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Geographical Information System in Agriculture

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ABSTRACT

Geographic Information Systems are incredibly helpful in being able to map and project current and future fluctuations in precipitation, temperature, crop output, and more. By mapping geographic and geologic features of current (and potential) farmland scientists and farmers can work together to create more effective and efficient farming techniques; this could increase food production in parts of the world that are struggling to produce enough for the people around them. GIS can analyze soil data combined with historical farming practices to determine what the best crops to plant, are where they should go, and how to maintain soil nutrition levels to best benefit the plants.
Keywords : Geographical information System, GIS, Agriculture

I. INTRODUCTION

Droughts, floods, swarms of insects and poor farming techniques have plagued the agricultural community for centuries. Improvements have been made to insure the safety and gain of crops worldwide and yet these factors and many more continue to make or break individuals and communities affected by them.

Many organizations are now implementing GIS systems including the USDA. They use many GIS variations in each of the USDA sectors to best capture what that department specializes in; in recent months, however, the benefit of combining this information has been realized due to the incredible capacity of GIS to transform and combine large amounts of data into a data set. In the United States GIS systems are used by the USDA to protect crops, solve crop issues, and investigate fraudulent claims of crop damage as well as give farmers an easy way to access information about their crops season by season.

Agricultural Geographic Information Systems (AGIS) can map not only topography and crop health, but help solve wider economic issues in municipalities and urban centers that may stem from rural farming practices. Farmers in the States are able to access the GIS data on their lands; a program called CropScape and another called VegScape allows farmers to interact with the data without having a GIS themselves, ask questions and interact with the data as well as provide valuable on-ground data that can't be gathered via satellite. Jeffrey Bailey, the chief of the National Agricultural Statistics Service's Geospatial Information Branch, estimates the accuracy of their crop data is in the mid-90th percentile with the added ground data from farmers.

The Agricultural Geographic Information System Laboratory (AGIS) at the University of California, Davis is deeply involved in the advancement of the agriculture/GIS relationship. This AGIS lab researches the effects a watershed area has on soil nutrients, the use and movement of pesticides on crops, mapping water use and availability in rural agricultural areas as well as cities, tracking potential plant diseases, and expanding the GIS capabilities to cover the entire state. In addition to expanding the potential uses of GIS the AGIS Laboratory is dedicated to disseminating the information they gather to local farmers, wineries, and city officials to best help promote healthy change in behaviors that affect the agricultural outputs of California.

The future implications of AGIS are incredible and immense in scope. With the permeation of technology in the global culture today it is possible that in a few years GIS could be available to rural farmers in the developing world to better help them grow crops, feed their families, and produce enough food to ship to neighboring areas. Farmers in severe-weather prone areas (like flood plains or drought zones) would be able to predict what this weather could do to crops, could move fields to better geographic locations, and know how to irrigate based on local water resources and weather patterns. The world food crisis could be alleviated by the use of GIS.

II. THE COMPANY USES DIFFERENT SPATIAL, SPECTRAL AND TEMPORAL RESOLUTIONS FOR

GIS application in agriculture has been playing an increasingly important role in crop production throughout the world by helping farmers in increasing production, reducing costs, and managing their land resources more efficiently. GIS application in agriculture such as agricultural mapping plays a vital role in monitoring and management of soil and irrigation of any given farm land. GIS agriculture and agricultural mapping act as an essential tool for management of agricultural sector by acquiring and implementing the accurate information into a mapping environment. GIS application in agriculture also helps in management and control of agricultural resources. GIS agriculture technology helps in improvement of the present systems of acquiring and generating GIS agriculture and resources data.

AABSyS IT uses GIS application in agriculture sector such as GIS agriculture for improving present method of acquiring and generating agricultural and resources data.

- Crop mapping yield estimation
- Crop assessment and Crop health
- Irrigated landscape mapping
- Application development for GIS agriculture
- Soil and irrigation amendment analysis
- Suitability assessment studies
- Erosion identification and remediation
- Agricultural mapping for detailed vegetation cover and monitoring
- Change detection studies and developing crop models
- Damage and land degradation assessment studies
- Elevation models for efficient drainage

These studies and projects can be executed on any standard GIS formats using high end software such as ArcGIS, ERDAS Imagine/ER Mapper, MapInfo and AutoCAD Map, and ArcFM

III. AGRICULTURE TECHNOLOGY: HOW GIS CAN HELP TO WIN THE FARM

3.1 Agriculture Technology and Stuff

Today's farmers use sophisticated **agriculture technology** because they can save time and money. Crops grow in specific locations. This makes Geographic Information Systems (GIS) an extremely relevant tool for farmers. Precision farming uses GPS on the field. While satellites and drones collect vegetation and weather information from the sky.

1) 3.2 Data from the Machine – Precision Farming

Farmers use precision agriculture because they can reduce the amount of fertilizer applied on the field. Not only do farmers save money on fertilizer, but they are saving the environment from over-application. This is because of lot of the excess fertilizer tend to end up in streams and rivers by run-off. Precision farming applies fertilizer only where it's needed. It's site-specific. Sensors on a machine gather information about the crops. In addition, the GPS gives you the exact position on the field. Precision farming then applies a variable rate of fertilizer to nutrient-deficient sites. The farmer who uses precision farming can save anywhere in the ballpark of 2-15$ per acre. Over time, this makes an incredible investment.

3.3 Data from the Sky – Satellites and Drones

What do crops need to grow?

Other than sunlight and nutrients, plants need the right amount of water. Too much (flooding) or little (drought) water impacts crop growth. Satellite technology like Soil Moisture Ocean Salinity (SMOS) collect real-time (passive) microwave energy from the Earth's surface. This can better forecast crop production and monitor drought and flooding. Landsat satellites analyze the greenness of vegetation using indices like Normalized Difference Vegetation Index (NDVI). We have a local and global estimate of crop productivity for the entire planet from a long list of satellites orbiting the Earth.

What can drones collect on a field?

- Plant height, count and biomass estimates
- Presence of disease and weeds
- Plant health and field nutrients
- 3D elevation and volumetric data

Instead of workers scouting fields, agriculture technology like drones can cover more ground. Drones can inspect crop health from the sky and where plant stress is occurring. Farmers can make actionable decisions on applying nitrogen and monitoring yields. Farmers can use precision watering sensors because they know *where* it's needed most. They can combat the spread of pests by identifying critical intervention areas. One small drone can help make some VERY powerful decisions for farmers.

3.4 Data online – Real-time mapping

The United States Department of Agriculture (USDA) National Agricultural Statistics Services (NASS) developed the mapping application CropScape where farmers can obtain acreage estimates of crop types. Simply, farmers can see *what* crops are growing *where* and *how much*. In addition, government has also used CropScape on issues like food security, land-cover change and pesticide control. At a global scale, the Food and Agriculture Organization of the United Nations AgroMap breaks down primary food crops with its global spatial database of agricultural land-use statistics.

For large-scale planning, online tools like **plant hardiness** define suitable climatic growing areas for different types of crops. Likewise, the Canadian Land Inventory was the first GIS data set produced. Its purpose was to classify the varying potential for agricultural production in Canada.

3.5 Modelling – Mashing data sets

Researchers are mashing together various inputs to better model and understand crop production. The Crop Assimilation Model (CAM) and Soil-Water-Air-Plant (SWAP) in GRASS GIS serve as crop productivity monitoring tools by simulating soil, water and crop processes. The Length of Growing Period (LGP) is when crops meet the full evapotranspiration demands of precipitation and soil moisture holding capacity. Each crop type has specific moisture requirements making LGP difficult to calculate.

The Erosion-Productivity Impact Calculator (EPIC) models crop yields and irrigation requirements to climate change. While the Agricultural Non-Point Source (AGNPS) Model predicts the effects of agriculture on water quality. And the Versatile Soil Moisture Budget (VSMB) simulates soil moisture conditions of cropland areas taking into account evapotranspiration, rainfall, runoff and other factors.

Geographic Information Systems assists decision-support. IDRISI's Reducing Emissions from

Deforestation and forest Degradation (REDD) determines the opportunity cost of potential agricultural revenue versus deforestation. Aspect and microclimate can locate potential areas that can be harvested like the south-facing slopes of the Swiss Alps. The south-facing slopes shelter from cold and dry winds which is critical to successful crop growth.

3.6 Meeting Future Food Demand

How can we fulfill the needs of a growing and increasingly affluent population?

Agriculture technology is helping diagnose food security like in this feeding the World Story Map. Can we learn from historical data? Landsat satellite data provides a unique view of historical agricultural land. When you plot historical trends of land use over time, is there enough arable land to serve a growing population?

Maps serve the purpose of raising awareness about global hunger and places that are in need like the FAO Hunger Map and World Food Programme Food Security Analysis. Satellite, mobile-collected and GIS data storage are safeguarding food-insecure populations by establishing underlying causes

IV. CONCLUSION

Precision farming, satellites, drones, web maps and sophisticated models – this list represents some of the **agriculture technology** being used on farmland today. The modern-day farmer needs to understand a lot more than just what to seed – soils, weeds, nutrients, weather, insects, disease, machinery and climate. These emerging trends provide the location intelligence farmers need to get the job done faster and with more knowledge.

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