to the registered mobile number of the end user.

ADVANTAGES

This system offers real-time monitoring and operates automatically, thereby eliminating the requirement for daily manual monitoring of the water level in the tensiometer tube. By preventing over-irrigation or under-irrigation, this system minimizes the wastage of irrigation water. As this system operates on clean energy, it eliminates the need for electricity. It has the potential to enhance water productivity by approximately 28% without any significant decrease in grain yield. Additionally, it boosts net returns for farmers by cutting down irrigation water pumping costs and fuel consumption. Field trials have shown that employing irrigation scheduling through this system reduces methane emissions by 51% and global warming potential by 21%.



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