

Precision Farming

- Precision farming is also known as Precision Agriculture, Prescription farming, variable rate technology.
- It is considered as the vibrant agricultural system of the 21st century, as it symbolizes the better balance between reliance on traditional knowledge as well as information and management intensive technologies.
- Professor **Pierre C. Robert** is considered as the **Father of Precision farming**.
- It refers to the **precise application of agricultural inputs with respect to soil, weather and crop need in order to improve productivity, quality, and profitability in agriculture.**

- It is a modern agriculture practice involving the use of technology in agriculture like remote sensing, GPS and Geographical Information System (GIS) for improving productivity and profitability.
- It enables farmers to use crop inputs more efficiently including pesticides, fertilizers, tillage and irrigation water.
- More effective utilization of inputs will bring in more crop yield and quality without polluting the environment and will result in sustainable agriculture and sustainable development.
- It basically means adding the right amount of input at the right time and the right location within the field.

Importance of Precision Farming

- Improve crop yield
- Provide information to make better management decisions
- Reduce chemical and fertilizer costs through more efficient application
- Provide more accurate farm records
- Increase profit margin
- Reduce pollution.

Advantages of precision farming

- It will enhance agricultural productivity and prevent soil degradation in cultivable land resulting in sustained agricultural development.
- It will reduce excessive chemical usage in crop production.
- Water resources will be utilized efficiently under the precision farming.
- GPS allows agricultural fields to be surveyed with ease. Moreover, the yield and soil characteristics can also be mapped.

- Dissemination of information about agricultural practices to improve quality, quantity and reduced cost of production in agricultural crops.
- It will minimize the risk to the environment particularly with respect to the nitrate leaching and groundwater contamination by means of the optimization of agro-chemical products.
- Non-uniform fields can be sub-divided into smaller plots based on their unique requirements.
- It provides opportunities for better resource management and hence reduce wastage of resources

Disadvantages of precision farming

- High capital costs may discourage farmers to not adopt this method of farming.
- Precision agriculture techniques are still under development and requires expert advice before actual implementation.
- It may take several years before the actual collection of sufficient data to fully implement the system.
- It is an extremely difficult task particularly the collection and analysis of data.

Elements/Components of Precision Farming

A. Information or data base

Soil: Texture, Structure, Physical condition, Moisture, Nutrients *etc.*

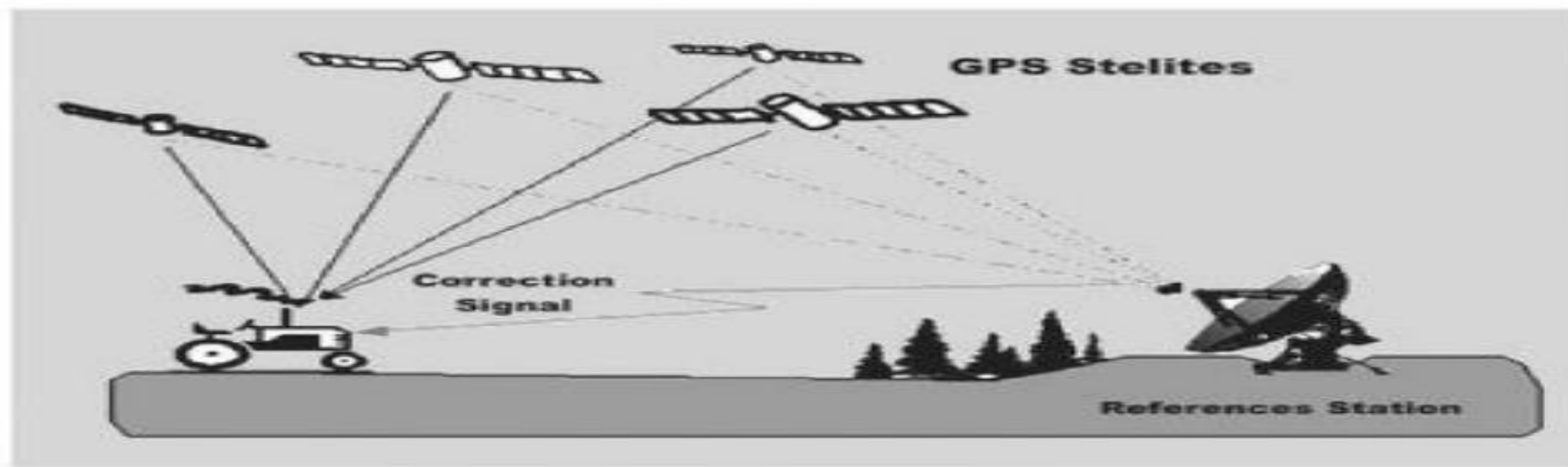
Crop: Plant Population, Plant Tissue Nutrient Analysis Status, Crop Stress, Weed patches (weed type and intensity), Insect or fungal infestation (species and intensity), Crop yield, Harvest Swath Width *etc.*

Climate: Temperature, humidity, rainfall, solar radiation, wind velocity *etc.*

Field variability (spatially or temporally), soil related properties, crop characteristics, weed and insect-pests population, and harvest data are important data bases for realizing the potential of precision farming.

B. Technology

Precision farming deals primarily with understanding the variability of field and its management over time and space. Precision farming includes a variety of tools of hardware, software and equipments like Global Positioning System (GPS), Differential Global Positioning System (DGPS), Geographic information systems (GIS), Remote sensing, Sensors, Variable Rate Applicator, yield mapping technology/yield monitors, Computer system *etc.* for variability assessment and its management in the field.



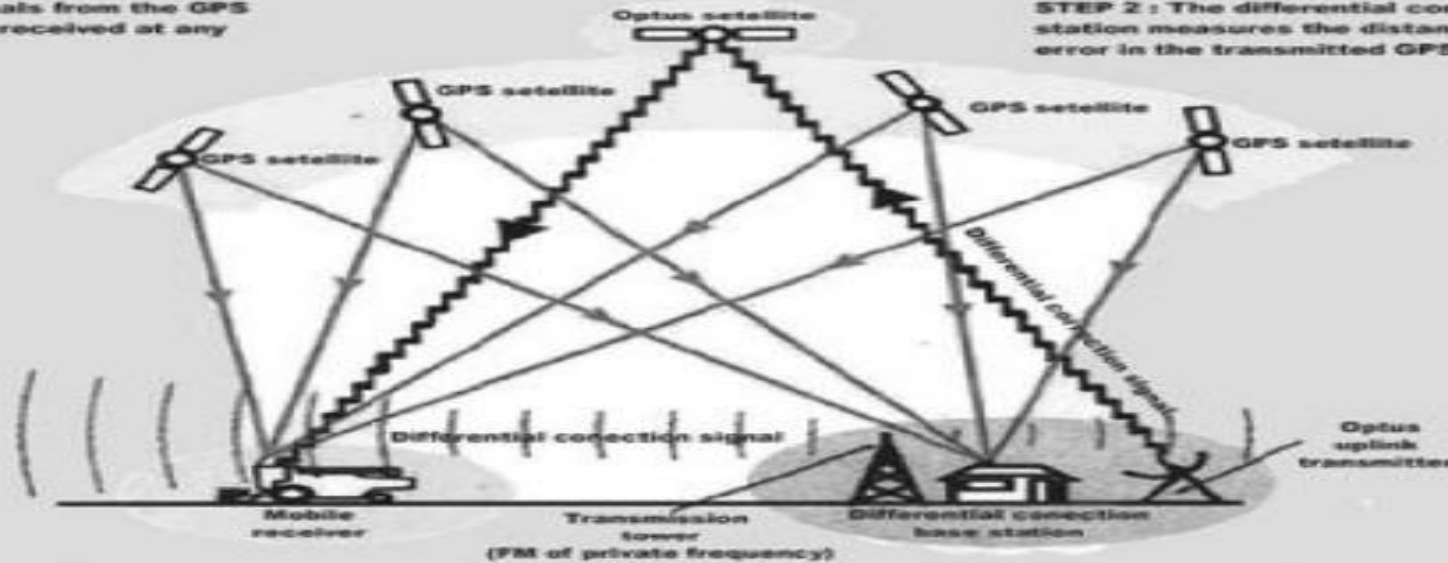
Global Positioning System

1. **Global Positioning System (GPS):** GPS makes available continuous position (location) information in real time, while in motion. Positioning system works with the help of different constellations of satellites and developments of such different positioning systems are the main technological interventions bringing precision farming concept into reality. GPS receivers can directly be carried to the field or mounted on implements that allow users to return to specific locations to sample or treat such areas and helps to allow mapping of soil and crop measurements at any time. GPS provides accurate positioning system for field implementation of variable rate technology. It helps to manage application of inputs by equipments and identify the precise location of farm equipment within specific positions of the field for precision application of fertilizers and pesticides to the soil-plant characteristics. GPS receiver with electronic yield monitors is generally used to collect yield data across the land in precise way. Global positioning systems (GPS) are widely used for mapping yields (GPS + combine yield monitor), variable rate planting (GPS + variable rate planting system), variable rate fertilizer application (GPS + variable rate controller), field mapping for records and insurance purposes (GPS + mapping software) and parallel swathing (GPS + navigation tool).

How a differential GPS System works

STEP 1 : The signals from the GPS Satellites can be received at any point on Earth.

STEP 2 : The differential correction base station measures the distance of the error in the transmitted GPS position.

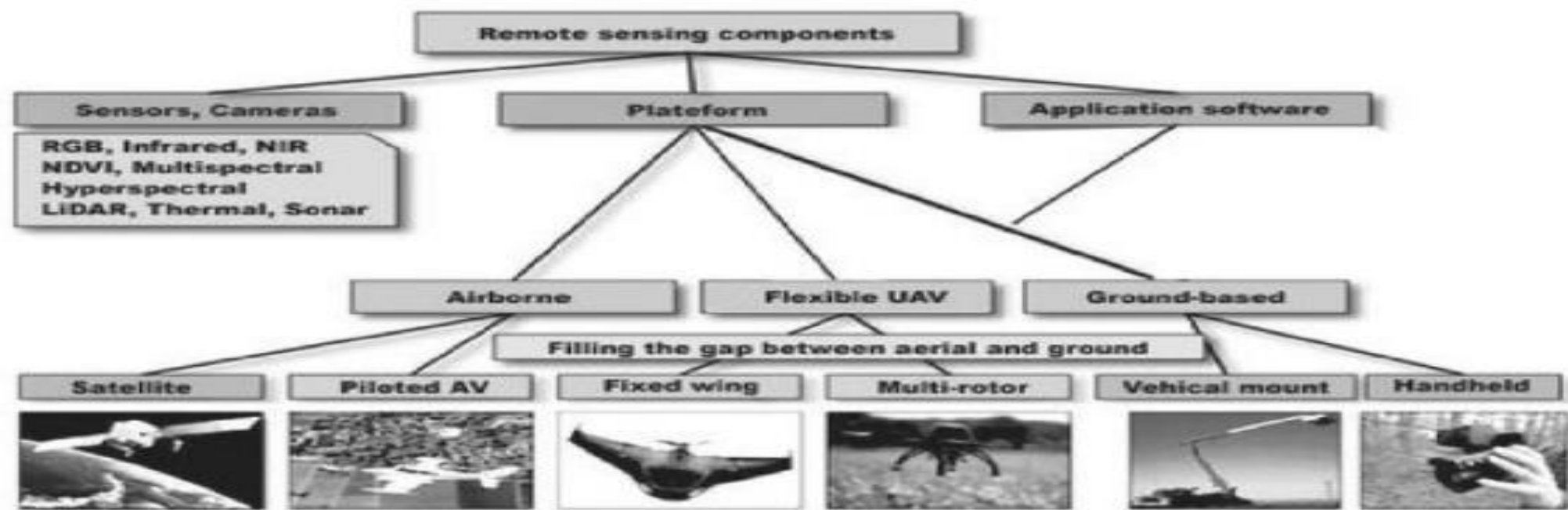


STEP 3 : The amount of the error is transmitted from the base station to the mobile receiver. This differential correction signal can be by satellite (Such as Optus) or a radio broadcast (such as ABC FM or a private base station using VHF or UHF)

STEP 4 : The mobile receiver also has a GPS receiver and it uses that position and the differential correction signal to calculate a more accurate position (usually accurate to 1 to 3 metres).

Differential Global Positioning System

- 2. Differential Global Positioning System (DGPS):** Differential Global Positioning System is a technique to improve GPS accuracy that uses pseudo range errors measured at a known location to improve the measurements made by other GPS receivers within the same geographic area. DGPS makes use of a series of satellites that identify the location of farm equipment within inches of an actual site in the field. The knowledge of a precise location helps to compare different locations of soil samples and the laboratory results in a soil map, thus enable to prescribe fertilizers and pesticides to fit well to soil properties like clay and organic matter content and soil conditions (relief and drainage). Various tillage adjustments can be made with the help of information generated through this system. The system also allows monitoring and recording yield data as one goes across the field. The systematic working of DGPS is shown in picture below.



Remote Sensing

4. **Remote Sensing:** Remote sensing refers to the collection of data from a distance with the help of sensors, which can simply be hand held devices, mounted on aircraft or satellite. Remotely sensed data provide a tool for evaluating crop health and plant stress in relation to moisture, nutrients, soil compactness, plant insect-pests and diseases, and other plant health concerns oftenly and easily detected in overhead images. Remote sensing can reveal and analyze seasonal variability affecting crop yield and can be helpful to make timely management decisions to improve profitability for the current crop. Remotely sensed data obtained either by aircraft or satellite containing electromagnetic emittance and reflectance data of a crop can provide information useful for soil condition, plant growth, weed infestation *etc.* This type of information is cost effective and can be very useful for site-specific crop management programmes.

Sensors: Remote sensors are generally categorized as aerial or satellite sensors that can provide instant maps of field characteristics. An aerial photograph is an example of optical sensor that can show variations in field colour corresponding to the changes in soil type, crop development, field boundaries, roads, water *etc.* Both aerial and satellite imagery can also be processed to provide vegetative indices reflecting plant health. Sensors are used to determine crop stress, soil properties, pest incidence *etc.* These can also be used to measure soil and crop properties as the tractor passes over the field, as a scout goes over the field on foot or as an airplane or satellite photographs the field from sky. Yield monitors are the primary sensing system that makes measurements. Commercial sensing systems are available that claim to measure soil properties and make changes in application rate.

Sensors can also be carried by a scout to the field and used to sense the health of plants and soil properties. These use light reflectance on leaves to determine chlorophyll levels, which directly correlate nitrogen levels in the plant proportionally to the chlorophyll production. Several soil chemistry mini kits sensors are also available to measure soil pH, EC, nitrogen, potassium, phosphorus *etc.* directly in the field.



6. **Variable Rate Applicator:** The variable rate applicator has three components namely computer controller, locator and actuator. A computer system mounted on a variable rate applicator uses the application map and a GPS receiver to direct a product delivery system that changes the amount and/or kind of product according to the application map *e.g.* Combine harvesters with yield monitors. Two methods are generally used for variable rate applications *viz.*, first one is map based on historical data (previous or present year) that help the process control technologies to draw information from the GIS (prescription maps) and adjust fertilizer application, seeding and pesticide selection and application rate, thus providing proper management of the inputs. The second method uses sensors that can adjust the applications rates of equipments by detecting some characteristics of plants or

- 7. Yield Mapping Technology:** Yield is an ultimate indicator of variations of different agronomic/horticultural parameters in different parts within a field. So, mapping of yield and its interpretation, and correlation of this map with the spatial and temporal variability of different crop parameters help in developing management strategy for successive season of a crop. Present yield monitors measure the volume or mass flow rate to generate periodical record of quantity of crop harvested during that time period and then, periodic yield data is synchronized with location obtained from onboard GPS system to create most common colour coded thematic map. Yield mapping can be carried out easily in mechanized crops, for example, loading cells weigh the crop passing on a conveying belt or an array of sonic beam mounted over the grape discharge chute to estimate the volume and the tonnage of fruit harvested. Radio-frequency identification (RFID) or bar code tags on the bins have also been used for yield mapping in which a weighing machine is combined with a tag reader and a GPS to record the weight and the place of each bin. The data collected are used to produce yield maps of the orchard.
- 8. Computer System:** Precision farming requires the acquisition, management, analysis and output of large amount of spatial and temporal data generated for a specific field. Computer software has now become better with time and the knowledge needed for managing variability and decision making on the field can be generated via such softwares to execute management strategies.

Applications of Precision Farming



Drip Irrigation



Fertigation



1. **Water Management:** Drip irrigation, sprinkler irrigation and fertigation are the important applications in precision farming for water management.
 - a. **Drip Irrigation:** It is a regulated or slow application of irrigation water through emitters at frequent interval around crop rhizosphere over a period of time. It saves about 50-70% water, reduces labour and energy cost and has almost negligible weeds problem.
 - b. **Sprinkler Irrigation:** Water is sprayed into the air and allowed to fall on the ground surface somewhat resembling to rainfall. The spray is regulated by the flow of water under pressure through small nozzles.
 - c. **Fertigation:** Application of water soluble fertilizers with irrigation water to the crop, which provide nutrients directly to the active root zone, less likely to be lost thus minimizing the wastage of expensive nutrients and ultimately helps in improving productivity and quality of produce.
2. **Surface Covered Cultivation:**
 - a. **Mulching:** It is used to reduce or increase the temperature, suppress weed growth and conserve soil moisture.
 - b. **Soil Solarization:** It is a method of heating up the soil by covering with transparent polythene sheets during hot periods to control soil-borne pathogens.
3. **Controlled Environmental Condition:** It includes greenhouse, polyhouse, grow tunnels, shade net houses *etc.* which are framed structures covered with a transparent or translucent material designed to provide protection against climatic fluctuations and create congenial environment for growth and development of crops.
4. **Organic Farming:** It uses natural and biodegradable inputs which deliberately avoids the use of synthetic fertilizers/ or chemicals *etc.* It mainly includes the use of vermicompost, manures, bio-fertilizers, animal husbandry, green manures, biological management and crop rotation *etc.*

5. Precise Space Utilization:

- a. **High Density Planting (HDP):** HDP is a system of planting more number of plants than the optimum or normal through manipulation of tree architecture. Different methods like genetically dwarf scion cultivars, dwarfing rootstock, training and pruning, use of growth retardants are generally adopted to manage the size of plants to fit well under HDP.
- b. **Meadow Orcharding:** It is also known as ultra high density planting system which accommodates 20000-100000 plants/ha which is literally called as grassland. In order to maintain tree form, severe top pruning is practiced similar to mowing of grassland.

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High Density Planting (HDP)

6. **Micro Propagation:** It refers to the production of plant from very small plant parts, tissues or cells (explants) grown aseptically in a test tube or containers under controlled environment.
7. **Integrated Pest Management (IPM):** A pest management strategy which involves different components such as use of resistant varieties, managing the natural predators, adopting cultural practices, physical, mechanical, biological, curative methods and judicious application of pesticides to minimize pest population to a state below threshold level thereby avoiding economic injury to plants.
8. **Integrated Nutrient Management (INM):** It involves application of nutrients from organic as well as inorganic sources with the aim of improving physico-chemical and biological properties of the soil.
9. **Vegetable Grafting:** It is a technique of uniting two plants, one which is horticulturally superior and has susceptibility or less tolerance against biotic/abiotic stresses, is used as scion and second with tolerance/resistance against biotic/abiotic stresses is used rootstock. Though, improvement work in vegetables crops has produced so many horticulturally superior varieties in the country and worldwide, however production constricts like soil-borne pathogens are difficult to address through breeding approaches owing to the complexity of inheritance for such traits. Sometimes, crossing barriers between different sources of resistance or tolerance make it impossible to transfer desirable genes into a crop of interest. Under such situations, vegetable grafting proves to be a potential alternative technique to mitigate various biotic and abiotic problems like nematodes, root rots, salinity, flooding *etc.*

Laser Land Leveling

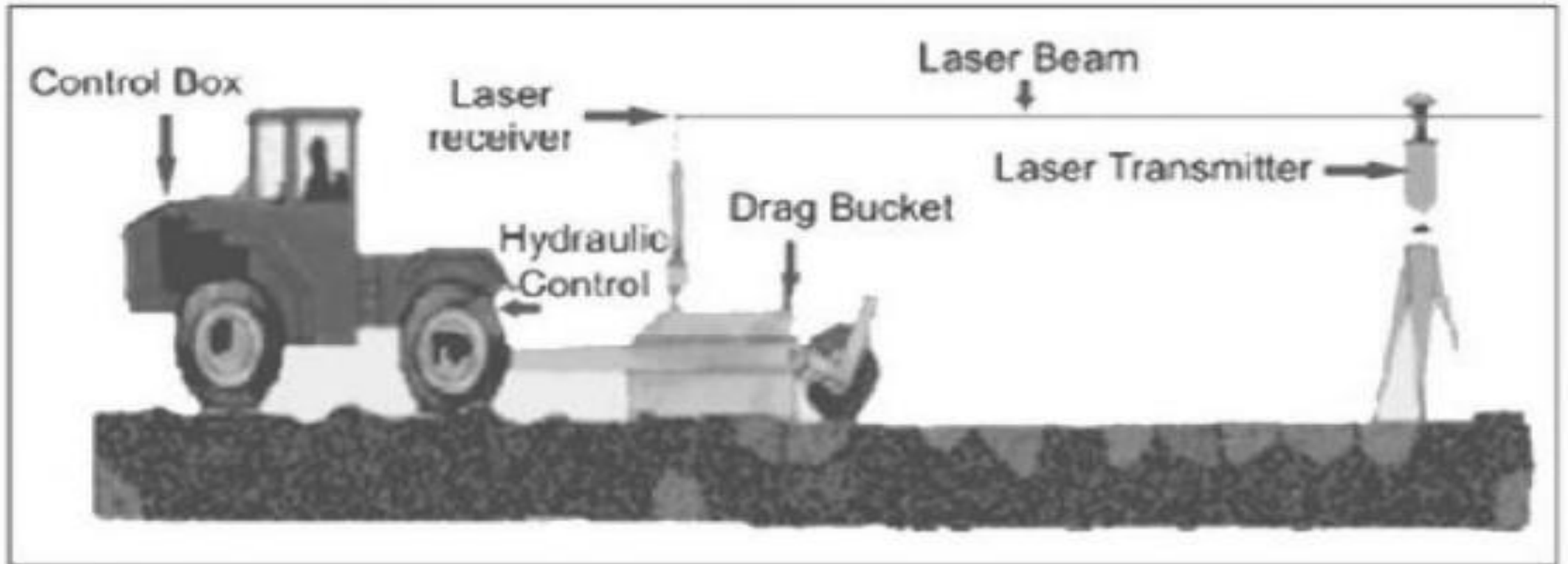
- Land leveling is a precursor to good agronomic, soil and crop management practices.
- Resource conserving technologies perform better on well levelled and laid out fields.
- Effective land levelling is meant to optimize water use efficiency, improve crop establishment, reduce weed problem, improve uniformity of crop maturity, reduce the irrigation interval and effort required to manage crop with significant effect on yield.
- There are two types of methods used for levelling the land; Manual and Mechanized.
- Laser land levelling refers to the levelling of field within certain degree of desired slope using a guided laser beam throughout the field.

Benefits of Precise Land Leveling

- Reduce weed problems in the field.
- Assist soil top management
- Save labour costs
- Save electricity used in irrigation
- Reduces the amount of water required for land preparation
- Totally automatic (less load on operator)
- Effective land levelling reduces the work in crop establishment and crop management, and increases the yield and quality.
- Improves uniformity of crop maturity.
- Reduction in seed rates, fertilizer, chemicals and fuel used in cultural operations.

Limitations

- High cost of the equipment's / laser instruments
- Requires skilled personals to set/ adjust laser settings and operate the tractor.



Working Principle of laser land leveling

Major components and connectivity of a Laser Leveling System

1. Tractor
2. Drag Bucket
3. Laser Transmitter
4. Laser receiver
5. Control panel
6. Hydraulic control system

Other equipment's/ tools may be needed while using laser system for topographic surveying and these are:

Tape, Staff (metric), Compass, Pegs/ Hammer, Book, Pencil/ Eraser.