

TOOLS and TECHNIQUES

In addition to mechanization, other tools and equipment (techniques) used in PF, are briefly presented.

1. Global Positioning System (GPS)

The 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

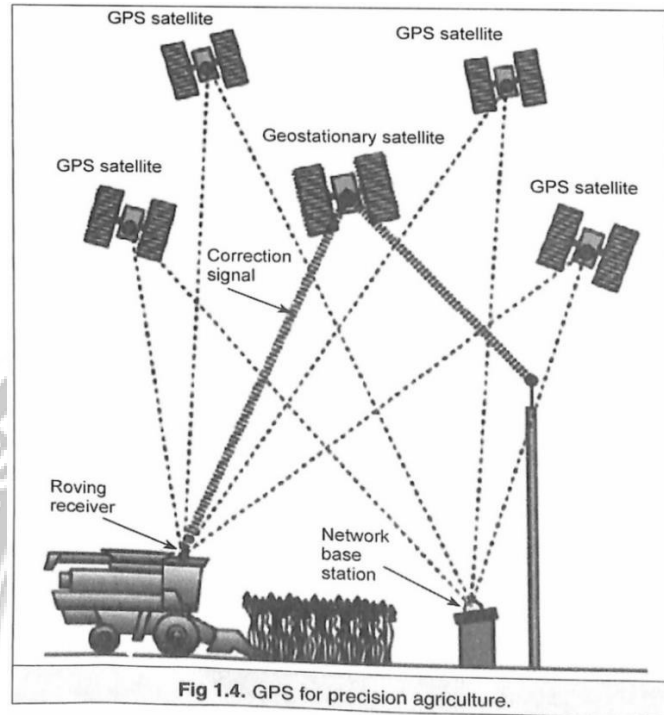
0.01 m. GPS allows farmers to locate the exact position of field features, such as soil type, pest occurrence, weed invasion, water holes, boundaries and obstructions. There is an automatic controlling system, with light or sound guiding panel (DGPS), antenna and receiver. GPS satellites broadcast signals that allow GPS receivers to calculate their position. In many developed countries, GPS is commonly used as a navigator to guide drivers to a specific location.

The GPS provides the same precise guidance for field operations. 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.

Specific advantages of GPS in farm operations include:

1. Farm machines are guided along a track hundreds of meters long making only centimetre scale deviations.
2. Rows are not forgotten and overlaps are not made.
3. Number of rows can be counted during work.
4. Tools and equipment can be operated in the same way from year to year.
5. It is possible to work at night or in dirt with precision.
6. The system is not affected by wind.
7. An additional recorder can store field information to be used in making a map.





2. Sensor Technologies

Various technologies - electromagnetic, conductivity, photo-electricity, ultrasound- are used to measure humidity, vegetation, temperature, vapour, air etc. Remote sensing data are used to: distinguish crop species, locate stress conditions, discover pests and weeds and monitor drought, soil and plant conditions. Sensors enable the collection of immense quantities of data without laboratory analysis.

The specific uses of sensor technologies in farm operations are as follows:

1. Sense soil characteristics: Texture, structure, physical character, humidity, nutrient level and presence of clay.
2. Sense colours to understand conditions relating to: Plant population, water shortage and plant nutrients.
3. Monitor yield: Crop yield and crop humidity.
4. Variable rate system: To monitor the migration of fertilizers and discover weed invasion.

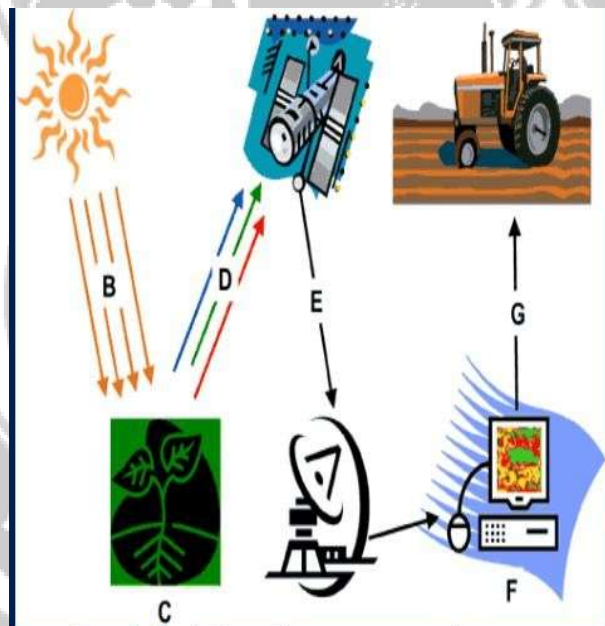
3. Geographic Information System (GIS)

Use of GIS began in 1960. This system comprises hardware, software and procedures designed to support the compilation, storage, retrieval and analysis of feature attributes and location data to produce maps. GIS links information in one place so that it can be extrapolated when needed. Computerized GIS maps are different from conventional maps and contain various layers of information (yield, soil survey maps, rainfall, crops, soil nutrient levels and pests). GIS helps convert digital information to a form that can be recognized and used. Digital images are analyzed to produce a digital information map of the land use and vegetation cover. GIS is a kind of computerized map, but its real role is using statistics and spatial methods to analyze characters and geography. Further information is extrapolated from the analysis. A farming

GIS database can provide information on: field topography, soil types, surface drainage, subsurface drainage, soil testing, irrigation, chemical application rates and crop yield. Once analyzed, this information is used to understand the relationships between the various elements affecting a crop on a specific site.

4. Remote Sensing

- Remote sensing has been used in soil mapping, terrain analysis, crop stress, yield mapping and estimation of soil organic matter, but on a scale larger
- Than what is required for precision agriculture.
- Remote sensing at high resolution can be of great use in precision farming because of its capacity to monitor the spatial variability.
- The role of satellite remote sensing in PF is to acquire spatially- and temporally-distributed information to identify and analyze crop and soil variability within fields.



5. Variable-Rate Technologies (VRT)

Variable rate technologies (VRT) are automatic and may be applied to numerous farming operations. The VRT systems set the rate of delivery of farm inputs depending on the soil type noted in a soil map. Information extrapolated from the GIS can control processes, such as seeding, fertilizer and pesticide application and herbicide selection and application, at a variable (appropriate) rate in the right place at the right time. The VRT is perhaps the most widely used PFS technology.

6. Grain Yield monitors For Mapping

A monitor mounted on a combine continuously measures and records the flow of grain in the grain elevator. When linked with a GPS receiver, yield monitors can provide data for a yield map that helps farmers to determine the sound management of inputs, such as fertilizer, lime, seed, pesticides, tillage and irrigation.