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Precision Forestry

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Introduction

Precision Forestry is the use of tools and technology to collect data to make decisions for site-specific management. It aims to improve wood quality, protect the environment, reduce waste, and increase profits. It can be used in all phases of forestry, such as planning, site operations, monitoring, processing, and marketing. Even agriculture is undergoing enormous change due to technologies like variable-rate fertilization and automated harvesting. Forestry, on the other hand, has lagged behind most other industries in the adoption of digital technology. Studies are already showing productivity increases in general agriculture at rates of 5 to 25 percent annually, with returns on investment of one to two years for digital technology (depending of course on many factors, such as farm size, crop selection, and other conditions). The size of these gains is comparable only to the shift from animal-powered to mechanized processes and in food farming, the Green Revolution of the 1960s. However, inspired by advances in agriculture, forestry operators globally have begun pioneering the use of advanced technologies to improve forest management results. Within the industry, this approach is widely called “precision forestry.” This management style is closest to agriculture, with monocultures, selectively bred tree species, and a relatively high degree of automation-indeed; these forests are often referred to as tree farms.

Advantages of Precision Forestry

The following are economic benefits that have so far been quantified in a site in the USA:

- ✓ Overall cost savings of 47%.
- ✓ Variable rate application has reduced chemical use for herbicides and fertilizers by two-thirds compared to traditional methods.

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The potential for value creation from improved forest management is significant. Besides the ecological benefits of increased productivity, which relieves pressure on natural forests, there is substantial economic and social value at stake. Globally, about 300 million hectares of plantation forests, an area roughly the size of India, and 900 million hectares of natural forests used for wood production, an area slightly smaller than the size of China or the United States, together supply nearly two billion cubic meters of industrial wood (for example, for construction, paper, and packaging) and two billion cubic meters of fuelwood for household heating and cooking. The economic value of the industrial wood is on the order of $200 billion, while the fuelwood remains a critical source of energy for households in developing countries.

Instruments and Technology used in Precision Forestry

Many but not all the technologies used in Precision Forestry are associated with remote sensing, geographic information systems (GIS), and global positioning systems (GPS).

- Remote sensing through satellite imagery relies on spectral images to give large-scale information on forest composition, forest health, drought conditions, or fire and flood risks.
- Drones or Unmanned Aerial System (UAS) can fly guided remotely by people. They are used to scan the area under the canopy of plantations without GPS navigation or automated operations. They have an efficient obstacle avoidance controller to handle under-storey vegetation. Drones are used on the site level to
    - map specific sites,
    - detect fires or flood risks,
    - scan burned areas for damages,
    - operate other technology like LiDAr technology or multispectral cameras,
    - disperse seeds, and
    - Apply herbicides and pesticides.
- Light Detection and Ranging (LiDAR) is a remote sensing technique which uses near infra-red laser and GPS to provide a precise three-dimensional mapping of land and

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forests. LiDAR can be used for large-scale maps with planes/drones or small-scale scans when installed on the ground. LiDAR is useful for generating the following information:

- ❖ Vertical forest structure
- ❖ Tree data such as the shape of trees, the density of leaves, etc
- ❖ Detecting forest under-storey vegetation like shrubs
- ❖ Forest Inventory of tree height, its basal area, and volume
- ❖ Detecting above-ground and underground diseases. For example, it can detect root rot—one of the main causes of loss in wood production (See Figure 1).

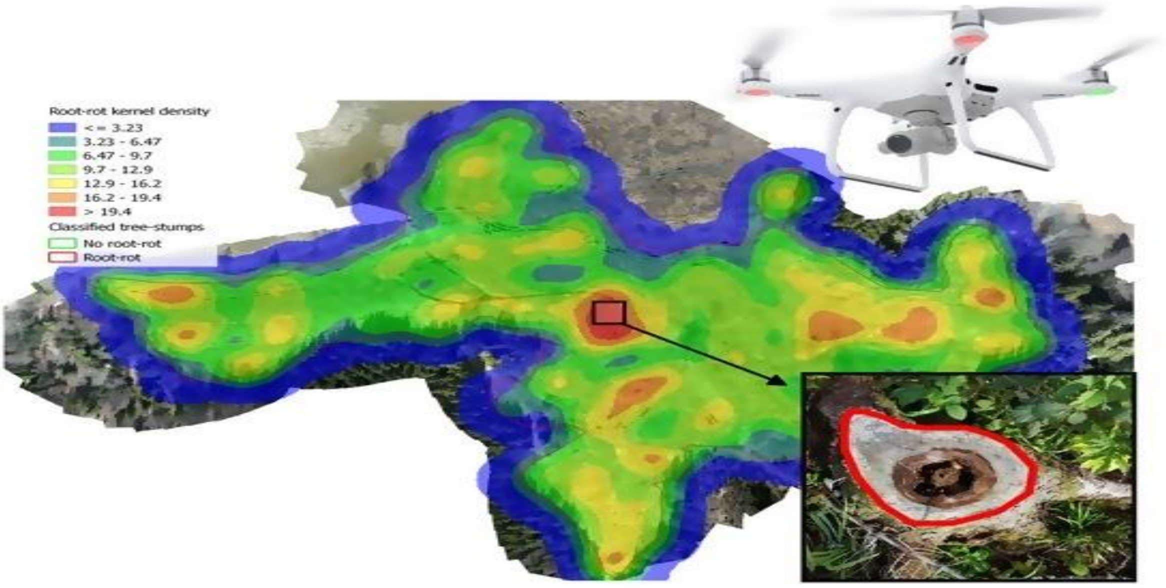

Figure 1: Post harvest surveys showing root rot. (https://doi.org/10.3390/f9030102)

- Sensors are used to collect field data about soil or individual plants to give site-specific information to help in variable rate applications. These are small and portable tools which give accurate information. Many have GPS to monitor growth over long periods and WiFi for easy data transfer. Some examples are
    - Soil sensors to detect soil temperature and water level.

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- Canopy Imagers to monitor tree growth and health, and success of trees, soil erosion, and carbon fixation for carbon accounting. An example of one such device is the CI-110 Plant Imager.
- Spectrometers that identify plants under stress and suffering from drought. For example, the CI-710 Miniature Leaf Spectrometer.

Traditional forestry systems	**Precision forestry system**
Natural regeneration of forests with seed trees of same genetic material	Selectively bred and cloned seedlings, raised in nurseries under tightly controlled conditions
Use of 2–3 standard fertilization prescriptions depending on broad soil-type classifications	Site-specific fertilization treatment based on granular assessment of soil nutrient defi-ciencies
Manual in-field forest inventory based on sampling to inform production planning	Digital forest inventory using drones and light detection and ranging (LiDAR), or in-forest scanning with smart phones
Motor-manual harvesting with no data capture	Fully mechanized harvesting, integrated with supply chain planning
Reacting to forest res detected only by direct observation	Satellites and drones to provide early re detection and inform centrally planned response

Constraints

Introducing advanced technology in forest management faces several challenges: ƒ

- There is little corporate involvement in forestry; 76 percent of forests globally are publicly owned, 2 and most of the remainder are held by small private owners (who typically hold, on average, less than one hectare, or roughly two-and-a-half acres). ƒ
- State and other public forest owners tend to be relatively conservative in their management style and, to a greater extent than private enterprise, need to balance diverse objectives for commercial performance with social and environmental goals.
- Many private forest owners have operations characterized by a lack of scale and expertise required to adopt the latest technologies.

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- Large-scale commercial forests, from eucalyptus plantations in South America to managed natural forests in Europe and North America, are in remote and rugged terrain, presenting many challenges for adoption of new technologies. ƒ
- While a wide range of precision forestry technologies exists, relatively few practical examples are up, running and few understand how the technologies translate into real use cases.

Figure 2: Examples of precision forestry

Conclusion

The application of Precision Forestry may have just begun, but it has already seen wide adoption. It is estimated to be worth USD 3.9 billion in 2019, according to Bloomberg, and is expected to see an annual growth of 9% by 2024. The number of companies that provide technology relevant for Precision Forestry is also increasing. Although, no information is available on precision forestry in India but there is much scope of these modern approaches in our country, which will lead to effective forest management. However, there are some companies, such as CID.Inc, who have been around for a few decades making precision tools for plant research and practitioners long before the term Precision Forestry was coined. They have the advantage of many years of experience and application, making them trustworthy.