# ENERGY CONSERVATION THROUGH LEACH CLUSTER HEAD ALGORITHM IN WSN BASED PRECISION AGRICULTURE

Kirti Soni[1], Rashid Hussain[2]
[1]M.Tech Research Scholar,,[2]Associate professor.
Kirtisoni1956@gmail.com, husaain1992@gmail.com.
Suresh Gyan Vihar University,Jaipur.

## ABSTRACT

It is well known that due to wrong prediction of weather and incorrect methods to crops, the farmers have to bear a huge financial loss. And it is also expected that by 2050 the world population will reach 34 percent higher than today. Evolution of wireless sensor network (WSN) technology enabled automatic irrigation in a greenhouse for precision agriculture (PA) application, which will help in feeding the increased population by maximizing food production, minimizing environmental impact and low cost. This paper will present the system architecture, design requirements of WSN for PA in a greenhouse. This paper also proposes a new improved cluster algorithm of LEACH protocol which is intended to balance the energy consumption of the entire network and extend the life-time of the network. This paper also concentrates on avoidance of congestion. Implementation of WSN in PA will optimize the usage of water fertilizer and also maximized the yield of the crops.

KEYWORDS: Precision agriculture, LEACH, WSN, Congestion, Cluster head



## INTRODUCTION

Agriculture, the backbone of Indian economy, contributes to the overall economic growth of the country and determines the standard of life for more than **50%** of the Indian population. Agriculture contributes only about **14%** to the overall GDP but its impact is felt in the manufacturing sector as well as the services sector as the rural population has become a significant consumer of goods and services in the last couple of decades.

Nearly 80% of the 140 million farming families hold less than 2 acres of land. Small land holdings restrict the farmer to use traditional methods of farming and limit productivity as a result farm income comes down. Most of the farming in India is monsoon dependent –when the monsoon fails, farmers are affected a lot as they do not have proper management of water.[8]Due to lack of knowledge of how to grow crops sustainably farmers are forced to enter in a situation of debts, low productivity, heavy use of fertilizers, etc. Farmers' access to markets is obstruct by poor roads, uncompleted market infrastructure, and excessive regulation.

Precision agriculture benefits**:** It monitors various parameters such as humidity, moisture, temperature etc. related to farm by placing different types of

sensors.[1]The application of sensing devices allows continuous monitoring of chosen parameters and will provide real time data. Reduce fertilizer costs. Reduce chemical application costs. Reduce pollution through poor use of chemicals. Improve crop yields. Provide better information for management decisions. Provide better farm records essential for sale and succession.

# PRECISION AGRICULTURE

In order to grow crops optimally farmers need to understand how to cultivate those crops in a particular area,[3]Once the seeds have been planted, The decisions made around fertilizing and maintaining the crops are time sensitive and heavily influenced by the weather. If farmers know they'll have heavy rain the next day, they may decide not to put down fertilizer since it would get washed away. Knowing whether it's going to rain or not can also influence when to irrigate fields. Weather not only affects how crops grow, but also logistics around harvesting and transportation. By understanding what the weather will be over several days and what fields will be affected, better decisions can be made in advance about which fields workers should be deployed to.

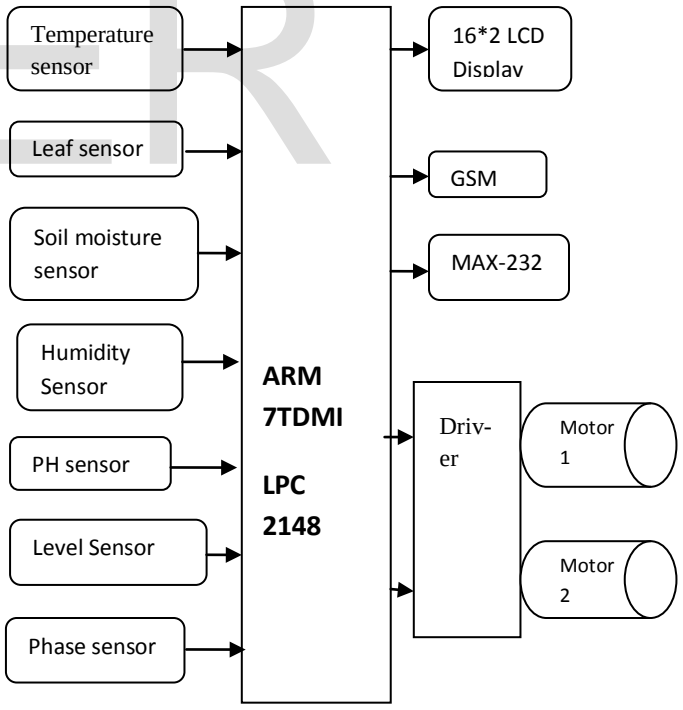
Precision agriculture is totally dependent on Wireless sensor network as we need various types of sensors to monitor multiple parameters. The wireless sensors are commonly battery or solar energy powered, which can be easily deployed into the farmland to form self-organized network by wireless communication. Various kinds of sensors can be integrated into the sensor node, therefore, the conditions of the crops and the soil, including temperature, humidity, illumination, crop disease, and insect pest etc. can be monitored remotely and in real time.

Precision agriculture system includes sensors that can handle local field survey and collects data of soil water availability, biomass yield, soil compaction, soil fertility, leaf area index, leaf temperature, leaf chlorophyll content, local climate data, insect-disease-weed infestation, plant water status, and yield of grain etc.

# SYSTEM ARCHITECTURE

The system architecture of sensors employed in precision agriculture farming is shown in figure 1.

FIG. 1




The system architecture consists of sensors that are used to monitor humidity, moisture and temperature. The software's that are being used monitors data from the sensors in a feedback loop which activates the control devices based on a

threshold value.[7] This paper aimed to change greatly the small scale production based sector into large scale agribusiness that contributes towards national economic growth and sustainability.

The main problem arises here because the variables that are monitored are not static but changes frequently which in turn will increase the traffic. Due to increased traffic flow the network will take more time to synchronize. As a result of which power consumption by the sensors to monitor various parameters and to send the collected data to the monitoring station will be more. The solution for all such problems is the implementation of LEACH protocol which will help in resolving the congestion.

Soil moisture sensors:
Soil moisture is one of the most important parameter for PA field measurement.[2]which is used to determine when to irrigate and amount of water to supply. It is found in a survey that most of the time, the fields are over irrigated. Over irrigation prevents the nitrogen to be used by roots, and lack of oxygen in the root area. Soil moisture is the water that is held in the spaces between soil particles.


Soil moisture sensor implemented at RARI


Sprinklers working with soil moisture sensor at RARI

To maximize the productivity different crops need different level of moisture.

Soil and surrounding atmosphere temperature play an important role in irrigation. In normal condition, the temperature near the plant is less due to evaporation process. Currently there are two main categories of soil moisture measurements: contact based and contact-free methods. Contact-based methods require direct contact with the soil. Examples of contact methods include capacitance sensors, heat pulse sensors, and fiber optic sensors.

The second category consists of contact free measurement techniques. Remote sensing methods are prominent in this category. Remote sensing methods include passive microwave radiometers, synthetic aperture radars, and thermal methods. These methods are either ground based or operated from airborne or space borne platforms. Limitations of current remote sensing methods are problems with spatial averaging and a small penetration depth. These limitations make it difficult to obtain accurate values of soil moisture at a much smaller spatial support than the observation, and to sense moisture variations beyond a thin surface layer.

# EFFECTS OF CONGESTION

There are mainly 2 parameters which are affected by congestion viz. throughput and delay[6].The throughput can be defined as the percentage utilization of the network capacity. Throughput varies as the offered load varies, initially it increase with offered load but after a certain it limit it starts decreasing. If load is increased further then no packet is delivered to destination, this is known as deadlock condition. This condition is responsible for delay in the network and increases energy consumption. The solution to all this is LEACH Protocol which is explained in the next section.

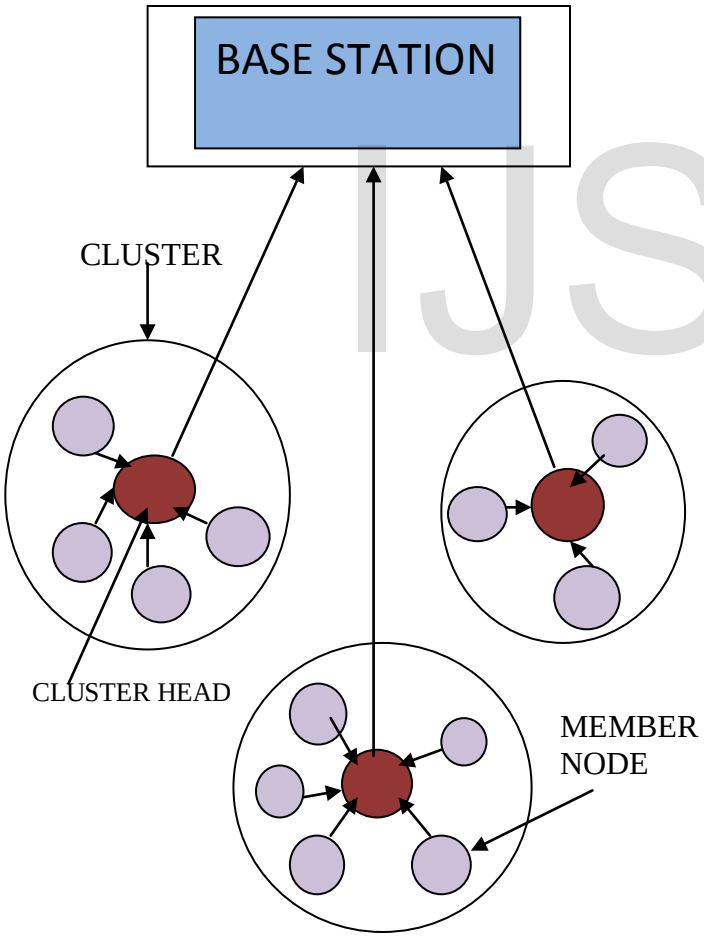
# LEACH PROTOCOL

LEACH (Low Energy Adaptive Clustering hierarchy) is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network. [4]. The operation

is divided into two phases which are explained below.

**Set-up phase:** In LEACH, clusters are formed autonomously with no long-distance communication with the base station and distributed cluster formation can be done without knowing the exact location of any of the nodes in the network. In addition, no global communication is needed to set up the clusters. Finally, the cluster-head nodes spreads throughout the network, which minimizes the distance the non-cluster head nodes need to send their data.

FIG2. LEACH PROTOCOL




After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV). This is a small message which contains the node's ID and a header. Each non-cluster-head node determines to which cluster it belongs by choosing the cluster-head that requires the minimum communication energy, based on the received signal strength of the advertisement from each cluster-head and finally it must inform the cluster-head node that it will be a member of the cluster by transmitting a join-request message (Join-REQ).

The cluster-heads in LEACH act as local control centers to co-ordinate the data transmissions in their cluster and sets up a TDMA schedule and transmits this schedule to the nodes in the cluster. This ensures that there are no collisions among data messages and also allows the radio components of each non cluster-head node to go in sleep mode except during their transmit time, thus minimizing the energy dissipated by the individual.

**Steady-State Phase:-**

During the steady phase, the sensor nodes i.e. the non-cluster head nodes starts sensing data and sends it to their cluster-head according to the TDMA schedule [10] The cluster-head node, after receiving data from all the member nodes, aggregates it and then sends it to the base-station .After a certain time, which is determined a priori, the network again goes back into the setup phase and new cluster-heads are chosen.

Each cluster communicates using different CDMA codes in order to reduce interference from nodes belonging to other clusters.

## ALGORITHM: [5]

Cluster heads are chosen based on this algorithm:

S(m)= K/1- K*( r mod 1/K)¥m €R
S(m) = 0 ¥m ÆR

Where m is random number between 0 and 1,

K is the cluster head probability,

R is the set of nodes that were not the cluster head the previous round

- If m < S(m), then that node becomes a cluster-head.

## Steps in each round of LEACH protocol are:

(1) First cluster heads are formed and it broadcasts an advertisement message(ADV)

ADV = node's ID + distinguishable header.

(2) In this round each of the non-cluster head node determines it cluster head by sensing the received signal strength of ADV message.

(3) After node picks cluster it must inform its respective cluster head using CSMA MAC protocol. Cluster heads now knows number of members and their identifiers after set up.

(4) Cluster head then creates a TDMA schedule telling each member node when it can transmit, allowing non used nodes to go in sleep mode thus minimizing energy consumption.

(5) Cluster head then aggregates all the data collected from member nodes and send it to the base station.

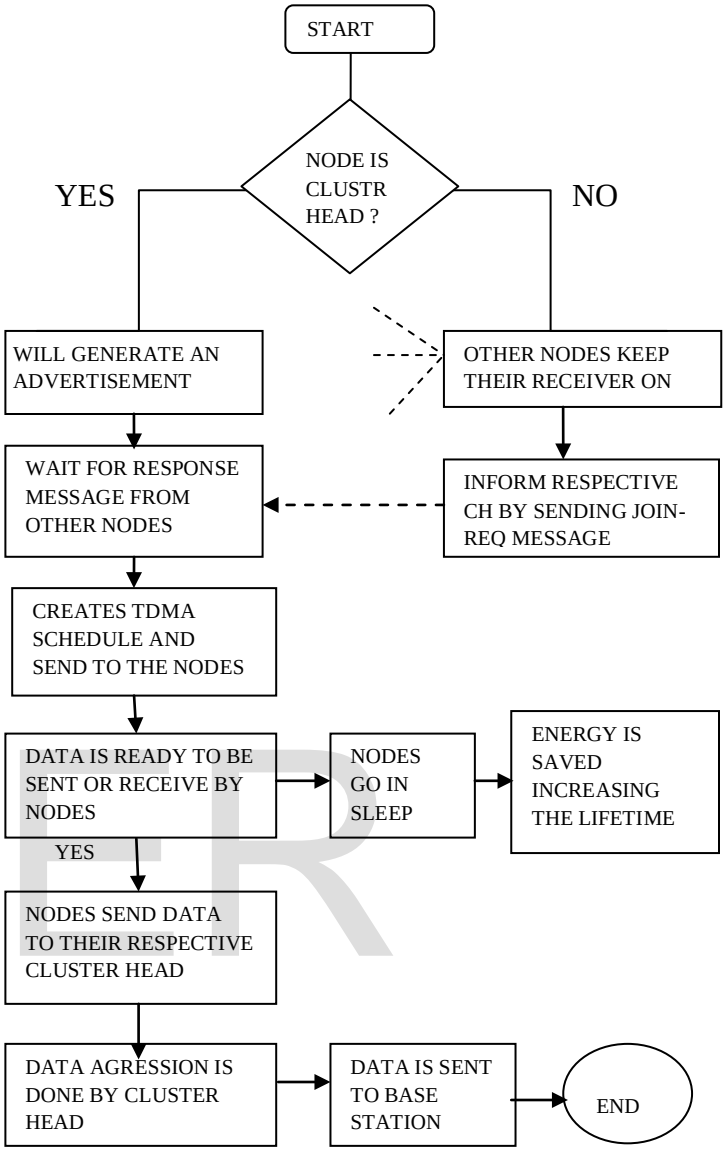



**FIG3. FLOWCHART OF LEACH PROTOCOL[9]**

# CONCLUSION

This paper mainly focuses on advancements being done to save energy consumption in the network in the precision agriculture. With increasing population the demands for food also increases so the solution for this problem is WSN with additional software and hardware for green house control. Precision agriculture is more benefited as it helps in improving the quality of product, improving the production efficiency, protects the environment and reduces energy consumption in the network using a

suitable algorithm LEACH. With the use of this algorithm we not only reduce the amount of network data transmission and energy consumption but also increase the network lifetime.

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