OBJECTIVES OF AGRO 3612 (THEORY)

GEO-INFORMATIC, NANOTECHNOLOGY AND PRECISION AGRICULTURE

1. n accurate application of agriculture inputs for crop growth considering relevant factors such as soil, weather and crop management practices is **Precision Farming**

2. **Precision agriculture:** It is actually information and technology based farming system where inputs are managed and distributed on a site-specific basis for long-term benefits.

3. Precision Farming within field also referred as **Site-Specific Crop Management (SSCM)**

4. What is need/objectives of studying this concept?

- Aims at optimizing profitability & protecting environment:
- To minimize wide gap between potential yield and actual yield:
- Resources needs for crop growth and protection needs are met at right time, right place, right quantity and by right method.

5. What are tools/technologies used in precision agriculture?

1. Global positioning system(GPS)
2. Sensors & Remote sensing
3. Geographical information system(GIS)
4. Soil testing
5. Yield monitoring
6. Variable rate technology(VRT)

6. What are steps to be followed in precision farming?

1. Identification and assessment of variability
2. Management of variability

7. What are techniques of identification and assessment of variability

1. Grid soil sampling
2. Yield map
3. Crop scouting
4. Use of precision technologies for assessing variability

8. The goal of grid sampling is to generate a map of nutrient/water requirement called a**n application map.**

9. What are the techniques of management of variability in precision farming

1. Variable rate application
2. Yield monitoring and mapping
3. Quantifying on farm variability
4. Flexibility

10. What are concerns for Precision Farming in Indian agriculture

- Small land holding
- Heterogeneity of cropping systems and market imperfections
- Complexity of tools and techniques requiring new skills
- Lack of technical expertise knowledge and technology
- Infrastructure and institutional constraints including market imperfections
- High cost

11. What are Steps to be taken for implementing Precision Farming in India

- Creation of multidisciplinary teams
- Formation of farmers co-operatives
- Government legislation
- Pilot study
- Creating awareness about bad effects of excess input/resource use

12. What is meaning of 'geo' in geoinformatics

- Earth's surface'

13. What is meaning of 'informatics' in geoinformatics

- Fact about something

14. "**Geo-informatics** is combination of technology and science dealing with spatial information, its acquisition, its qualification and classification, its processing and storage and dissemination.

15. "**Agro-geoinformation** is branch of geoinformatics the science & technology about handling digital agro-geoinformation such as Collecting, processing, storing, archieving, preservation, retrieving, transmitting, acessing,visualisation, analysing, synthesising, presenting and disseminating agro-geoinformation."

16. What are tools and techniques used in geo-informatics ?

- Remote sensing(RS)
- Digital Catography & Photogrammetry
- Global Positioning system(GPS)
- Geographical information system(GIS)
- Automated data capture systems.

17. Remote sensing involves the aquisition of spatial data of the environment without physical contact with the objects or features sensed by using electromagnetic energy radiation, interaction and detected principles in analogue or digital formats.

18. Digital Catography principles involve map, map design and map visualization and production in analogue or digital computer environment.

19. Photogrammetry principles involve the art and scienfic process of obtaining reliable information about the physical environment by interpreting remotely sensed aerospace data (aerial photographs and satellite imageries) in analogue or digital formats.

20. Global positioning system (GPS) involve precise surveying by applying resection and satellite constellation principles and the presentation of the results in analogue or digital formats.

21. Geographic information system (GIS) involve data gathering, data processing, database management, data modelling and visualization in a digital environment.

22. Automated data capture systems Include multispectral remote sensing process, GPS data, map digitisation and scanning and computer input and output technologies

23. Use of remote sensing to identify variability in different crops, as per their growth features by using spatial as well as spectral resolution images is called Crop discrimination:

24. Different crops show distinct phenological characteristics and timings according to their nature of gernimation, tillering, flowering , boll formation, ripening etc. This variability is called **features.**

25. Feature extraction is a process of defining image characteristics which effectively provides meaningful information for image interpretation or classification.

26. Feature in which feel, appearance or consistency of a surface or a substance can be described is called **Texture.**

27. Features in which act, process or manner of weaving parts into whole is called as **Contexture.**

28. Features in which there is study of shape and relative arrangement of something is called as **Geometry.**

29. Ultimate **goals of feature extraction** are.

- Effectiveness and efficiency in classification
- Avoiding redundancy of data
- Identifying useful spatial as well as spectral features
- Maximizing the pattern discrimination

30. Full form of **NVI** is Narrowband Vegetation Indices

31. Band selection is important step in **hyperspectral remote sensing**

32. Which are Vegetation properties measured with Hyperspectral vegetation indices ?

1. Structural
2. Biochemical
3. Plant physiological and stress indices

33. Structural properties measured with hyperspectral vegetation indices.

- Fractional cover,
- Green leaf biomass,
- Leaf area Index(LAI),
- Senescened biomass and
- Fraction absorbed Photosynthetically Active Radiation(FPAR)

34. Biochemical properties mesured with hyperspectral vegetation indices are.

- Water,
- Pigments (chlorophyll, carotenoid, anthocyanins),
- other nitrogen rich compounds (proteins)
- Plant structural materials (Lignin and cellulose)

35. Physiochemical and stress indices measured with hyperspectral vegetation indices are.

- Measures delicate changes due to a stress-induced change in the state of....
- Xanthophyll's,
- Chlorophyll content,
- Fluorescense or change in leaf moisture

36. Full form of NDVI: **Normalised Difference Vegetation Index**

37. Full form of ARVI: **Atmospherically Resistant Vegetation Index**

38. Full form of EVI: **Enhanced Vegetation Index**

39. Full form of SGI: **Sum Green Index**

40. Full form of RENDVI : **Red Edge Normalised Difference Vegetation Index**

41. Full form of VREI : **Vogelmenn Red Edge Index**

42. Full form of SIPI: **Structure Intensive Pigment Index**

43. Full form of PRI : **Photochemical Reflectance Index**

44. Full form of DWSI: **Disease Water Stress Index**

45. Yield prediction is estimation of crop yield well before the harvest.

46. Which are Methods of yield monitoring/predicting

- Aerial photography
- Multispectral scanners
- Radar
- Satellite data

47. Full form of **RADAR** is Radio Detection and Ranging

48 Full form of **IRS** is Indian Remote Sensing Satellite

49. **Soil map** is a geographical representation showing diversity of soil types and/or soil properties in the area of intrest.

50 Soil maps are of **different scale** varies from **1:1million to 1:4000**.

51. The ratio of a distance on the map to the corresponding distance on the ground is called as **Scale of map.**

52. Soil map of scale **1:1million** is used for macro level planning at **national level**

53. Soil map of scale **1:2,50,000** is used for agriculture uses, at **regional or state level**

54. **Soil map of scale 1:50,000 is used for** planning resources conservation and optimum land use at District level.

55. **Soil map of scale 1:8000 to 1:4000 is used for** degraded lands, eroded soils, waterlogged areas, jhum lands at Field level.

56. What are methods of soil mapping ?

- Aerial photographs
- Multispectral satellite data

57. Methods of fertilizer recommendation is done using geospatial data ?

- Soil cum plant analysis based SSNM
- Plant analysis based SSNM

58. **Site specific nutrient management** is based on the indigenous nutrient supply from the soil and nutrient demand of the crop for achieving targeted yield.

59. What are the **Five steps** in assessing nutrient requirement using **SSNM approach.**

1. Selection of the yield goal
2. Assessment of crop nutrient requirement
3. Estimation of indigenous nutrient supplies
4. Computation of nutrient rates
5. Dyanamic adjustment of N rates

60. **Ymax** is defined as "the maximum possible grain yield limited only by climatic conditions of the site, where there are no other factors limiting crop growth"

61. A **yield goal** exceeding **70-80percent** of variety specific potential yield(Ymax) has to be chosen in yield target method of management.

62. **Indigenous Nutrient Supplies is the** total amount of a particular nutrient that is available to the crop from the soil during the cropping cycle, when other nutrients are non-limiting.

63. Full form of **LCC** is leaf color chart.

64. **Spatial data** represents the location, size and shape of an object on planet Earth such as a building, lake, mountain or township.

65. Spatial data is described using **raster** and **vector** models.

66. Descrete features point, bore hole lineare orads rivers, sales teriories river catchments is represented using **Vector model.**

67. Raster model is used for study of continuous features like **soil types**

68. **GIS (Geographical Information System)** Is a computer based tool for mapping and analysing thing that exist and events that happen on earth."

69. Applications of spatial data in GIS are

- Perform geographic queries and analysis
- Improve organisational integration
- Make better decision
- Making maps

70. **Remote sensing** is the art and science of gathering information about objects or areas from a distance without having physical contact with objects of area being investigated

71. What are elements/components of remote sensing ?

- Energy source
- Atmosphere
- Target
- Sensor
- Transmission
- Interpretation
- Application

72. Remote Sensing platforms used for studying spatial data are grouped into 3 platforms which are.

1. Ground based: Infrared thermometer, Spectral radiometer, Pilot-Balloons and Radars
2. Air based: Aircrafts
3. Space based: Satellite

73. What are different types of satellites?

- Polar orbiting satellites (At an altitude: 550 to 1,600 km)
- E.g. LANDSAT (USA), SPOT (FRANCE), and IRS (INDIA)
- **Geostationary satellite (**Altitude: 36,000 km)
- INSAT series (INSAT-3A was launched on 10th April, 2003.)

74. **Indian Space Research Organisation (ISRO)** as the nodal agency for establishing an operation remote sensing system in the country.

75. Advantages of satellite Remote sensing

- Synoptic view
- Receptivity
- Coverage

76. **Digital Image processing** is the application of a set of techniques and algorithms to a digital image to analyze, enhance, or optimize image characteristics such as sharpness and contrast.

77. What are processes involved in image processing ?

1. Processes involved
2. Pre-processing
3. Image enhancement
4. Image classification
5. Spatial feature extraction
6. Measurement of biogeophysical parameters
7. Use of GIS

78. **Ground Control Points** (GCPs) are defined as points on the surface of the earth of known location used to geo-reference Landsat Level-1 imagery.

79. **Standard correction procedures** in image processing include

- Radiometric correction:- for uneven sensor response over whole image
- Geometric correction:- for geometric distortion due to earth's rotation

80. Image enhancement is done by Visual appearance of objects improved by **grey level stretching & Examing image histograms:**

81. Picture elements or pixels have assigned digital numerical value called as **digital number(DN)** Which in remote sensing relates to Brightness of cell...or brightness of given colour

82.. Image classification involves two types which are

- Supervised classification
- Unsupervised classification

83. Supervised classification is also known as User classification

84. Spectral features of known land covers are extracted from image called **training areas.**

85. in Unsupervised classification of image Each class of land covers is reffered to as a theme and the product of classification is known as a thematic map.

86. Image interpretation is an act of examining images for the purpose of identifying objects and judging their significance.

87. Image interpretaton elements includes shape, size, shadow,Tone/colour, Texture, Pattern, association, site, resolution.

88. Shape refers to the general form, configuration or outline of an individual object.

89. Tone is the measure of the intensity of the reflected or emitted radiation of the objects of the terrain.

90. Texture refers to the frequency of tonal variation in an image and is produced by an aggregate unit of features which may be too small to be clearly discerned individually on the image.

91. Pattern:- Pattern refers to the spatial arrangement of the objects.

92. Association :- Association refers to the occurrence of certain features in relation to others objects in the imagery.

93. Site :- Site refers to topographic or geographic location

94. GPS (Global Positioning System) is a global navigation system that uses satellites, a receiver and algorithms to provide location, velocity and time synchronization for air, sea and land travel.

95. What are components of GPS ?

1. GPS Ground control stations
2. GPS Satellites
3. GPS Recievers

96. Atleast **Three** satellite signals to determine our exact position on the earth's surface

97. **GPS satellite constellation** is desingned in such a manner as to guarantee that at least four satellites are visible from any place on earth at any moment in time.

98. What are functions of GPS ?

- Giving locations
- Point to point navigation
- Plot navigation
- Keeping track of your track
- Timing
- Mapping
- Control

99. **Simulation** is a technique for studying real-world dynamical systems by imitating their behaviour using a mathematical model of the system implemented on a digital computer.

100. Types of simulations

- Continuous simulation & Discrete simulation

101. **Agricultural models** are mathematical equations that represent the reactions that occur within the plant and the interactions between the plant and its environment

102. Input data requirement for crop modeling can be grouped into following

1. Weather data
2. Crop data
3. Soil data crop management data
4. Pest data

103. **Crop modeling** is useful is uses can be discussed under three broad groups

1. As research tools
2. As crop management tools
3. As policy analysis tools

Crop model	Use
SLAM II	Forage harvesting operation
SPICE	Whole plant water flow
MODVEX	Model developement and validation system
IRRIGATE	Irrigation scheduling model
COTTAM	Cotton

APSIM	Modelling framework for a range of crops
GWM	Geral weed modell in row crops
CropSysts	Wheat and other crops
SIMCOM	Crop and economics
DSSAT	Framework of crop simulation models including modules of CERES, CROPGRO and CROPSIM
WAVE	Water and agrochemicals
AUSCANE	Sugarcane, potential & water stress conditions.

104. STCR **(Soil Test Crop Response):** It is concept of application of fertilizer nutrients based on soil testing reports and crop performance or yield performance data.

105. In STCR apporach nutrient contribution from which sources is considered

- Soil fertility (available nutrients based on soil tests)
- Added fertilizers
- Added organic manures

106. The goal of grid sampling is to generate a map of nutrient/water requirement called an **application map.**

107. In STCR Approach formula for calculating Nutrient requirement (NR)

$$= \frac{\text{Total nutrient uptake by grain \& straw (kg/ha)}}{\text{Grain yield(q/ha)}}$$

Soil Efficiency (SE)

$$= \frac{\text{Total nutrient uptake in control (Kg/ha)} \times 100}{\text{Soil test value in control (Kg/ha)}}$$

108. Nanotechnology is considered as **6th industrial revolution.**

109. Word 'nano' is a greek word which means **'dwarf'**

110. 1 nm= **10^{-9}m (billionth of a meter)**

111. Human DNA is closest to nm scale 1DNA is about **2nm.**

112. Buckyball is carbon compound is about **1nm scale.**

113. **Technology** is sum of techniques, skills, methods and processes used in the production of goods or services or in accomplishment of objectives such as scientific investigation

114. **Nanotechnology** is the understanding and control of matter at dimensions between 1 and 100 nanometers (nm), where unique phenomenon enable novel applications"

115. **ichard Feynman** stated a famous statement "**There's Plenty of Room at bottom"** in 1959 for which he got Nobel prize for his contribution in 1965.

116. In 1974, **Norio Taniguchi:** Coined the **term Nanotechnology.**

117. in **1981** IBM developes **Scanning Tunneling Microscope**

118. In 1985 scientists at Rice University discoverd a Bucky ball : fullrene C_{60}

119. In 1991 : **Carbon nanotube** : by **S. Lijima**

120. In 2000 : **National Nanotechnology Initiative** in US (NNI)

121. Which approaches are used to develope nano particles ?

- Bottom up approach
- Top-down approach

122. In **Bottom up approach** material and devises are built from molecular components and which assemble themselves chemically by principles of molecular recognition. e. g. DNA

123. **Top-down approach,** Nano objects are constructed from larger entities without atomic level control.

124. Tools used in Top down apporach of synthesizing nano particles are

- Scanning probe microscope
- Atomic Force Microscope**(AFM)**
- Scanning Tunneling Microcope**(STM)**

125. Tools used in bottom up apporach of synthesizing nano particles are

- Chemical synthesis
- Self assembly and positional assembly
- Molecular Beam Epitasy (MBE)

126. Three major physical properties of nanoparticle are

1. Highly mobile in free state
2. Enormous specific surface area
3. Exhibit what are known as quantum effects

127. What are nanoscale effects ?

1. Number of mechanical, electrical, optical, Electronic properties of solids are altered with reduction in particle size. It occurs because of Quantum size effects.

Phenomenon change at nanoscale	Material
Opaque substances become tranasperant	**Copper**
Stable materials turn combustible	**Aluminium**
Solids turn into liquids at room temperature	**Gold**
Insulators become conductors	**Silicon**
Inert material turn reactive	**Gold**
Red or Purple colour	**Gold**

2. Adsoprtion matter on large surface area & Tunnelling

Size of cube side	Number of cubes	Collective surface area
0.0^{-9} (1nm)	10^{27} (1 billion)	$6x10^9$ m^2 = **$6000km^3$**

128. Nano-particles : Ultrafine unit with dimensions measured in nanometers

129. Nano formulations available are

- Nano emulsion
- Nano capsule
- Metal nanoparticle in a polymer formulation

130. Materials used for synthesis of nanoparticles

Inorganic materials	Organic Materials
Metal oxides such as ZnO, TiO2, MgO, AgO	Carbon nanotubes, Lipids Polymers

131. Importance of these materials

- **Increasing solubility** of poorly soluble active ingredient
- **Releasing** active ingredient **slowely** or targeted manner
- **Protecting** active ingredient **against fast degradation**

132. Applications of nanotechnology in agriculture

1. **Crop protection** by using Nanopesticides formalations
2. **precision farming** by using Nanobiosensors
3. **Stress tolerance** by using Nanoparticles
4. **Soil enhancement** by using Nanoclays and Nano-zeolites
5. Nanotechnology application in **crop improvement** by using Nanobiotechnology

133. Products using Nano particles in agriculture

- Nano pesticide/Nano fungicide/ Nano herbicide
- Nano-fertilizer
- Nano sensors
- Zeolites and Nano-clays

Examples of Nanopesticides

Polymer	**Active compound**	**Nonmaterial**
Lignin-polyethylene Glycol-ethylcellulose	**Imidacloprid**	**Capsule**
Polyethylene	Piperonyl Deltamethrin	Capsule
Carboxymethylcellulose	**Carbaryl**	**Capsule**
Alginate-glutaraldehyde	Neem seed oil Imidacloprid	Clay
Polyamide	**Pheromones**	**Fiber**
Lignin	Aldicarb Imidacloprid Cyromazine	Granules
Polyetheleneglycol-dimethyl esters	**Carbofuran**	**Micelle**
Poly (methyl methacrylate)	**Carbofuran**	**Suspension**
Chitosan-poly(lactide) Polyvinylchloride	Imidacloprid Chlorpyrifos	Particle

134. **Nanofertilizers :** Are nutrient carriers of nanodimension ranging from 30-40 nm capable of holding bountiful of nutrient ions due to their high surface area and release it slowly and steadily

135. **Nano zeolites & Nanoclays :** Are naturally occuring minerals with a honeycomb-like layered crystal structure

136. **Nano sensors** are biological, chemical or surgical sensory points used to convey information about nanoparticles to macroscopic world

137. Use of nano sensors

- Capable of detecting very small amounts of contaminanants, Nutrients & Pests
- Capable of detecting Stress caused by drought, temperature and Nutrients deficiencies or pathogen presence.

138. Use of nanotechnology in seed

1. **Detecting pollen load**, to prevent pollen from genetically, modified crop from contaminating field crops.
2. **Disease spread** can be eleminated.
3. Smart seed can be **programmed to germinate when adequate moisture is available**
4. To **determine ageing of seeds** are some possible thrust areas of research.

139. Nanotechnology in water use

1. Water purification
2. Detection of contaminants in water samples.
3. It can be used for removal of sediments, chemical effluents, charged particles, bacteria and other pathogens.
4. Remove negatively charged contaminants such as virus, bacteria and organic and inorganic colloids at a faster rate than conventional filters.