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Internet of Things to Improve Agriculture in Sub Sahara Africa - A Case Study

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ABSTRACT

Agriculture is the main source of income in many countries in sub-Sahara Africa (SSA). In these countries, farmers get less yield because they depend on rainfall only. Integrating Internet of Things and Agriculture (smart agriculture) helps farmers to grow more crops in any season of the year. Also, it improves farmer's living standard and raises the economy of these countries. Moreover, it reduces labor work or manual work which takes more time and more cost. This paper is evaluating the areas where smart farming can be applied in agriculture and brings the direct impact to farmers in SSA.

Key Words: *Internet of Things (IoT), sub-Sahara Africa (SSA), Agriculture, Wireless sensor network (WSN).*

1. INTRODUCTION

From survey of United Nations; Food and Agriculture Organizations, the worldwide food production should be increased by 70% in 2050 for growing population [11]. Population growth within sub-Saharan Africa (SSA) has significantly increased than other regions in the world. Since 1990, the SSA population expanded by 96%, more than double the world average of 38% (45% in Oceania, 37% in Asia, 27% in North America and less than 3% in Europe). Over the next decade, a further expansion of 28% is projected, compared to a global average of only 11% [6]. The projection is estimated to reach 2 billion by the year 2050 [2].

It would have been impossible to feed all these people when there are limited farming methods. African farmers have been cultivating less area and harvest less comparing to the cultivated area due to the lack of the technology. SSA face similar issues in the domains of agriculture, and they are still using traditional methods which results in the low cultivation of crops [11]. Agriculture remains underdeveloped in Africa, not only does the continent have the lowest harvest of any global region, but also a large area of land stay unutilized. Africa has 25% of the world's arable land, however, it produces only 10% of global agricultural output [7]. Moreover, agriculture accounts for 70% of all water withdrawals globally [14].

Currently, there are some of the threats that harm the progress of agriculture: Need for freshwater/irrigation systems, drastic changes in climate, low harvest and lack of labor due to effects of urbanization [15]. In order to overcome these threats, improve the quality of crop production, and increase in production with low cost. There is need to implement modern science and technology (smart farming) in agriculture for increasing the cultivation. Implementation of smart farming in SSA needs integration of wireless sensor network, Internet, personal digital accessories, and smartphones.

As explained in [3,17], Africa's smartphone penetration is currently at 23% and is expected to reach 50% in leading SSA in the next 5 years from 2016 with the reduction in the cost of mobile phones. The average internet penetration is 54.4% but in Africa internet penetration is 35.2%, whereas mobile phone penetration is already above 75% in southern Africa countries. Therefore it is possible to implement smart farming in SSA.

The economy of many countries in Africa depends on agriculture, therefore by using smart farming would rise the economy and improve living standard for farm workers by reducing heavy labor and tiresome jobs. As explained in [5, 6], the agriculture employs more than half of the total labor force, especially in the rural areas. Smallholder farms constitute approximately 80% of all farms in SSA and employ about 175 million people directly. Furthermore, agriculture is the root of the human as it is the main source of food and it plays a vital role in the growth of country's economy. On average, agriculture contributes 15% of total Gross Domestic Product (GDP), however, it ranges from 3% in Botswana and South Africa, to 42% in Ethiopia and 53% in Chad, inferring a different range of economic structures [4, 5].

The rest of the paper is discussed as follows; Chapter two explains about Internet of Things technology, chapter three clarify about smart farming, chapter four describe the areas of farming that can be transformed by IoT in SSA countries and chapter four is the conclusion.

2. IoT TECHNOLOGY

The Internet of Things (IoT), refers generally to the digital interconnection of everyday objects to the internet and to each other, and the ability to collect and send data between devices. The IoT includes devices for consumer usage, as well as devices for businesses which may help improve operational efficiency through the ability to collect and interpret large data and automate communication between machines [22].

IoT involves different network architectures, including Wireless Sensor Network (WSN), Wireless Fidelity (Wi-Fi), Mobile Communication Network (MCN), Wireless Mesh Network (WSN), and Vehicular Network. These various network units work with Radio Frequency Identification (RFID), smart terminals and sensors to get complete sensing information anytime and anywhere. Furthermore, internet or satellites is used to connect them to cloud server and transmit data in real time to the monitoring center for processing. The monitor at the central server processes and analyzes a large amount of data to achieve the smart control of objects [1].

3. SMART FARMING

Smart Farming is the integration of Internet of Things (IoT) and agriculture in order to increase production efficiency and quality of crops. Through smart farming, it is possible to receive real-time information, control and monitor weather conditions, quality of soil, theft detection, manage the cost of labor and water for irrigation from anywhere. Moreover, farmers will have knowledge of what kind of seeds to plant and when deciding harvest time and prediction of plant disease and insect pests. Lastly, it will enable farmers to reduce waste and enhance the productivity of crops [16, 20].

4. AREAS OF FARMING THAT CAN BE TRANSFORMED BY IOT IN SSA.

A.Pest Management and Control

Pest and disease management has played its role in doubling food production in the last 40 years, but pathogens still claim 10 to 16% of the world harvest [10]. It is projected that insects destroy between 20 to 30% of all food produced in Africa each year [11]. With IoT, farmers can monitor pests remotely and tell, what kind of pesticide to use and in what quantity. Furthermore, farmers can predict pest behavior by using pest control. IoT, in this case, prevents the farmer to use more pesticides on the crops which is very harmful to humans.

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B. Crop Water Management

Most of SSA depends on rain-fed agriculture and they are highly affected by changes in weather like in the past decade some countries in eastern and Southern Africa faced adverse weather conditions which reduced cereal output by more than 10% in 2015[6, 12]. Smart agriculture will boost irrigation process, farmers will be able to control the irrigation through the apps in their smartphones to avoid water wastage. By using sensors farmers can calculate the amount of water in the tank or dams and decide the minimum level of irrigation required for the crops.

C. Food Production and Safety

As explained in [13], 50% of the harvest is lost in many parts of Africa because farmers lack post-harvest storage, access to market information and are unable to get their goods to the market on time. Therefore using sensors which are connected to IoT farmers get the status of yield on real-time by monitoring food production and adjusting temperature in the food storage centers. A huge network of devices will communicate with one another in the automated mode requiring absolutely no human involvement which reduces the time and labor cost. These sensors constantly have to monitor the quantity and quality of food that is transported, thus ensuring that food safety standards are maintained [15]. The application of IOT allows getting the product information throughout the whole process involving raw materials supply, production, processing, circulation, and sales. Then the consumer can use this information and decide whether to buy products [21].

D. Smart Greenhouses

Greenhouse controls the environmental parameters through manual control mechanism. The manual system is less effective, it results in energy loss, production loss, and high labor cost. With the help of IoT farmer can get a smart greenhouse which can intelligently monitors and controls the climate and eliminating the need for manual system [16].With smart greenhouse, environmental parameters can be controlled automatically according to the plant requirement and remove manual system. Cloud server can be created for remotely accessing the system when it is connected using IoT. The wireless sensors in the greenhouse offer information on the temperature, pressure, and humidity [9]. These sensors can control the actuators automatically to open a window, turn on lights, control a heater, turn on a fan, all controlled through a wireless network by using a smartphone.

5. RECOMMENDATIONS

In this paper, we have discussed the problems facing Sub Saharan Africa countries and how to eliminate them by using Internet of Things. The implementation of IoT enables farmers to monitor crop, produce more and get more profit. Also farmers get real-time information anytime and anywhere, there is no need to stay in the field all the time.

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