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# Remote sensing Satellites and its application for agricultural development – Technical Aspect

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***Abstract*—** Remote sensing is the escalating field in the ultimate modern world. It helps to the society in various aspects. Digital communication reaches the highest level with the help of remote sensing. Water development department works effectively with the remote sensitivity support. Not only has the digital division, Remote sensing also plays a major role in the advancement of food production and agriculture for human development. Agriculture is the backbone for every country. Agriculture development is one of the deciding factors for national development. Agriculture helps to increase domestic production and it leads to eliminating the problems of food shortages. Remote sensing plays a vital role in agriculture development like Crop production forecasting, Assessment of crop damage and crop progress, Crop Identification, Crop acreage estimation and etc. now a day's crop required level water irrigation and crop disease identification was also done with the help of remote sensing. Every country shows the interest to launch the satellite for agriculture development. This paper helps to analyze the agriculture satellites technology and the remote sensing application for agriculture development.

***Keywords*—** Remote Sensing, Agriculture, Crop acreage estimation, Crop production forecasting, Agriculture Satellites.

## I. INTRODUCTION

Remote sensing is used to detect and monitor the physical characteristics of land cover from the distance. Today's technological development entirely depends on satellite data communication. Remote sensing makes as possible to detect the problems on dangerous or inaccessible areas. The remote sensing process may split into active and passive sensors to sense the data remotely. Some of the uses of remote sensing technology are mapping of forest fires from the space, tracking of clouds to predict weather report of earth space, tracking the changes of the city for developments etc.

Remote sensing is working in such numerous fields includes agriculture, forestry, environmental monitoring, geology, hydrology, sea ice data collection, land cover and land use, oceans and coastal monitoring, atmosphere monitoring. Among these applications, agriculture is considered a major application. To increase the country development as economically agriculture made a unique contribution.

Agriculture serves as a backbone of Indian economy. India uses satellite technology to generate regular updates on crop production and land based observation. Agriculture makes its contribution in several ways to increase the economic growth such as giving the source of food supply, shift of man power, reduce inequality, create effective demand to non- agriculture sectors, providing the source of foreign exchange, rural peoples get employment opportunities, improving of rural welfare etc.

According to the Indian Space Research Organization, remote sensing uses in the following applied field of agriculture includes agriculture land monitoring, agriculture drought assessment, crop area production, horticulture crop area estimation, soil mapping and monitoring, water resources monitoring, identify the characteristics of soil and crop etc.

## II. APPLICATIONS OF AGRICULTURE IN REMOTE SENSING

### *A. Crop Production Forecasting*

Crop production is one of the important and essential things to execute the different level of agriculture planning. Remote sensing is a useful technology for the development of natural resources like crop production. Crop production is entirely based on the two independent parameters includes crop area and yield estimates. In crop production four main processes are available for crop identification which includes stratification, area estimates through area frame sampling, area estimates through remote sensing, area estimates through administration level [1].

 

Earth observation data can be used to monitor the cropping area. RISAT -1SAR satellite data is used for rice production, R2 LISS III satellite data used for sugarcane production. For wheat production R2AWiFS satellite data used. For crop production, the ministry of agriculture and corporation from the government of India running the projects named as Crop Acreage and Production Estimation. Based on the weather and remote sensing data CAPE project provides crop production.

*B. Horticulture and cropping system analysis*

The process of cropping system analysis is used to determine the area of less productivity in agriculture. These kinds of low productivity areas should need to increase its productivity with the help of new crops. Agro-ecological zonation can be used to identify the climate, soil and provide better land use plan. Generally, the cropping system is a spatial and temporal arrangement of crops, management of soil, water and vegetation to optimize the biomass production. To increase the horticulture remote sensing technology advised to formers by merging the process of multi-layer cropping, intercropping, off season cultivation, relay cropping. To increase the horticulture the following techniques are more useful to utilize time and space management [2].

Table 1. Cropping methods to increase horticulture

| Name of Method | Usage |
|---|---|
| Row Intercropping | Planting two or more crops at the same time |
| Multi-layer cropping | Growing plants of different height |
| Off-season cultivation | Production of crops not in its appropriate season |
| Double cropping | Cropping two crops per year in a sequence |
| Mixed cropping | Cropping two or more crops with no arrangements |

*C. Crop condition assessment and stress detection*

Remote sensing data helps to monitor crop health condition. Crop spectral reflectance properties are varies based on crop phenology, stages of crop growth, crop health. This crop condition could be monitored and measured using multispectral satellite data [3]. The advantage of optical VIR sensor is to provide highly sensitive wavelengths, using these wavelengths easily identify crop vigor, crop damage and crop stress.

Crop growing season and crop conditions are clearly identified by the remote sensing satellite data. The sensor includes LST, LSWI, TVDI, NDVI are used to identify the crop condition assessment. For assessment of crop growth and crop, stress needs high spatial and temporal resolution on remote sensing satellite data.

*D. Irrigation monitoring and management*

Remote sensing satellite data are the essential one to monitor the problems of the irrigated area. Multi-temporal imagery and ancillary data are useful methods to improve the identification of irrigated area using remotely sensed satellite data [4]. Multi –temporal imagery and ancillary data are included climate, soil. The distribution of the irrigation is entirely based on climate changes, it determines crop demand and crop schedules. To avoid the irrigation ground water is considered as a better source.

Table 2. Satellites used for irrigation study

| Satellites / Sensors | Frequency of uses in irrigation |
|---|---|
| Landsat | high |
| SPOT | medium |
| LISS | Low |
| AVHRR | medium |
| MERIS | low |
| MODIS | medium |
| RapidEYE | low |

*E. Soil Mapping*

The soil is a fundamental and essential resource of growing plants. Mostly hundred percent of food production is based on the soil. Different types of soils are available here. Characteristics and elements like land type, land cover, vegetation type are mapping with the help of remote sensing data. In remote sensing thermal infrared used to identify and estimate salinity and moisture. Mapping of minerals in soil is made by hyper spectral remote sensing method. The efficient method to the mapping of soil moisture is microwave [5]. The common microwave configuration is SAR (Synthetic Aperture Radar).

Soil mapping depends upon the spectral reflectance of soil characteristics like colour, texture, structure, mineralogy, organic matter, free carbonates, salinity, moisture etc. Satellite sensors used for soil mapping includes IRS WiFS, IRS-LISS-II, IRS-LISS-III, IRS PAN [6].

*F. Droughts Assessment and Monitoring*

In many aspects, droughts differ than the other natural hazards. Agriculture droughts provide crop stress and wilting, it could not support crop growth and maturity due to inadequate rainfall and soil moisture. A mechanism for rainfall prediction and drought early warning gives solution for drought management problem [6]. The satellites/sensors include Resourcesat1, Resourcesat2, AVHRR, MODIS are carried out the problems of drought assessment and monitoring system.

Droughts stages can be divided into three different levels, 10 to 20 percent has been considered as the low level of

 

droughts. 26 to 50 percent has considered as a medium level of droughts and above 50 percent has considered as a high level of droughts.

Satellite or mission which has launched and used for drought assessment and monitoring system is depicted in the below table 3.

Table 3. Current and future satellite missions of drought monitoring and assessment.

| Launched year | Satellite/mission |
|---|---|
| 2000-2005 | CALIPSO, CloudSAT,EOS-Aura,NOAA-N |
| 2005-2010 | GOES-N-P, SMOS |
| 2010-2015 | GPM,LDCM,ALOS 2, SMAP |
| 2015-2020 | ICESat-2, LDCM, GRACE-FO,GOES-R, SWOT, NPOESS. |

The region from south Asian due to increased population peoples and crops has affected by the frequent presence of droughts. The data of affected people is depicted in the table below.

Table 4. Causes by droughts in south Asia

| Area from South Asia | Year of droughts causes | Affected people ( in millions) |
|---|---|---|
| India | 2002 | 300 |
| India | 2014-15 | 330 |
| Pakistan | 1999-2002 | 3.3 |
| South India and Sri lanka | 2017 | 0.2 |

### *G. Land Cover and Land Degradation Mapping*

Land degradation created by overgrazing, deforestation and practices of inappropriate irrigation. The most active land degradation factors are salinization, compaction and water logging. The absence of conservation measurements, heavy machinery usage of improper time, human intervention in natural drainage, excessive irrigation are the main factors of causing human induced land degradation[7].

For mapping land degradation area the following sensors used which includes TM, ETM+, MSS, ERS, JERS-1, Radarsat. To mapping small surface area the sensors used with high spatial resolution like IKONOS, SPOT-5, Hyperion, AVIRIS.

### *H. Crop identification*

Crop identification is an essential process to increase the growth of crop in the agriculture field. There are two steps approaches are available for crop identification includes training sample generation and classification technique [8].

The satellites include LISS, AWIFS, SPOT 5, MODIS, LANDSAT are the better source for providing multispectral data to proceed the crop identification process. Satellites like AVIRIS, Hy-Map are the good source for providing hyper spectral data for crop identification.

### *I. Crop nutrient deficiency detection*

To identify the nutrient deficiency in crop need to know some data includes soil type, cropping history, regional geography. Once the nutrient deficiency has occurred and identified, farmers should take steps to resolve it. Some important issues are made by crop nutrient deficiency which includes lack of pH, Flooding or poor drainage, drought stress, disease damage, nematode damage, herbicide drift.

Some elements are considered as an essential one in the soil to increase and complete the growth of the crop. Such elements are hydrogen, oxygen, carbon[9]. To avoid the nutrient deficiency soil should need some elements which are tabulated in the table below.

Table 5. Essential nutrient for plant growth

| Soil and Amendments nutrients | | | Water and Atmosphere nutrients |
|---|---|---|---|
| ***Primary nutrients*** | ***Secondary nutrients*** | ***Micro nutrients*** | ***Structural elements*** |
| Nitrogen (N) | Calcium (Ca) | Boron (B), Chlorine (Cl), Copper (Cu) | Carbon (C) |
| Phosphorous (P) | Magnesium (Mg) | Iron (Fe), Manganese (Mn), Molybdenum (Mo). | Hydrogen (H) |
| Potassium (K) | Sulfur (S) | Nickel (Ni), Zinc (Zn) | Oxygen (O) |

### *J. Identification of Pests and Disease Infestation*

Plant pests and the disease affect plant growth and gets loss of yields. Due to plant pests and diseases, 10 percent of food production has affected globally. Excessive pesticides are an effective one to save the crops from diseases. The prediction of pest damage is done by spectral indices based on leaf pigments, optical and video imaging in microwave region and near infrared, multi spectral remote sensing, and areas identified with help of portable GPS equipment [10].

Table 6. Crop pest and Disease monitoring by remote sensing

| Name of Sensor | Definition |
|---|---|
| MSI | Moisture Stress Index |
| DSWI | Disease Water Stress Index |
| RVSI | Red-edge Vegetation Stress Index |
| WI | Water Index |
| SIWSI | Shortwave Infrared Water Stress Index |
| MCARI | Modified Chlorophyll Absorption in Reflectance Index |

 

Major pests include fruit borers, leaf feeding caterpillars, leaf rollers, beetle borers, scarab beetles, soft scales, bugs, mites, gall flies, fruit flies. Some major diseases are brown blight, anthracnose, tree decline, parasitic algae and nematodes.

Remote sensing satellite data used to monitor the disease and pest with the help of following sensors which are tabulated in the table below [11].

## III. SATELLITES DESIGNED FOR AGRICULTURE – TECHNICAL ASPECT

Remote sensing satellite data can play a vital role to manage the agriculture field as better.

Agriculture factors include plant health, plant cover, soil moisture is monitored by the satellite data with GIS environment. The technical details of agriculture supported satellites are depicted clearly. Some of them are displayed in the table below.

Table 7. Agriculture satellite with technical details

| Name of Satellite | Date of Launch | Sensors | Cost incurred (in crores) | Operator | Objectives |
|---|---|---|---|---|---|
| Resourcesat-2A (PSLV – C36) | 07.12. 2016 | VNIR, SWIR | 106.11 | ISRO | Provide multispectral images for natural resources, crop production, water resources, and disaster management. |
| INSAT-3DR | 08.09.2016 | DRT, SAS&R | 116.38 | INSAT | Designed for improved weather forecasting, enhanced meteorological observations and disaster warning. |
| Lansat 8 | 11.02.2013 | OLI, TIRS | 85.5 | NASA/USGS | Designed for water resources and coastal zone investigation |
| GPM | 27.02.2014 | DPR, GMI | 97.8 | JAXA/NASA | Designed for environmental research |
| ICESat-2 | 15.09.2018 | ATLAS | 9.66 USD | NASA | Examine ocean exchanges of energy, mass and moisture, quantify recent sea level change and the linkages to climate conditions. |
| NOAA – 19 | 06.02.2009 | AVHRR | 11 USD | NOAA | Designed for weather prediction |
| Kalpana-1 | 12.09.2002 | VHRR, DRT | 71.30 | ISRO | Provide meteorological data for weather forecasting services. |

## IV. CONCLUSION

Agriculture is the stamina for a national economic growth. Most nations have an economy that is subject to agriculture in an enormous way. From agriculture to national revenue, agriculture is important for domestic production and rural employment. In 2010, around 25 million people were frequently occupied with farming work. Remote sensing plays a vital technical role to the human society in agricultural development aspect. Remote sensing based satellite optical and phenology imagery are used to agriculture monitoring. Horticulture and cropping system analysis, Crop condition assessment and stress detection, Irrigation monitoring and management, Soil Mapping, Land Cover and Land Degradation Mapping are the major remote sensing supportive application for agriculture development. Timely information about agriculture is significant for taking decisions on food security issues. Remote sensing takes that kind of responsibility. This paper helps to analyze agriculture development based on remote sensing applications.

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