A Study on Hyper Spectral Remote Sensing Pest Management

A. Swarupa Rani, S. Jyothi
[1]Research Scholar, Sri Padmavathi Mahila Visvavidyalayam, Tirupati, AP, India.
E-mail: swaruparani_kanta@yahoo.com
[2]Dept. of Computer Science, Sri Padmavathi Mahila Visvavidyalayam, Tirupati, AP, India.
E-mail: jyothi.spmvv@gmail.com

Abstract:- Designing innovative combination of techniques to improve the sustainability of cropping system is a major challenge in many regions of the world. Long-term cropping systems research is important in order to reduce production costs, to control crop pests, and to optimize the sustainability of agro-ecosystems. Research into vegetative spectral reflectance can help us gain a better understanding of the physical, physiological and chemical processes in plants due to pest and disease attack and to detect the resulting biotic stress. This has important implications to effective pest management. Pest surveillance programs such as field scouting are often expensive, time consuming, laborious and prone to error. As remote sensing gives a synoptic view of the area in a non-destructive and non-invasive way, this technology could be effective and provide timely information on spatial variability of pest damage over a large area. In this paper to study management of water, nutrients, and pests in agricultural crops and assesses the role of hyperspectral remote sensing in yield prediction and also remote sensing can guide scouting efforts and crop protection advisory in a more precise and effective manner in the field of pest management.

Keywords*: Pest Management, Remote Sensing, Chemical Process, GIS, Hyper Spectral, Weed Management, Eradication, Suppression, Agriculture, Soil fertility, Crop nutrition, Pest attack, Insect populations.*

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1. Introduction

Pest management means to reduce pest numbers to an acceptable threshold. An acceptable threshold, in most cases, refers to an economically justifiable threshold where application of pest control measures reduces pest numbers to a level below which additional applications would not be profitable. Pest and nutrient management in general should be coordinated to better integrate both sets of management strategies into the agricultural production system. An IPM approach to pest control can reduce the amount of pesticides applied to cropland, lowering pesticide expenses while protecting water quality. Managing pests (weeds, insects and plant diseases) in agriculture involves the safe and environmentally sound use of pesticides to control crop pests when and where needed, as well as integrated pest management (IPM) strategies that avoid total reliance on chemical pesticides. There are mainly three types of pesticide formulations (liquid, solid and gas). A single pesticide may be sold in more than one formulation. Some products are ready to use and require no further mixing. However, most products applied in the liquid form must be diluted in water or oil before use. Formulation type depends on several factors:

• Toxicology of the active ingredient,
• Chemistry of the active ingredient,
• How effective the product is against the pest,
• The effect of the product on the environment (plant, animal or surface etc.),
• How the product will be applied and the equipment needed the application rate.

1.1 Methods of Pest Control

Pest causes lot of reduction in the yield and quality of crops. Broadly the measures of pest control are of two types, preventive and protective. Preventive measures are used before the attack of the pest and protective measures are used to control the pest after their attack. Methods of control can be categorized as chemical, biological, cultural, physical/mechanical, or genetic, and are discussed in further detail below. The methods of controlling pest are as follows.

- **Mechanical methods:** Picking of pests, larvae by hand and destroying them. Remove the part or whole plant that is infested. Use of traps and Catch them with the help of net.
- **Physical methods:** By heat: High temperature kills the pest, Low temperature. X-rays and gamma ray.
- **Cultural methods**: Crop rotation, Clean cultivation, Proper use of fertilizers and water, Growing pest resistant Varieties, Timely or late sowing and Proper harvesting.
- **Chemical:** Chemical pesticides are often toxic to non-target organisms including the pest's natural enemies, can persist in the environment affecting water supply, soil productivity, and air quality, and can be biomagnified in the food chain. Inappropriate use of pesticides can result in target pest resurgence from killing off natural enemies, secondary pest outbreaks by removing natural enemies of other organisms and allowing them to rise to pest status, and evolved resistance to the pesticide.
- **Biological:** Biological control involves the use of a pest's natural enemies to control pest abundance. Measures to conserve or enhance the impact of natural enemies should be attempted first. Perhaps biological control is most known for importation of natural enemies, often from the pest's area of origin, to control non-native pests.
- **Cultural:** Application of broad-spectrum pesticides which kill off natural enemies in addition to target pest species, the type of crop plant, the crop environment, and cropping practices. Modern

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497 – 503

crop varieties often inadvertently create conditions which favor pest species.

- **Physical:** Removal methods include use of animal traps, sticky cards for insects, manual removal of insects from plants, removing diseased or infected materials. Physical barriers such as fences, nets, mulch, and tree trunk guards can exclude pests and reduce the damage they inflict.
- **Genetic:** Straightforward genetic manipulation to create pest resistant plant strains is another form of controlling pest impacts. However, genetic manipulation research and development is costly, and introduces a whole other series of ethical and environmental issues that are not easily addressed.

1.2 Importance of Practice Pest Management on your farm

Environmental benefits

- May reduce or eliminate the risk of surface and ground water contamination from pesticide runoff or leaching
- May reduce or eliminate pesticide drift and other environmental risks that pesticides may pose to air quality, soil quality and wildlife & mdash; including natural pest predators and important pollinator species that many crops rely upon, such as bees

Practical benefits

- May improve profits by reducing both chemical pesticide expenses and pest damage to crops and produce
- Expands pest control options
- Helps prevent the development of pesticide-resistant pests
- Protects the health of family, employees, neighbors and livestock
- Helps farmers comply with environmental regulations

Fungal pathogens cause serious losses to yields and quality of agricultural crops globally. Remote sensing is being increasingly used in different agricultural applications. Hyper spectral remote sensing in large continuous narrow wavebands provides significant advancement in understanding the subtle changes in biochemical and biophysical attributes of the crop plants and their different physiological processes, which otherwise are indistinct in multi spectral remote sensing. Integrated crop management and pesticide pathways process describes spectral properties of vegetation both in the optical and thermal range of the electromagnetic spectrum as affected by its attributes by using hyperspectral remote sensing. The fig.1: represents the integrated crop management and pesticide pathways process.

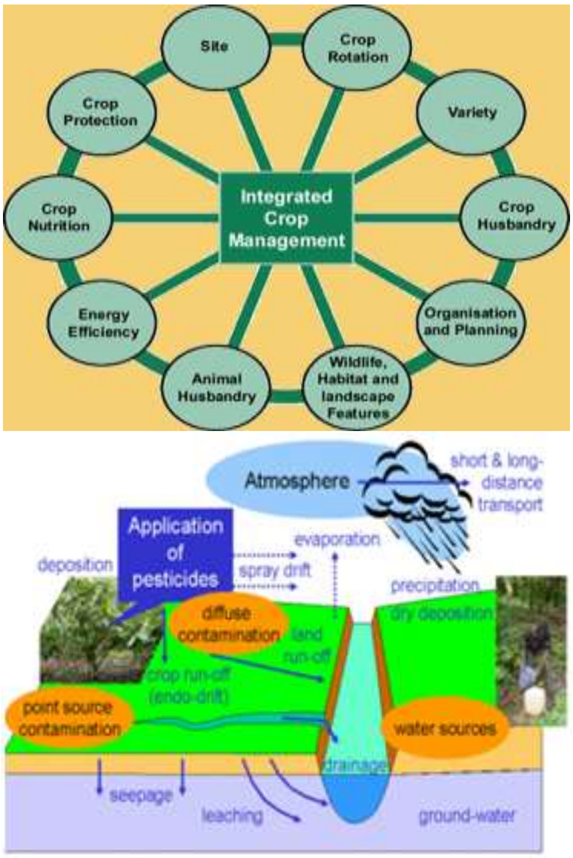

Fig.1: integrated crop management and pesticide pathways process

2. Literature Survey

Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object under investigation. When electromagnetic energy is incident on any feature on the earth surface, three energy reactions with the feature are possible: reflection, absorption and/or transmission (Lillesand et al. 2004) . The possibilities for these types of studies related to precision agriculture are virtually endless as indexes for each species, nutrient or soil property continue to be developed and improved. Studies have been conducted to estimate yield in corn by taking images during the mid grain filling stage and developing yield maps.[23] And, Okamoto and Lee (2009) demonstrated that immature fruits in orchards of oranges could be detected on individual trees.[24] Assessment of chilling, heat or insect injuries in the field would be another use of this technology in yield estimation. The major pests are observed after data analysis, in kharif season-gundhi bug, hispa, jassids, bollworm, grass hopper, thrips, top borer, pyrilla, aphids and white grub; in rabi season -termite, cutworm, whitefly, tuber moth, hairy caterpillar, hooded hopper, hawk moth, painted bug and gall fly (Singh et al. 2003).The reflectance characteristics of earth surface features may be quantified by measuring the portion of incident energy that is reflected (Panda 2005)

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497 – 503

Repentance is measured as a function of wavelength and is called spectral reflectance.

3. Pest Species and Their Deleterious Effects

A number of insects and pathogens have been identified as pests particularly for their impacts to agricultural industries. Cultural controls include crop rotation, pest-resistant crop varieties and timing of field operations to avoid or better manage pest outbreaks. Also, field borders and other types of conservation buffers near crops can be designed to provide habitat for natural predators. Mechanical controls include weed cultivators, rotary hoes and techniques such as flame-weeding. Monitoring of agricultural pests includes tracking soil/planting media fertility and water quality. Weather conditions at the time of application as well as temperature and relative humidity change the spread of the pesticide in the air. The following table presents a number of important pest species and their deleterious effects.

Pest	Type	Effects
Pierce's Disease (*Xylellafastidiosa*)	Fungus	A lethal disease of the grapevine which is often spread by insects with piercing/sucking mouthparts that feed on xylem sap such as the glassy-winged or blue-green sharpshooter.
Oak Root Fungus (*Armillariamellea*)	Fungus	Parasitizes the roots of orchard trees, oaks and many other woody plants including grapevines sometimes causing sudden death.
Botrytis Bunch Rot (*Botrytis cinerea*)	Fungus	Directly affects grape bunches reducing yield and quality of grapes. Infected fruit causes off-flavors and aromas in wine, and is unsuitable for most wine production.
Powdery Mildew (*Uncinulanecator*)	Fungus	Damages or destroys berries, reduces photosynthesis and can affect wine flavor and quality.
Grape Leafhopper (*Erythroneura elegantula*)	Insect	Damage vines by inserting their stylets to suck out the contents of leaf cells reducing the vine’s photosynthetic ability, and are often a nuisance to vineyard workers during harvest
Spider Mites (*Tetranychus pacificus, and Eotetranychus willamettei*)	Insect	Destroys grapevine leaf tissue feeding on the lower surface of the leaf reducing photosynthesis and other physiological functions.
Pocket Gopher (*Thomomysbottae*)	Mammal	Damages vines by chewing on roots while tunneling underground, and above-ground portions as well. Gophers cause other problems by chewomg on plastic irrigation pipes, and building burrows which can divert and concentrate runoff, causing significant erosion problems in the vineyard as well as lawns and gardens.
Starling (*Sturnus vulgaris*)	Bird	Starlings, in addition to a number of birds, including house finches, and robins, flock consume ripening and mature grapes causing significant damage. In Napa County, flocks of starlings can reach numbers in the thousands, and damage from them can be the most severe.
Deer (*Genus odocoileus*)	Mammal	Damages vines by grazing on the foliage, often stripping canes clean of leaves causing extensive damage and stunting of vines.

3.1 Process

The IPM process starts with monitoring, which includes inspection and identification, followed by the establishment of economic injury levels. Integrated pest management employ a variety of actions including cultural controls, including physical barriers, biological controls, including adding and conserving natural predators and enemies to the pest, and finally chemical controls or pesticides. Reliance on knowledge, experience, observation and integration of multiple techniques makes IPM appropriate for organic farming. For conventional farms IPM can reduce human and environmental exposure to hazardous chemicals, and potentially lower overall costs. The IPM process is shown in fig.2 is a series of continuous and interrelated steps that help the pest manager decide how to deal with a pest problem. IPM is a decision-making process that guides pest managers toward efficient, effective, and sustainable pest management that emphasizes pest prevention and non-chemical methods. Having a written IPM process makes communication between the IPM service provider and the customer easier,

ISSN: 2321-8169
497 – 503

and prevents misunderstandings about expectations on both sides.

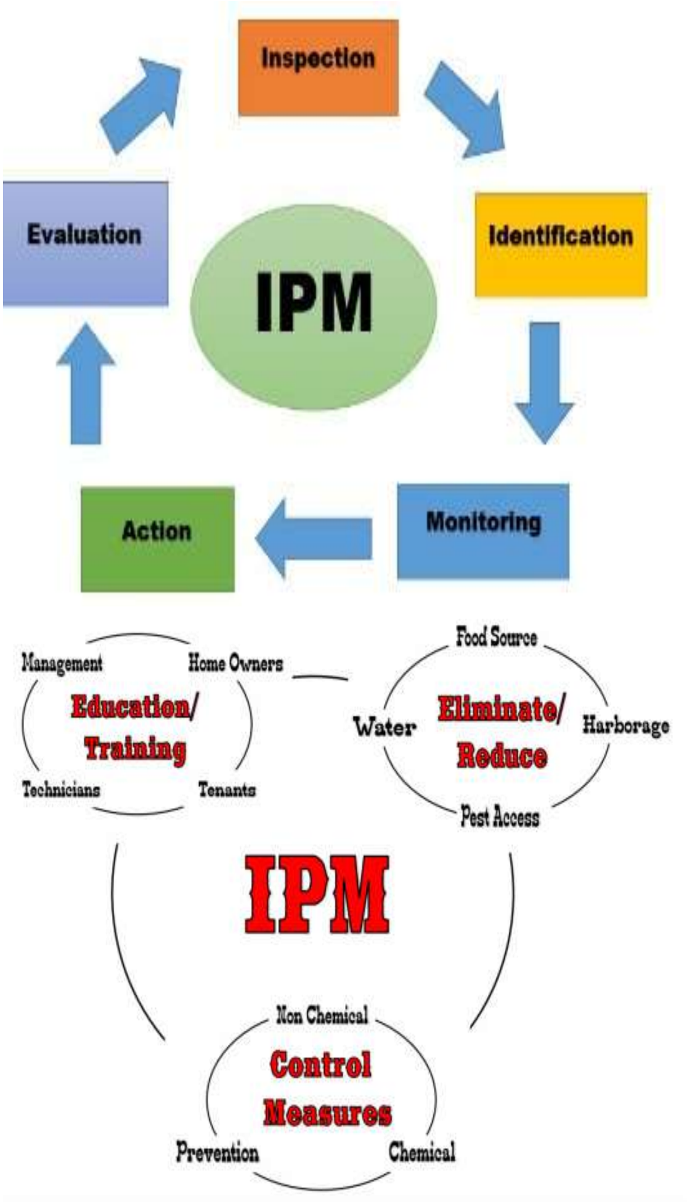

Fig.2: IPM Process

3.2 Types of Remote Sensing Platforms

Remote sensing platforms can be field-based (ground based), or mounted on aircraft (airborne) or satellites (space borne). Ground-based platform, such as hand held spectroradio meter, is typically used for ground truth study. Airborne RS is flexible and able to achieve different spatial resolutions with different flight altitudes. Satellite RS is generally for small scale (large area) study but it often times cannot meet the requirement of spatial resolution in applications. However, with recent advent of high resolution sensors, there is lot of potential for large scale (small area) field applications. Depending on the band width, number of bands and contiguous nature of recording spectral scanner scan be of two types viz., multispectral or broadband and hyperspectral or narrowband. The remote sensing platforms are shown in fig.3.

Fig.3: Remote Sensing platforms

3.3 Principle of Operation

The portion of energy reflected, absorbed or transmitted will vary for different earth features depending on their material type and condition. Even within a given feature type, the portion of reflected, absorbed and transmitted energy will vary at different wave-lengths. Thus, two features may be distinguishable in one spectral range and be very different in another wavelength band. Because many remote sensing systems operate in the wavelength regions in which reflected energy predominates, the reflectance properties of earth surface are very important. A graph of the spectral reflectance of an object as a function of wavelength is termed as ‘spectral reflectance curve’ (fig.4).

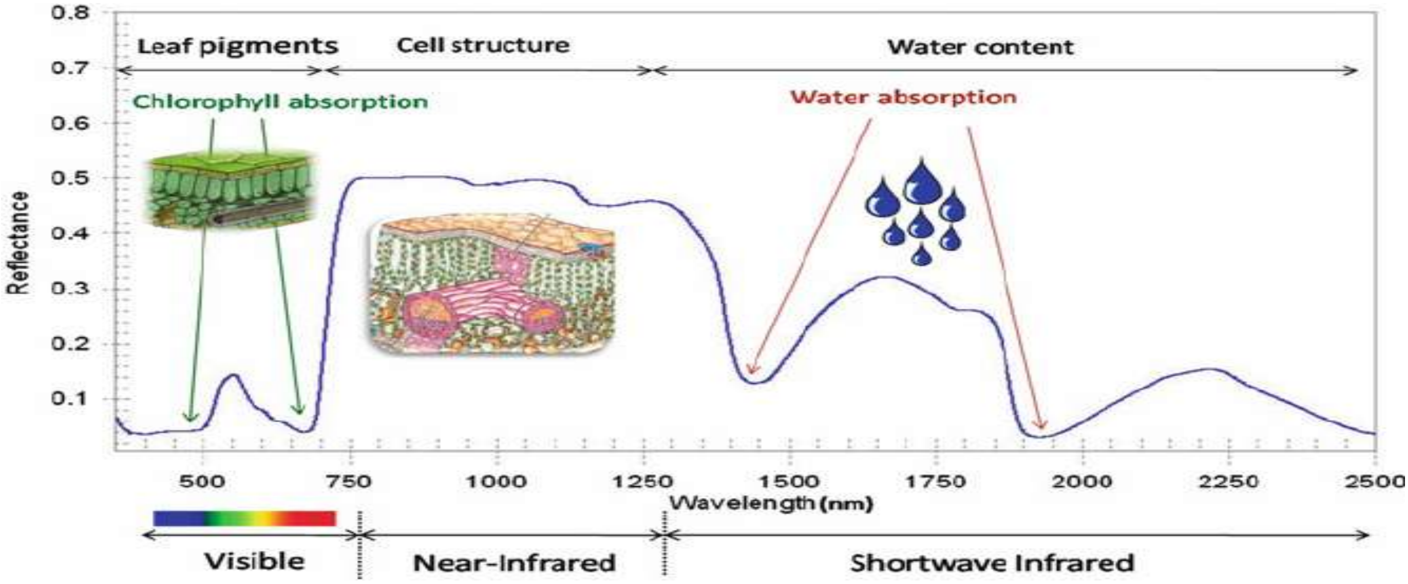

Fig.4: Typical spectral reflectance curve of healthy vegetation depicting different absorption peaks

3.4 Remote Sensing on Agriculture

Remotely sensed data provide the only source of information to make a complex global agricultural monitoring system feasible by being consistent, repeatable, routine, rapid, and scalable. The first critical component for any remote sensing program is solid ground truth information. Without ground data to identify land cover categories, to train the classifier and validate the output image products, it is impossible to run a defensible program that provides reliable results. Ground truth is mentioned first, because it must be seriously considered before initiating plans for any remote sensing application. Secondly, a source of satellite imagery is required. There are many sources of satellite imagery which vary considerably in cost, as well as, spatial, temporal, spectral and radiometric resolution. Finding an imagery source that also provides a guarantee of future continuity is an important consideration, since once a program has been researched and implemented, it becomes more difficult to transition to another satellite. Thirdly, using remotely sensed data requires a sizable investment in Information Technology (IT) resources. However, with the speed of computers continuing to increase and the price of disc storage on the decline this has become much less of a hindrance. Hyperspectral sensors record the reflectance from the Earth's surface over the full range of solar wavelengths with high spectral resolution. The fig.5 has shown various methods of remote sensed data on agriculture.

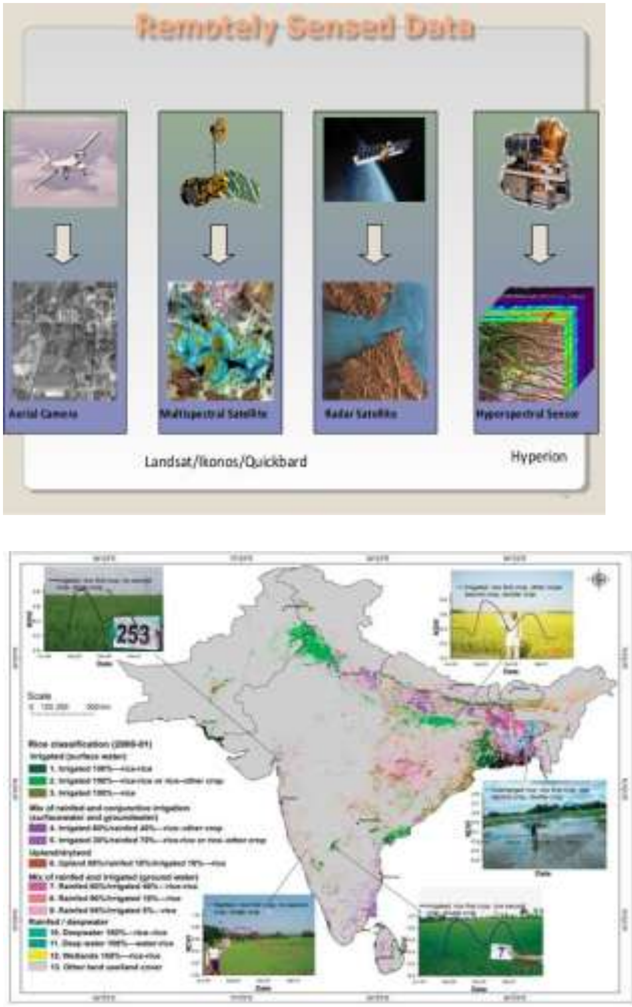

Fig.5: Various methods of Remote Sensed data on Agriculture

3.5 Our Methods

Hyperspectral imaging delivered by lower-cost, portable devices that still deliver high-quality accurate data has become a vital tool for researchers and farmers. The ability of these devices to enhance and enable day-to-day monitoring promises to create a new paradigm of agricultural efficiency. Our map products are created with data such as Landsat and Modis imagery using remote sensing techniques by analyzing millions of image pixels. For example, we combine temporal patterns of the Normalized Vegetation Difference Index with our reference data to classify the world's cropland by the following measures.

- Cropland or Non Cropland
- Irrigation or Rain fed
- Crop Types
- Intensity of Cropland

Modern precision agriculture relies on site-specific management tactics to maximize yield and resources while reducing environmental impacts such as over-fertilization and the broad applications of pesticides. Pin-pointing areas requiring attention – be it water, weed or pathogen treatment, or nutrient adjustments – allows for spot application rather than whole-field treatment. The collection of key data at a sufficient level of accuracy depends on the availability of equipment that can be operated at a cost-effective level. While many of these responses are difficult to visually quantify with acceptable levels of accuracy, precision, and speed, these same plant responses will also affect the amount and quality of electromagnetic radiation reflected from plant canopies. Thus, remote sensing instruments that measure and record changes in electromagnetic radiation may provide a better means to objectively quantify disease stress than visual assessment methods. Furthermore, the effects of many pest/disease infestations are often not noticeable to the human eye, until it reaches an advanced stage when it becomes too late to control the outbreak. Some of the benefits of hyperspectral and multispectral imaging are that these technologies are: low cost, give consistent results, simple to use, allow for rapid assessments, non-destructive, highly accurate, and have a broad range of applications. In the fig.6 shows object based crop species classification based on airborne mapping.

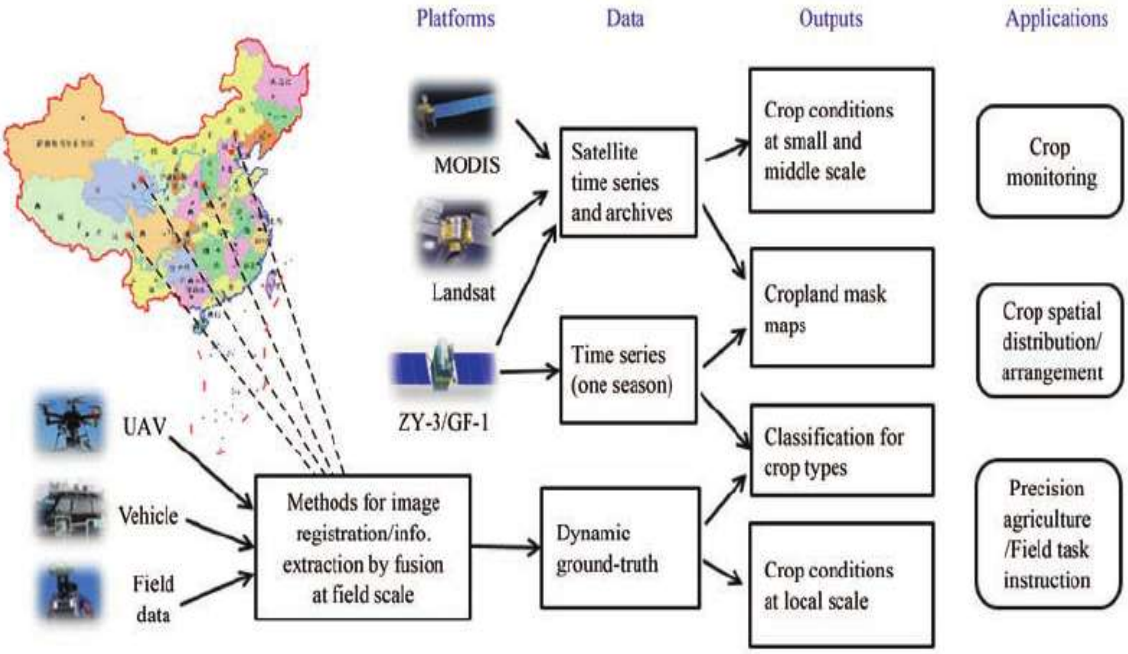

Fig.6: Object based Crop Species Classification based on Airborne Mapping

Conclusions

The pest largely affected crop area and control is essential before the effect so remote sensing technology play a great role to control pest affect the area. It gives very good information before if precisely identified the cyclic study the remote sensing data of the area. Currently, many other applications of hyperspectral and multispectral imaging are being tested in: post-harvest quality control, grading, and sorting of agricultural products, insect and contaminant detection, manage the pests and numerous other uses in food safety. The combination of remote sensing and crop growth models has become an effective tool for yield estimation and a potential method for crop quality estimation. The software allows user to either tabulate the measured quantities or generate maps as soon as data collection has been terminated. The system may also incorporate GPS data to create geo-referenced soil maps. The software enables the user to graph penetration resistances at a specified coordinate. Alternately, soil compaction maps could be generated using data collected from multiple coordinates. Soil compaction is an important physical limiting factor for the root growth and plant emergence and is one of the major causes for reduced crop yield worldwide. This was mounted on the three-point hitch of an agricultural tractor, consisting of a mechanical system, data acquisition system and 2D/3D imaging and analysis software. It was concluded that the system tested in this study could be used to assess the soil, weed compaction at pest management and the randomly distributed hardpan formations just below the common tillage depths, enabling visualization of spatial variability through the imaging software. Remote sensing technique is very useful, less time consuming and cost effective in delineation of pest-affected areas. The GPS, DGPS, LAPTOP and other sophisticated instruments give the very precise information. Immediate attention needs to be paid for control the pest affected area and prevent affected areas through chemical. The interchange the cropping systems also help to control the pest problems.

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