IOT - BASED SURVEILLANCE SYSTEM FOR AGRICULTURE CONDITION MONITORING AND REPORTING APPLICATION

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**A report submitted
in partial fulfillment of the requirements for the Bachelor of
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DECLARATION

I declare that this thesis entitled “IOT - BASED SURVEILLANCE SYSTEM FOR AGRICULTURE CONDITION MONITORING AND REPORTING APPLICATION” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this report entitled "IOT - BASED SURVEILLANCE SYSTEM FOR AGRICULTURE CONDITION MONITORING AND REPORTING APPLICATION" and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours.

Signature : ....

Supervisor Name : ASSOCIATE PROFESSOR DR. MUHAMMAD HERMAN JAMALUDDIN

Date : 5 JULY 2021

DEDICATIONS

Thank You God

For taking care of me and help me solving all the problems

Father and Mother

For the sake of love, support, encouragement to complete the whole project

Along with all respected and hardworking

Profesor Madya Dr Muhammad Herman Bin Jamaluddin

For being my supervisor and guide me throughout the entire project

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ABSTRACT

Technology has revolutionised the agriculture industries in recent years, bringing with it a slew of new opportunities and reforms, as well as a slew of new obstacles. The Internet of Things (IoT) plays a vital role in agriculture condition monitoring and reporting. The goal of this research is to integrate an IoT-based system for farm condition monitoring into the agriculture intelligent system using GSM communication technology. In this experiment, an Arduino board with a GSM SIM900A module is used to connect to the internet using a SIM card data plan. The sensor readings are published through MQTT by the Arduino board with a GSM connection network, and the readings are presented in the reporting application. Monitoring real-time farm conditions with a PC via Node-red dashboard and pressing a button to send on and off orders to control the microcontroller. IoT is a new technology that can be used to improve and replace old agriculture condition monitoring systems. The Internet of Things (IoT) has the potential to solve the traditional farm condition monitoring system's flaws.

ABSTRAK

Teknologi telah merevolusikan industri pertanian dalam beberapa tahun terakhir, membawa banyak peluang dan reformasi baru, serta sejumlah halangan baru. Internet of Things (IoT) memainkan peranan penting dalam pemantauan dan pelaporan keadaan pertanian. Tujuan penyelidikan ini adalah untuk mengintegrasikan sistem berasaskan IoT untuk pemantauan keadaan ladang ke dalam sistem pintar pertanian menggunakan teknologi komunikasi GSM. Dalam eksperimen ini, papan Arduino dengan modul GSM SIM900A digunakan untuk menyambung ke internet menggunakan pelan data kad SIM. Pembacaan sensor diterbitkan melalui MQTT oleh papan Arduino dengan rangkaian sambungan GSM, dan pembacaan tersebut disajikan dalam aplikasi pelaporan. Memantau keadaan ladang masa nyata dengan PC melalui papan pemuka Node-red dan menekan butang untuk menghantar dan mematikan pesanan untuk mengawal mikrokontroler. IoT adalah teknologi baru yang dapat digunakan untuk memperbaiki dan menggantikan sistem pemantauan keadaan pertanian lama. Internet of Things (IoT) berpotensi untuk menyelesaikan kekurangan sistem pemantauan keadaan ladang tradisional.

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LIST OF SYMBOLS AND ABBREVIATIONS

FYP	-	Final Year Project
IoT	-	Internet of Things
GSM	-	Global system for mobile communication
MQTT	-	Message Queuing Telemetry Transport
Wi-Fi	-	Wireless Fidelity
LCD	-	Liquid Crystal Display
VM	-	Virtual Machine
COM	-	Commercial
IP	-	Internet Protocol
GPS	-	Global Positioning System
GPRS	-	General Packet Radio Service

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

In the growth of human civilisation, agriculture has played a key role. People are trying to put additional effort and special techniques to multiply food production due to the increased demand for food. One of these efforts is the use of various technologies for agriculture. In addition to the use of scientific technology in agriculture, information technology is now heavily practiced in this region. For enhanced monitoring and decision making capabilities, technologies such as satellite navigation, grid computing, sensor network, ubiquitous computing and context-aware computing support the authors assisted [1], [2].

The Internet of Things (IoT) industry is heading toward the agricultural sector at a rapid pace, striving for the vast applicability of new technologies. In agriculture, current applications are divided into four main areas, which are: (i) agricultural environment monitoring and control systems, (ii) open field agriculture systems (Geographical Information Systems), (iii) food supply chain tracking and (iv) livestock monitoring [3], [4], [5], [6]. This paper focuses on the monitoring and control systems for the agricultural environment, proposing an IoT management and report system to be introduced.

1.2 PROBLEM STATEMENT

Agriculture is one of the most important fields in which human life depends heavily. The overwhelming majority of the human population was active in the agricultural sector in the time before industrialization. Individuals tended to try to improve efficiency by using distinct approaches. In order to enhance the standard of agriculture and the productivity of agricultural land, the agricultural research group works on various aspects of agriculture.

An agricultural researcher has addressed the problem of the existence of agriculture activities which a farmer or landlord difficult to monitor their farm when outside the area. Physical monitoring of a large agricultural land does not produce good results because 24 hours of monitoring is almost difficult to achieve and several variants are kept under control at a time.

The solution for this problem is to development IoT-based surveillance for agriculture condition monitoring and reporting application system through GSM communication that can remotes the temperature, humidity, soil signal, and wind speed from outside the area. Sensors were deployed to measure all the parameter of the agriculture such as air temperature, soil moisture, relative humidity and speed of the wind. From this solution, all the agriculture monitoring data will be uploaded into cloud so that the farmer or landlord can monitor their farm outside the area.

1.3 OBJECTIVES

The objectives of this project are:

i. To design an agriculture surveillance system using Arduino.
ii. To integrate an IoT-based system through GSM communication technology for agriculture condition monitoring in the agriculture surveillance system.
iii. To develop the monitoring and report application for data of agriculture conditions.

1.4 SCOPES

The scope and limitations that need to be considered for completing this project are as follows:

i. The system consists of an Arduino microcontroller to process the sensor data, GSM communication technology.
ii. The parameter for agriculture monitoring is the temperature, humidity and soil moisture.
iii. The sensor such as soil moisture sensor, temperature and humiduty sensor is used to collect the parameter.

iv. The IoT- based system is using Node-RED application as a IoT programming tool to transfer parameter from the cloud and monitoring application.

v. The data is monitor or report at the dashboard of Node-RED in PC.

1.5 SUMMARY

It was organized into five chapters of this report. Chapter 1 presents the introduction of this research work. Section 1.1 explains the context of research. The problem statements are defined in Section 1.2. Section 1.3 presents the research goals and Section 1.4 defines the scope of study to achieve the research goals. Finally, the overall description id provided in Section 1.5.

Chapter 2 reviews of the literature addresses relevant and important historical surveillance system for agriculture research work. The historical aspects of surveillance system for agriculture are reviewed in Section 2.2 and 2.3. Section 2.4 and 2.5 describes specification and features of several surveillances system for agriculture.

Chapter 3 explains the methodology used to achieve the aims of the project. This chapter also explains the project design, system design, hardware design and software design. Besides that, this chapter provided the flow chart and block diagram of the project system.

Chapter 4 shows the result such as the simulation of the Arduino microcontroller with GSM module and sensors of the project. This chapter also analyzes and compare for the result of two experiments of design agriculture surveillance system.

Chapter 5 is a closing chapter for the IoT - based surveillance system for agriculture condition monitoring and reporting application thesis. This chapter consists of conclusion and recommendations for this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The increasing frequency and severity of extreme climatic events and their impacts are being realized in many regions of the world. These events underscore the need for timely early warning. Today, systems and tools that leverage these developments to provide open access actionable early warning information exist. Some have already been employed by early adopters and are currently operational in selecting national monitoring programs. Despite these capabilities, many governments still rely on traditional crop monitoring systems, which mainly rely on sparse and long latency in situ reports with little to no integration of EO-derived crop conditions and yield models [7]. Agriculture applications rely on accurate land monitoring, especially paddy areas, for timely food security control and support actions. However, traditional monitoring requires field works or surveys performed by experts, which is costly, slow, and sparse. Agriculture monitoring systems are looking for sustainable land use monitoring solutions, starting with remote sensing on satellite data for cheap and timely paddy mapping [8]. Global and regional scale agricultural monitoring systems aim to provide up-to-date information regarding food production to different actors and decision makers in support of global and national food security. To help reduce price volatility of the kind experienced between 2007 and 2011, a global system of agricultural monitoring systems is needed to ensure the coordinated flow of information in a timely manner for early warning purposes. Agricultural monitoring on a regional and national level has been in place for decades, e.g., the Global Information and Early Warning System (GIEWS) from the Food and Agriculture Organization (FAO) of the United Nations, the Famine Early Warning Systems Network (FEWS NET) from the United States Agency for International Development (USAID), CropWatch in China, and the Monitoring Agriculture with Remote Sensing (MARS) system from the European Commission (EC). These systems have tended to operate somewhat independently with little sharing of information, where the focus has been on either food security for developing countries or food production for the global market. [9].

2.2 Agriculture Condition Monitoring System

In recent past, first system to provide globally comprehensive information on crop production and crop condition was the United States Department of Agriculture's Foreign Agricultural Service (USDA-FAS) [10]. This estimation of crop production are used as indicators, for early warning alerts, in foreign assistance assessments for food import, in commercial market trends and analysis, and in trade policy and exporter assistance. However, it was proved that national and regional monitoring systems cannot monitor agriculture efficiently at all level so there needs to be greater coordination and sharing of information, i.e., a Global Agricultural Monitoring System of Systems [11]. The Group on Earth Observations (GEO) became the main to undergo the flagship initiative GEOGLAM (GEO Global Agricultural Monitoring), which has become the important part for bringing together key players in the global agricultural monitoring community, to share information internationally, and to produce two regular bulletins (one for the Agricultural Market Information System (AMIS) and one for Early Warning covering approximately 95% of the world's croplands) that represents consensus of the current situation globally. Other initiatives have also been undergo to support GEOGLAM, e.g., the Anomaly Hot Spots of Agricultural Production (ASAP) system, which started in 2017 [12].

In the last decade, improvement of technological also affected agricultural crop production. With the aid of electronic and electrical devices, agriculture experts can remotely know about their field information like saturated soil temperature, soil moisture, an occurrence of plant diseases and pests in plants. Experts react timely manner to preserve crop loss based on received information. The IoT experts can get high production yield based on smart agriculture methods. The traditional agriculture methods did not achieve an normal range of production yield. Because there is no suitable measurement to predict the utilization of natural resources like temperature, soil moisture, water, fertilizers, and nutrients. If this resource lacked, then the crop gets related diseases which lead to decreasing of production yield. A new measurement function which is used to calculate the growth of the crop, crop comfort levels and these are the input parameters to make a successful smart agriculture monitoring system. The optimal temperature and relative humidity values must be calculated to extract the above parameters. IoT cloud is used to store sensor data and assessing this sensor data to get an appropriate result. Cloud-IoT plate forms, plays a important role in IoT for storing data which is collected from sensors and cameras. The important function of the decision-making system is discover faulty and crop diseases based on the analysis of sensed data. This information is sent to experts to get action according decision. IoT is one of the important technologies throughout the world in society. Under that thermal detection is an important measurement and it can be done practically with pen-paper and real implementations. From the past three decades, greater decreasing in agricultural yield production because changes in the environment due to global warming and damaged hazards. To solve this issue, measuring temperature, soil moisture and relative humidity values in a periodical manner and take a necessary action to prevent this loss. Thermal comfort estimation is an existing plan in such circumstances. The thermal comfort is controlled by measuring some parameters like air temperature, air flow, relative humidity.

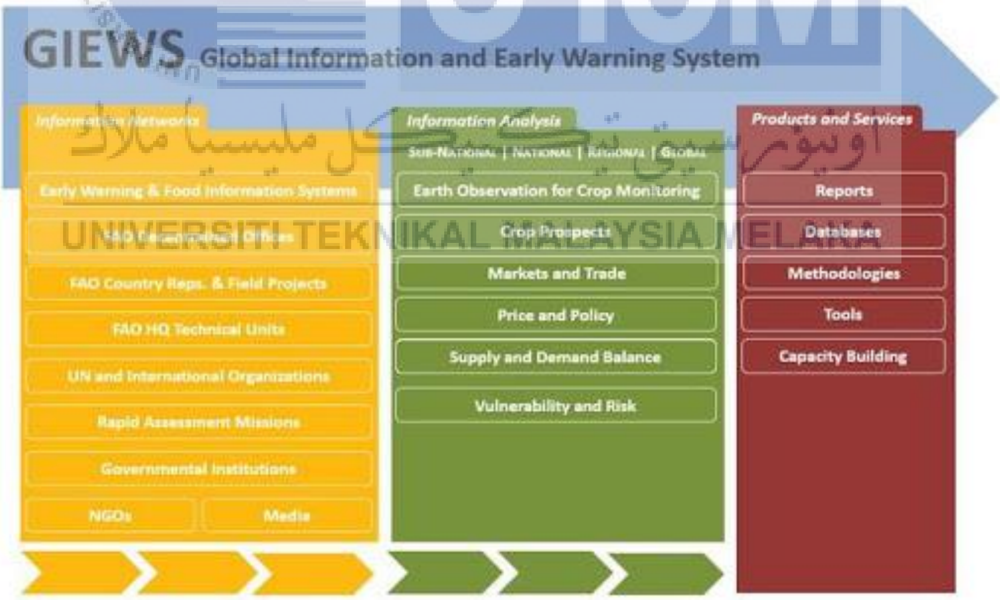

Figure 2.1 Global Information and Early Warning System

To look into a better view of the current state of global agricultural monitoring, eight major operational systems were identified that either play an significant role in regional or global agricultural monitoring or which contribute to GEOGLAM at an international scale. In early 1970s, GIEWS was one of the global sources of information on food production and food security. The system produces regular bulletins of food crop production and markets on a global scale, as well as more particular regional reports based on intelligence from FAO's regional and country offices. GIEWS includes a network of 115 governments, 61 non-governmental organizations (NGOs) and numerous trades, research, and media organizations. The GIEWS team continuously tabulated the world's food supply and demand situation, using geospatial data as an auxiliary variable to measure weather-related problems that could have a negative effect on food security in member countries. In rainfall estimates and the Normalized Difference Vegetation Index (NDVI), the Agricultural Stress Index (ASI) adopted in 2013, as an indicator for early identification of agricultural areas that may be affected by dry spells or droughts [13], which was developed to fill an information gap in the existing early warning system. Every ten days, the ASIS (ASI System) draw a map showing hotspots where crops are affected by water stress during the growing period, which are then proved by data from public institutions or using agrometeorological models based on data obtained from national meteorological networks, which ultimately show indicator convergence [14].

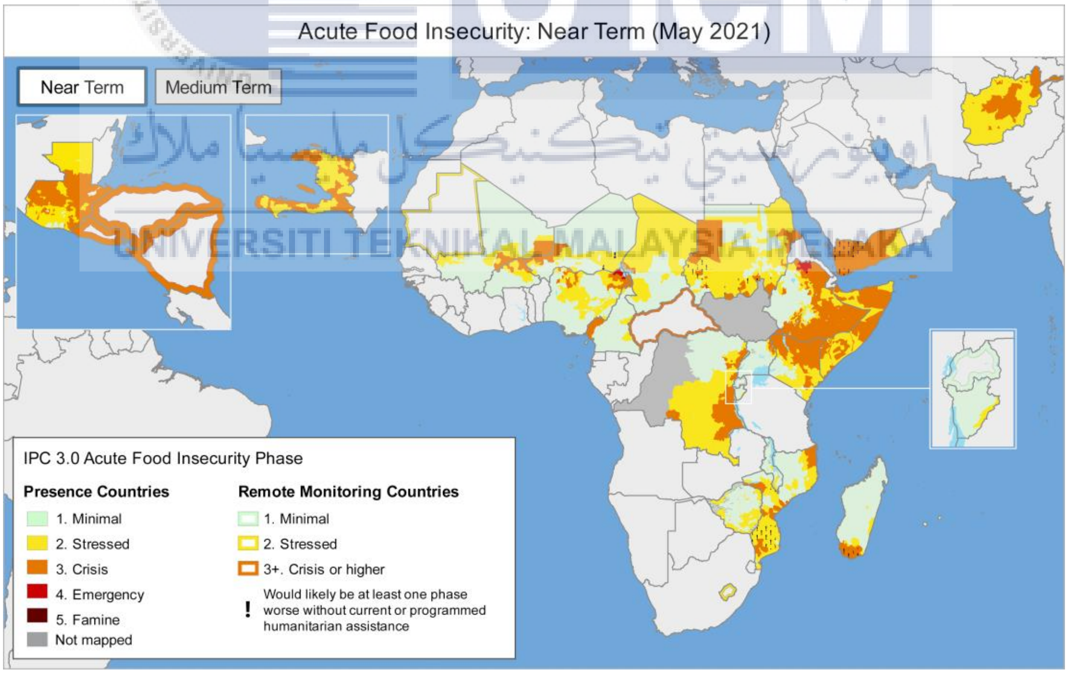

Figure 2.2 Data & Monitoring of Famine Early Warning System Network

In 1985, the FEWS NET system was developed by USAID to act as decision support to food assistance programs and relief agencies [15]. FEWS NET try to manipulate both changes in the area planted as well as crop yield but does not monitor production directly

[16]. Currently covering 36 of the world's most food-insecure countries, the system not only monitor specialized monthly reports on current and projected food security but also provides constantly alerts on emerging crises. FEWS NET undergo a convergence of evidence strategy to achieve its goals. Data from field assessments, nutrition surveillance, acro-climatology, market/price monitoring and conflicts are combined to make out scenarios, carry out livelihood analysis and developed information for effective decision support. In additional to outlook reports, FEWS NET monitors scenarios monthly as new information becomes available. FEWS NET draws heavily on acro-climatology data for its food security analysis, relying mostly on anomaly analysis [17].

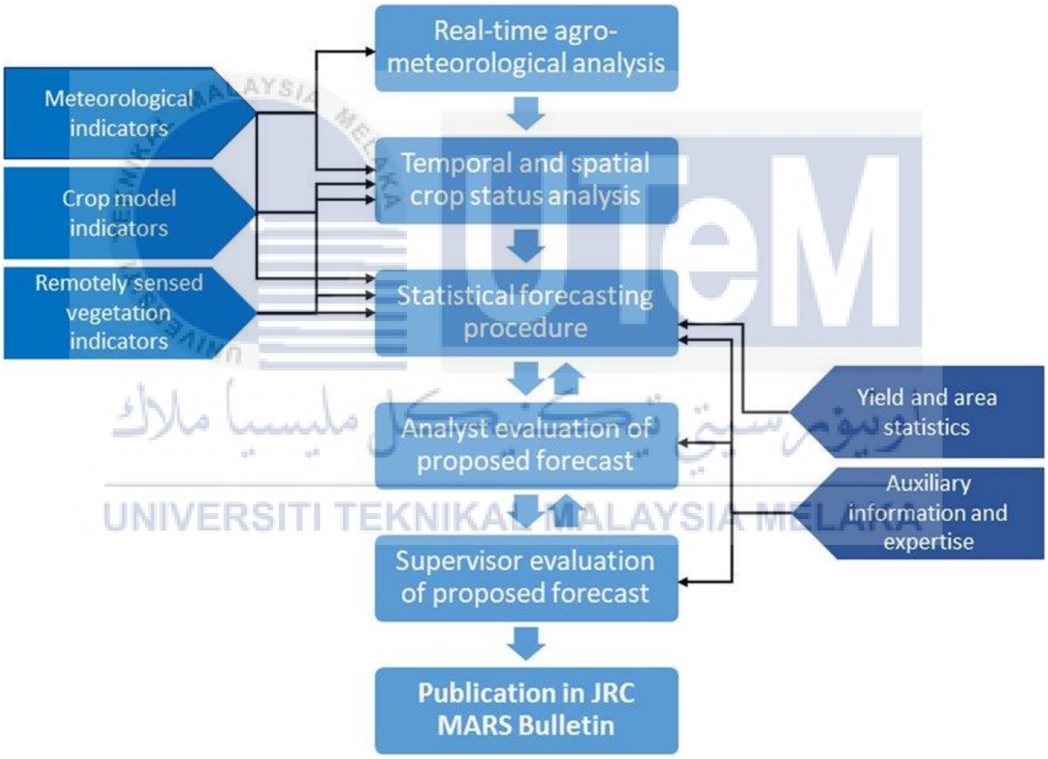

Figure 2.3 Flow Chart Illustrating the MARS-Crop Yield Forecasting System Work

In 1992, the MARS program of the JRC operate the operational MARS Crop Yield Forecasting System (MCYFS) to overcome for operational estimates of area, yield and production at pan-European level for EU member states. It is undergoing under the mandate of the European regulation No 1306/2013 (Art. 6 and 22). This regulation developed an agricultural monitoring system and production and yield forecasts to manage agricultural markets. As a decision support system, the MCYFS provides independent and evidence-based information on the status of annual crops in the EU and neighbouring countries by monitoring crop growth and forecasting crop yields. The MCYFS is based on near real-time acquisition and processing of three main data sources: crop model simulations, weather data (observations and forecasts), and biophysical parameters derived from satellite remote sensing to monitor the crop status. All these data plus a time series of historic area and yield statistics are used within a statistical yield forecasting process. Monthly bulletins are produced that provide an overview on the condition of the main crops and areas of concern including yield forecasts for cereals, oilseeds, and tuber crops, a pasture analysis and country specific analyses. Near real-time and historic information on weather conditions and the progress of crop growth can be monitor via the JRC MARS Explorer. Maps for several weather and crop indicators are available and the information is updated three times per month [18], [19], [20], [21], [22], [23] .

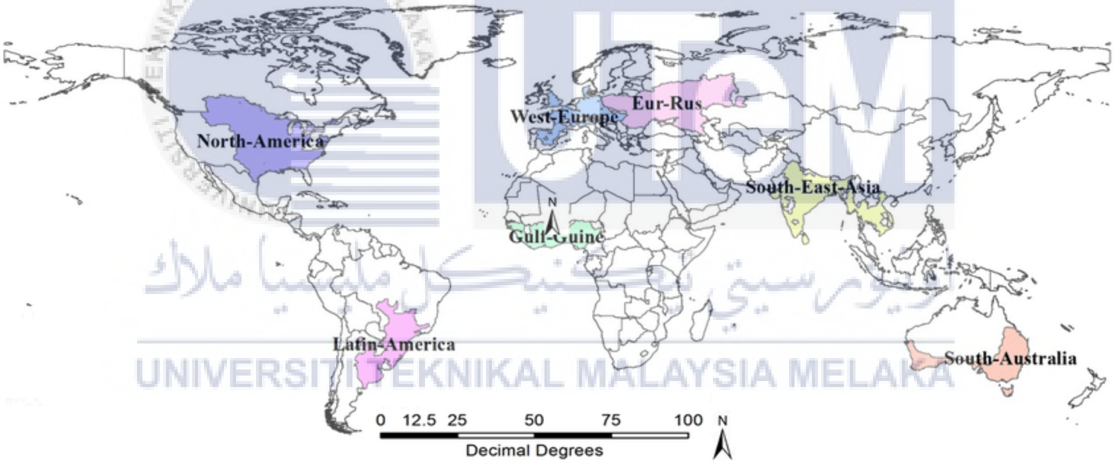

Figure 2.4 Major Production Zone in The CropWatch System

CropWatch, which is developed by the Institute of Remote Sensing and Digital Earth at the Chinese Academy of Sciences, evaluates national and global crop production. In 1998, the purpose of this system is to provide constantly, reliable, and independent estimation of crop conditions and production, both within China and globally, to plan crop imports, exports, and prices and ensure national food security [24]. Since 2013, CropWatch has been published bulletins internationally. Four spatial levels are considered: global, regional, national (thirty-one key countries including China), and sub-national (for the nine largest countries). These thirty-one countries encompass more than 80% of both production and exports of maize, rice, soybean, and wheat. Global patterns of growing conditions are determine using indicators for rainfall, temperature, photosynthetically active radiation (PAR) as well as potential biomass. At the regional scale, other indicators such as the Vegetation Health Index (VHI) and the Vegetation Condition Index (VCI) are used to predict the crop situation, farming intensity and stress. CropWatch also undergo detailed crop condition analyses at the national and sub-national scale with a comprehensive array of variables and indicators to derive food production estimates [25].

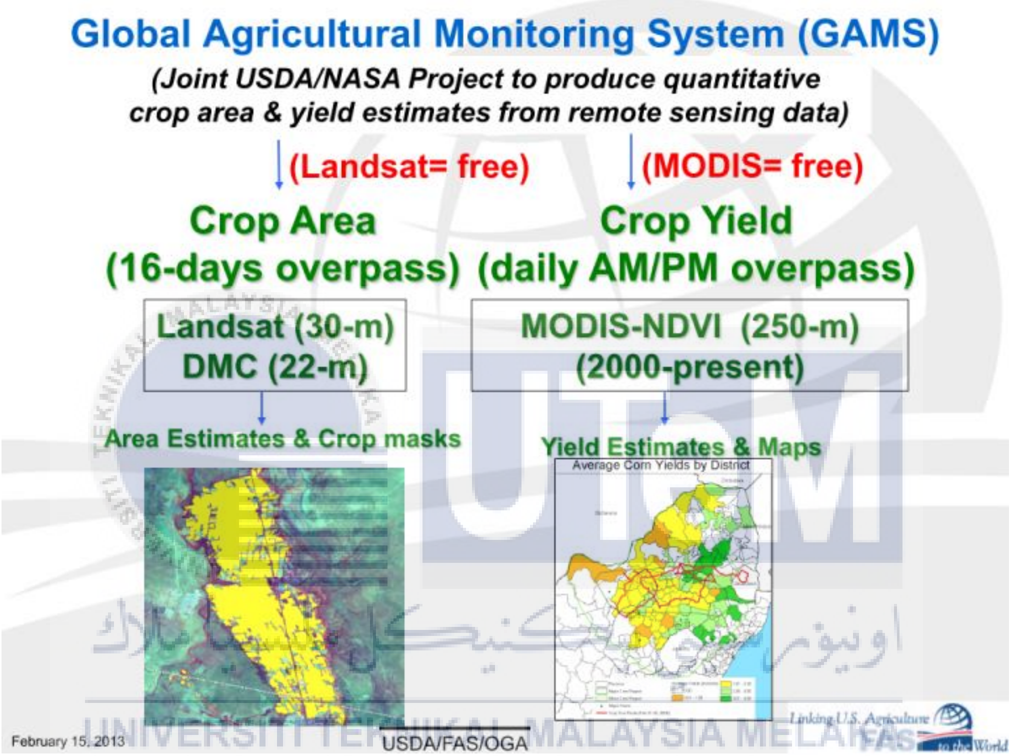

Figure 2.5 Global Agricultural Monitoring System

In 1998, after Hurricane Mitch devastated Honduras, the Honduran Ministry of Agriculture require near real-time information on agriculture during the reconstruction period. Hence in 2001 the Foreign Agricultural Service (FAS) of the US Department of Agriculture (USDA) developed the Crop Explorer service, which monitor remote sensing-based information used by agricultural economists and researchers to estimate global crop production. The system automates the extraction and processing of agro-meteorological indicators from MODIS (Moderate Resolution Imaging Spectroradiometer), TOPEX/Poseidon and Jason-1 satellites to monitor data visualization products every 10 days. FAS also has provide market intelligence in the form of timely, objective, unclassified, global crop conditions and production estimates, for all major commodities, for