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A Study on Modern Farming using Wireless Sensor Networks

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1. INTRODUCTION

Agriculture is the backbone of our country and economy, which accounts for almost 30 per cent of GDP and employs 70 per cent of the population. Though this is a rosy picture of our agriculture, how long will it meet the growing demands of the ever-increasing population? This is a difficult question to be answered, if we depend only on traditional farming. To meet the forthcoming demand and challenge we have to divert towards new technologies, for revolutionizing our agricultural productivity. In the post-green revolution period agricultural production has become stagnant, and horizontal expansion of cultivable lands became limited due to burgeoning population and industrialization. In 1952, India had 0.33 ha of available land per capita, which is reduced to 0.15 ha at present. It is essential to develop eco-friendly technologies for maintaining crop productivity. Since long, it has been recognized that crops and soils are not uniform within a given field. Over the last decade, technical methods have been developed to utilize modern electronics to respond to field variability. Such methods are known as spatially variable crop production, geographic positioning system (GPS)-based agriculture, site-specific and precision farming (precision agriculture). The term 'spatially variable crop production' seems to be more accurate and descriptive than the term precision agriculture. The concept of Precision Agriculture avails the recent developments in sensors, green-house and protected agriculture structures.

Key words: *Modern Farming, Wireless Sensor Networks.*

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1. INTRODUCTION

Precision Agriculture can have a positive impact on environmental quality. The opportunity exists to show producers how changing production practices will not place crops at risk and produce positive economic and environmental benefits. Conducting experiments on precision agriculture will require field or farm scale studies and perhaps watershed-scale adoption of new management practices.

Completing this type of study will require:

- Appropriate questions that can be addressed at the field scale.

- Methods for measuring environmental endpoints that will demonstrate the efficacy of Management practices.

- Commitment to multiple years of study to overcome meteorological variation.

- Adequate monitoring equipment for crop production, soil properties, and environmental quality in order to understand the changes occurring due to the management practices.

- Use of comparison fields or farms in which no changes are made to provide a validation of the improved practices.

- Cooperation of producers to implement the practices with minor modifications across years so that variations can be isolated to the management practice and not producer influence.

These factors are critical to the development of a research effort on precision agriculture. The tools are available to address these questions. The scale of the study will require fields or sub basins of watersheds rather than experimental plots or strip trials within fields. This places an additional constraint on the design and implementation of these types of studies and will require integrating producers into the research discussion at the project development stage. One problem that has been a barrier to producer involvement has been the willingness of producers to place new management practices on fields without some assurance that profit margins will not be compromised.

2. PRECISION AGRICULTURE

Precision agriculture (PA) also known as **satellite farming** or **site specific crop management** (SSCM) is a farming management concept which is based on observing, measuring and responding to inter and intra-field variability in crops. Typically Crop variability has both a spatial and temporal component which makes statistical/computational treatments little involved.

The main motive of **precision agriculture** research is the ability to define a Decision Support System (DSS) for the whole farm management with the goal of optimizing returns on inputs while preserving resources.

Precision agriculture is a management philosophy or approach to the farm and is not a definable prescriptive system. It identifies the critical factors where yield is limited by controllable factors, and determines intrinsic spatial variability. It is essentially more precise farm management made possible by modern technology. The variations occurring in crop or soil properties within a field are noted, mapped and then management actions are taken as a consequence of continued assessment of the spatial variability within that field by adoption of site-specific management systems using remote sensing (RS), GPS, and geographical information system (GIS). Precision agriculture requires special tools and resources to recognize the inherent spatial variability associated with soil characteristics, crop growth and to prescribe the most appropriate management strategy on a site specific basis.

2.1 Topology

In communication networks, a **topology** is a usually schematic description of the arrangement of a network, including its nodes and connecting lines. There are two ways of defining network geometry: the physical **topology** and the logical (or signal) **topology**.

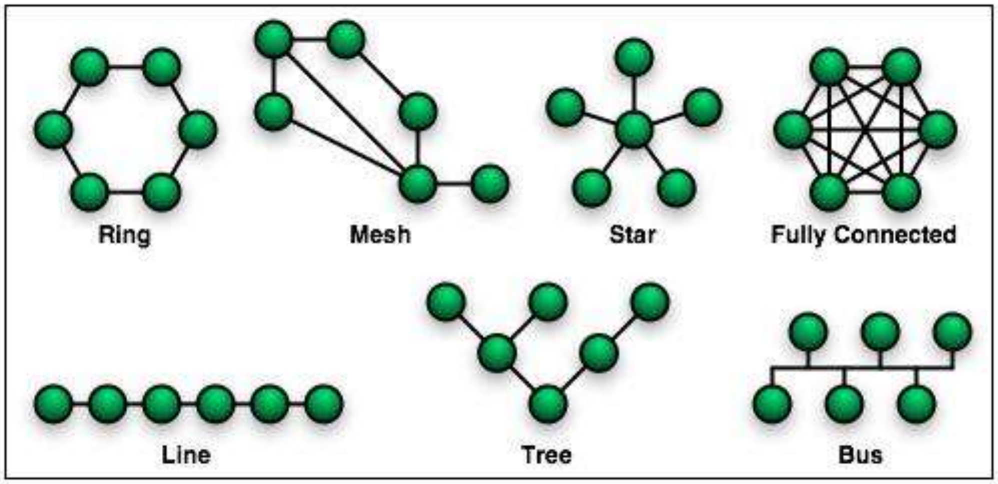


Figure.1. Various Topologies

3.1 Parameters For Measuring The Effectiveness Of A Topology

- **Range and coverage**: Range and coverage are probably the most obvious requirements for a WSN starting from the node to node range at a given transmission power / antenna gain and data rate. The main factors affecting range of a wireless network are the quality of physical layer and the efficiency of data transmission through the network. The coverage requirements are elimination of dead spots in the network and the extent of coverage area in range, both of which are closely related to range.

- **Scalability**: Scalability is the property of being able to cope up with network cells as small as a few nodes to cells of thousands or even tens of thousands of nodes as well as increasing the size of existing network by order of magnitude without employing expensive cellular communication or other long range solutions.

- **Expected Transmission Count (ETX**): It accounts for data loss due to medium access contention and environmental hazards and considers the number of transmissions needed to successfully transmit a packet over a link.

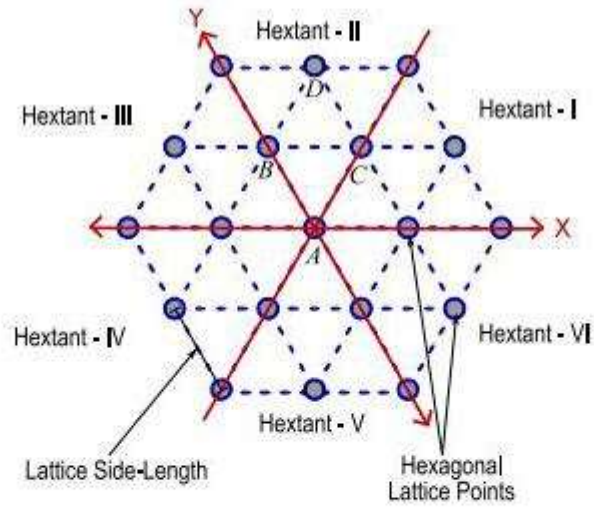
- **Hop Count:** Hop count is the most commonly used metric in wireless multi-hop networks. The path having the minimum number of links between a given source and the destination node is selected.

- **Power consumption/Network Longevity**: In most of the published communication protocols for WSNs, network lifetime extension has been mentioned as an important

optimization objective. The position of nodes can affect the network lifetime significantly. For example, a non uniform node distribution in a given area may lead to bottlenecks and unbalanced traffic. On the other hand, uniform distribution of nodes in a network may result in depletion of energy of nodes that are close to the base station at a rate higher than the other nodes, which in turn will shorten the network lifetime.

3.2 Selection of Topology in WSN

The above parameters should be considered while selecting the topology for the WSN (Wireless Sensor Network) various topologies are available, but each and everything should be considered while doing so, because it's the topology which would decide the path of the network. And the routing algorithm also depends on the topology used, so topology should be selected keeping all these points in mind. It should be efficient enough.



Literature Review Summary

Component	1	2	3	4	5	6
Monitoring System	Vineyard	Orchard	Agriculture and Food Industry	Apple Farming	Green House	ZigBee based WSN
Area Size		700 acres on hilly area				30m to 75m
Measured Factor	Humidity, Air temperature, Wind speed, Wind direction			Air Temperature, Humidity, Soil moisture		Weather temperature, Wind speed, Wind direction
Topology/ Architecture	Star/Single Hop Topology		Star/Hybrid/Mesh		Star Topology	
Node Platform	Crossbow barkeley- Mica2,MicaZ & shockfich etc.	MICA2				MICA2
Microcontroller	MSP430 & ATmega microcontroller					
Radio Transceiver					Wireless Transceiver module	
Sensors	Sensirion SHT75 or SHT71		MEMS sensors	Capacitance type moisture sensors		

Component	1	2	3	4	5	6
Monitoring System	**Mkrishi Framework**	**Real Time Health Monitoring**	**Farmland & Green House**	**Health Monitoring**	**Green House Monitoring**	**Irrigation Management System**
Area Size	**Range 400m (for 6 months)**	**10m to 100 m**				**75m to 110m**
Measured Factor	**Soil moisture, Temperature, Ambient temperature, Humidity**		**Temperature, Humidity, Illumination, CO2 level**	**Temperature,/Moisture**	**Temperature, Light, Wind speed, Wind direction & Water level**	**Soil moisture, Temperature, Battery voltage level**
Topology/ Architecture	**Mesh Topology**				**Star/Multihop**	**Star/Cluster Tree/Mesh**
Node Platform	**MICA/Telos**	**MICA2/MICAZ**		**MICA2**		**MICA2**
Microcontroller		**Neck mounted animals sensory color to track**	**Atmega 8-bit high performance microcontroller**	**MDA300CA**	**IEEE802.5.4**	**IEEE802.15.4/ wapsmote microcontroller**
Radio Transceiver	**CC2530 Texas Instrument**		**AT86RF230**			**Xbee transceiver**
Sensors			**NPU Mote**	**EC-5 Soil moisture sensor**	**Ambient light sensor, temp & humidity sensor**	**Soil moisture sensor (TP1000)**

Component	1	2	3	4	5	6
Protocols/Algorithm	**Delta Compression Algorithm**					

Node O/S	**Tiny O/S**	**Tiny O/S**			**Tiny O/S**	**Tiny O/S**
Communication N/w					**N/w communication with gateway/ one way communication**	
Power Supply	**Lithium, NiMH & Alkaline**				**6V Lithium-Carbon Batteries**	**Solar Cell or AA Batteries**
Waterproof Case						
Technology		**Zigbee Technology**	**Zigbee Technology**		**Zigbee Technology**	
Processor Used					**ATMEGA8535 Processor**	

Component	**1**	**2**	**3**	**4**	**5**	**6**
Protocols/Algorithm	**TCP/IP, UDP,HTTP,FTP**		**CTP Protocol/ EDABA (Energy Balanced Data Aggregation Algorithm)**			
Node O/S	**Tiny O/S**		**Tiny O/S 2.1**	**Tiny O/S 2.1.1**	**Tiny O/S**	
Communication N/w			**TCP/IP**		**RS-232 from sink to data over TCP**	
Power Supply	**Lithium-ion Batteries**				**Lithium-ion Rechargeable**	**Lithium-ion Battery L182D01-2B10A**
Waterproof Case	**Rain fed**					**Watermark 200SS**

	farming					**sensor**
Technology						**Zigbee Technology**

4.CONCLUSIONS

Precision Agriculture gives farmers the ability to use crop inputs more effectively including fertilizers, pesticides, and tillage and irrigation water. More effective use of inputs means greater crop yield and/or quality, without polluting the environment. However, it has proven difficult to determine the cost benefits of Precision Agriculture management.

At present, many of the technologies used are in their infancy, and pricing of equipment and services is hard to pin down. This can make our current economic statements about a particular technology dated. Precision Agriculture can address both economic and environmental issues that surround production agriculture today. Questions remain about cost-effectiveness and the most effective ways to use the technological tools we now have, but the concept of “doing the right thing in the right place at the right time” has a strong intuitive appeal. Ultimately, the success of Precision Agriculture depends largely on how well and how quickly the knowledge needed to guide the new technologies can be found.

The approach required to be adopted by the policy makers to promote Precision farming at farm level:

1. Promote the precision farming technology for the specific progressive farmers who have sufficient risk bearing capacity as this technology may require capital investment.

2. Identification of niche areas for the promotion of crop specific organic farming.

3. Encourage the farmers to adopt water accounting protocols at farm level.

4. Promote use of micro level irrigation systems and water saving techniques.

5. Encourage study of spatial and temporal variability of the input parameters using primary data at field level.

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