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Need of Precision Farming in Horticultural Crops

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SUMMARY

Farmer and consumer are driving the request for sustainable production of fruit and vegetables. Precision agriculture has been developed over the last twenty-five years when global positioning systems (GPS) and yield monitors were made available in field crops. Its application to tree crops and vegetables started later and has been developing with an increasing number of researches in the beginning of the 21st century. First applications were described for mechanical harvesting of horticultural crops with commercial solutions for harvesting fruit that is subjected to processing. The precision agriculture domains with specific implications in horticultural crops captured are: data collection, yield mapping, remote sensing, quality mapping, and variable rate application.

INTRODUCTION

Precision agriculture can be defined as management of spatial and temporal variability in fields using information and communications technologies. Precision agriculture is a system that applies technologies and principles to manage variables such as seed, fertilizer management, water management, etc. Precision horticulture targets individual trees or zones of tree blocks adaptively to its apparent status that shall trim down environmental footprint of fruit and vegetables production through enhanced resource efficiency and improved production performance. In horticulture, quality analysis of the product is more important than in any other crop. The field size is frequently smaller compared to arable production. The planting density is lower and even single plants may be treated individually adapted to the spatial or temporal pattern. So, precision agriculture will help in better management of the trees or orchards.

Need of Precision Agriculture in Horticulture:

Precision agriculture helps in management of resources through location specific hi-tech interventions. Precision farming is an approach where inputs are utilised in precise amounts to get increased average yields, compared to traditional cultivation technique. In India one major problem is small field size. More than 58% of operational holdings in the country have size less than one hectare. Utilisation of various interventions of Hi-tech horticulture with the aim of achieving higher output in given time period leads to precision agriculture. Yield mapping in mechanized crops can be easily carried out. In vines, sensors are developed for relatively early harvesting of grapes for wine making. Precision agriculture allows target-oriented treatments, spot treatment applications. Precision plant protection treatments can result in 35-70 % savings on plant protection materials.

Tools used in Precision Farming:

Global positioning system (GPS): GPS is a navigation system based on a network of satellites that helps users to record positional information (latitude, longitude and elevation) with an accuracy of between 100 and 0.01 m. GPS allows farmers to locate the exact position of field information, such as soil type, pest occurrence, weed invasion, water holes, boundaries and obstructions. The system allows farmers to reliably identify field locations so that inputs (seeds, fertilizers, pesticides, herbicides and irrigation water) can be applied to an individual field, based on performance criteria and previous input applications.

Geographical Information system (GIS): A geographic information system is a computer-based system for storing very large amount of data, retrieving, manipulating, and displaying them for easy interpretation. GIS system gives farmers a possibility to aggregate data in a visually-rich way. By generating custom colour-coded maps, the tool gives a full view on soil condition, crop fertility, insect, or disease pressure.

Yield monitors: Yield monitors are crop yield measuring devices installed on harvesting equipment. The yield data from the monitor is recorded and stored at regular intervals along with positional data received from the GPS unit.

Variable Rate Technology: Variable rate technology consists of farm equipment with the ability to precisely control the rate of application of crop inputs and tillage operations.

Remote sensing: Remote sensing is the science of acquiring information about an object or phenomenon by measuring emitted and reflected radiation.

Application of Precision Agriculture in Horticultural Crops:

1) Data collection and localization:

In orchards several types of data can be collected in situ during the growing season either from micro-climate, soil, tree, and fruit, which all have to be georeferenced using mainly GPS receivers. For most applications such as yield and quality mapping, crop scouting and product sampling, differential GPS (DGPS) with accuracy below 1 m seems to be sufficient. Measurement of intervals to carry out cultural practices can be accessed by using technologies in precision agriculture. Physiological processes such as leaf gas exchange, xylem sap flow, maximum daily shrinkage, water potential etc. can be analyzed.

2) Water stress management:

The use of remote sensors to directly measure soil moisture. Synthetic Aperture Radar (SAR) sensors are sensitive to soil moisture and they have been used to directly measure soil moisture. A crop evapotranspiration rate decrease is an indicator of crop water stress or other crop problems such as plant disease or insect infestation. Remote sensing images have been combined with a crop water stress index (CWSI) model to measure field variations.

3) Nutrient stress management:

Plant nitrogen stress areas can be located in the field using high resolution color infrared aerial images. The reflectance of near infrared, visible red and visible green, wavelengths have a high correlation to the amount of applied nitrogen in the field. Canopy reflectance of red provides good estimate of actual crop yields.

4) Quality analysis in-situ:

For non-destructive analysis of internal quality sensors are developed and used commercially. Fruit diameter can be measured by dendrometer and shadow imaging. Instruments are available equipped with wireless sensor network. Optical properties of fruit and vegetables that may be considered in their non-destructive analyses are: absorption coefficient, scattering coefficient and refractive index.

5) Yield monitor:

Yield mapping can be carried out easily in mechanized crops with sensors added to the harvesting machine. However, most horticultural crops are not mechanically harvested and therefore many customised approaches for specific horticultural crops have been tested for yield mapping.

Table: Yield monitor for handpicked horticultural crops:

Crop	Method of yield monitoring
Citrus	Weighing pallet bins using load cells from neighbouring trees on tractor platforms. Estimating yield by tree canopy (ultrasonic sensor, Lidar, multi-spectral camera).
Apple/ Pear/olive	Weighing bins of handpicked fruits of neighbouring trees, geo-referenced using DGPS.
Peaches / Kiwis	RFID or barcodes on the bins together with a weighing machine, RFID or barcode reader and DGPS
Potato	Load cells under the conveying chains. 2-D vision system above the conveying belt
Onion/ watermelon	Dividing the field into block and weighing the platforms carrying the fruits per block.

6) Post-harvest process management:

Precision agriculture applications of post-harvest process management use sensors to monitor conditions in curing or storage to achieve optimum storage parameter and preserve quality. Automatic controls are used to regulate temperature, humidity and fresh air delivery. By continuous monitoring of curing or handling conditions, adjustments can be made that would not be possible in the conventional method of manual control.

CONCLUSION

Now a day's horticultural crops pose an emerging and challenging sector for precision agriculture technology and management. Quality management is one major component in horticultural crops. Methods to estimate fruit status in the production are required. As, many horticultural crops are in small fields, site- specific technologies and strategies should be developed for small fields, which should be economically viable and easy for small farmers to adopt. Question remains about cost effectiveness and the most effective ways to use the technological tools we now have, but the concept of doing the right thing in the right place at right time has a strong initiative appeal.

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