Model Answers
MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD PUNE
SEMESTER END THEORY EXAMINATION
B.Sc. (Hons.) Agriculture

Semester	: VI (New)	Term : II	Academic Year : 2023-2024
Course No.	: AGRO-3612	Title : Geo-informatics, Nano-technology and Precision Farming.	
Credits	: 2(1+1)		
Day & Date	:	Time :	Total Marks : 40

Note:
1. Solve **ANY EIGHT** questions from SECTION "A".
2. All questions from **SECTION "B"** are **compulsory.**
3. All questions carry equal marks.
4. Draw neat diagrams wherever necessary.

SECTION "A"

Q.1 Describe precision farming with its component. (4 M)

Ans: Precision farming may be defined as an accurate application of agricultural inputs for crop growth, considering relevant factors such as soil, weather and crop management practices. It is actually information and technology based farming system where inputs are managed and distributed on a site-specific basis for long-term benefits.

Precision farming basically depends on measurement and understanding of variability. Main components of precision farming system must address the variability. Precision farming is a farm management concept based on modern information technologies.

Components of precision farming include:

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

Q.2. Discuss the practical difficulties of precision farming in Indian agriculture? (4 M)

Ans: Precision agriculture has been mostly confined to developed countries.Limitations for its implementation in developing countries like India are:

1.Small land holdings.
2.Heterogeneity of cropping systems and market imperfections.
3.Complexity of tools and techniques requiring new skills.
4.Lack of technical expertise knowledge and technology (India spends only 0.3 per cent of its agricultural GDP in research and development).
5.Infrastructure and institutional constraints including market imperfections.
6.High cost.

In India, major problem is the small field size. **More than 58 per cent** of operational holding:, in the country have size less than 1 ha. Only in the states of Punjab, Rajasthan, Haryana and Gujarat more than 20 per cent of agricultural lands have operational holding size of more than 4 ha. There is scope of implementing precision agriculture for crops like, rice and wheat especially in the states of Punjab and Haryana. Commercial as well as horticultural crops show a wider scope for precision agriculture.

Q.3 Define GIS and describe major component of GIS? (5M)

Ans: Geographic information system is another informatics technique that is quite relevant in agricultural development. There are numerous definitions of geographic information systems in the literature. For our purpose geographic information system **can be defined as a system for capturing, storing, checking, manipulating, analysing and displaying data, which are spatially referenced to the earth.** Thus, a true geographic information system is designed to accept, organise, statistically analyse and display diverse types of spatial information that are geographically referenced to a common coordinate system of a particular projection and scale.

Geographic information system comprises **five major components** and three main subsystems. Main components of geographic information systems are:

1. **The hardware** which include a host computer, data acquisition device(s) such as digitiser, scanner, digital image processing system, digital theodolite, analytical and digital photogrammetric plotter and output device(s) such as plotter, printer, high resolution screen among others.
2. **The spatial database,** containing the objects of interest, including the objects' geometric (position and spatial relationships) and thematic data in structured form.
3. **Software** for the acquisition, manipulation and management of data in the database.
4. **Procedures** (conventions and algorithms to guide its operations).
5. **Expertise** in terms of skilled human operators.

Q.4 Elaborate the importance of GIS in agriculture. (4M)

Ans: The importance of GIS in agriculture is as follow.

1.Perform geographic queries mid analysis: The ability of GISs to search databases and perform geographic queries has saved many companies literally millions of dollars. GISs have helped reduce costs by:

Streamlining customer service.
Reducing land acquisition costs through better analysis.
Reducing fleet maintenance costs through better logistics.
Analysing data quickly,

2.Improve organisational integration: Many organisations that have implemented GIS have found that one of its main benefits is improved management of their own organisation and resources. Because GISs have the ability to link data sets together by geography, they facilitate interdepartmental information sharing, and communication. By creating a shared database, one department can benefit from the work of another data can be collected once and used many times.

3.Make better decisions: The old adage "better information leads to better decisions" is as true for GIS as it is for other information systems. A GIS, however, is not an automated decision making system but a tool lo query, analyse and map data in support of the decision making process. The GIS technology has been used to assist in tasks such as presenting information at a planning inquiries, helping resolve territorial disputes and siting pylons in such a way as to minimise visual intrusion.

The GIS can be used to help reach a decision about the location of a new housing development that has minimal environmental impact, is located in a low-risk area and is close to a population canter. The information can be presented succinctly and clearly in the form of a map and accompanying report, allowing decision makers to focus on the real issues rather than trying to understand the data. Because (GIS products can be produced quickly, multiple scenarios can be evaluated efficiently and effectively.

4.Making maps: Maps have a special place in GIS. The process of making maps with GIS is much more flexible than are traditional manual or automated cartography approaches. It begins with database creation. Existing paper maps can be digitised and computer-compatible information can be translated into the GIS. The GIS-based cartographic database can be both continuous and scale free.

This allows the creation of map products which are cantered on any location, at any scale and showing selected information symbolised effectively to highlight specific characteristics.

Q.5 Elaborate the components and significance of GPS? (4M)

Ans: Global positioning system (GPS) is a satellite-based navigation system, consisting of more than 20 satellites and several supporting ground facilities, which provides accurate, three-dimensional position, velocity and time, 24 hours a day, everywhere in the world and in all weather conditions.The global positioning system consists of three main components.

Basic components of global positioning include:

I. GPS ground control stations.
II. GPS satellites.
III. GPS receivers.

GPS Ground Control Stations

The ground control component includes the master control station at Falcon Air Force. Base Colorado Springs; Colorado and monitor stations at Falcon AFB, Hawaii, Ascension Island In (the, Atlantic, Diego Garcia in the Indian Ocean and Kwajalein Island in the South Pacific. The control segment uses measurements collected by the monitor stations to predict the behaviour of each satellite's orbit and atomic clocks. Prediction data is linked up to the satellites for transmission to users. The control segment also ensures that GPS satellite orbits remain within limits and that the satellites do not drift too far from nominal orbits.

GPS Satellites

The space segment includes the satellites and the delta rockets that launch the satellites from Cape Canaveral in Florida, United States. GPS satellites orbit in circular orbits at 17440 kin altitudes, each orbit lasting 12 hours. The orbits are tilted to the equator by 55A° to ENSURE Coverage in Polar Regions. The satellites are powered by solar cells to continually orientate themselves to point the solar panels towards the sun and the antennas towards the earth.Each satellite contain four atomic clocks.

GPS Receivers

The ground stations send control signals to the GPS satellites. The GPS satellites transmit radio signals and the GPS receivers, receive these signals and use it to calculate its position.

Calculations used to determine your GPS receiver's position is based on very small time differences, from when the satellite transmitted the signal to when the GPS receiver received the signal. These small differences are then used to calculate the distance from the receiver in the satellite. However, when receiving only one signal, we can only calculate how far away from the satellite we are. When receiving two signals, we can determine two likely positions where we are. We need three satellite signals to determine our exact position on the earth's surface (2D/2 dimensional positioning). When more than three satellites are 'visible' to the GPS receiver, it will also calculate the altitude of the receiver (3D/3 dimensional positioning).

The GPS receiver requires signals from at least three satellites to determine your unique position on the earth's surface. With a fourth signal, altitude can also be determined. Receiving signals from more than four different satellites, the position of the GPS receiver can more accurately be determined.

The GPS satellite constellation is designed in such a manner as to guarantee that at least four satellites are visible from any place on earth at any moment in time. **Most of the time (+95%) however**, we should have at least **six satellites visible.** Many commercial GPS receivers can receive and process signals from **12 satellites** for increased reliability and accuracy.

Q.6 What is image processing and interpretation of remote sensing images? (4M)

Ans: Image processing and interpretation/analysis can be defined as the "act of examining images for the purpose of identifying objects and judging their significance" Image analyst study the remotely sensed data and attempt through logical process in detecting, identifying, classifying, measuring and evaluating the significance of physical and cultural objects, their patterns and spatial relationship, Some procedures commonly used in analysing/interpreting remote sensing images are briefly presented.

1.Pre-processing.
2.Image enhancement.
3.Image classification.
4.Spatial feature extraction.
5.Measurement of biogeophysical parameters.
6.Geographical information system.

Q.7 In which situation simulations can be used? (4M)

Ans: There are several situations in which simulations can be used as indicated below:

1.Study internals of a complex system e.g. biological system.
2.Optimise an existing design e.g. routing algorithms, assembly line.
3.Examine effect of environmental changes e.g. weather forecasting.
4.System is dangerous or destructive e.g. atom bomb,atomic reactor, missile launching.
5.Study importance of variables.
6.Verify analytic solutions (theories).
7.Test new designs or policies.
8.Impossible to observe/influence/build the system.
9.When it allows inspection of system internals that might not otherwise be observable.
10.Observation of the simulation gives insights into system behaviour.
11.System parameters can be adjusted in the simulation model allowing assessment of their sensitivity (scale of impact on overall system behaviour).
12.Simulation verifies analysis of a complex system or can be used as a teaching tool to provide insight into analytical techniques.
13.A simulator can be used for instruction, avoiding tying up or damaging an expensive, actual system (e.g. a flight simulation vs. use of multi-million dollar aircraft).

Q.8 Enlist any eight crop models as reported in recent literature. (4M)

Ans: Some crop models reported in recent literature include :

Software	Details
SLAM II	Forage harvesting operation
SPICE	Whole plant water flow
REALSOY	Soybean
IRRIGATE	Irrigation scheduling model
COTTAM	Cotton
APSIM	Modelling framework for a range of crops
GWM	General weed model in row crops
GOSSYM-COMAX	Cotton
CropSyst	Wheat and other crops
SIMCOM	Crop (CERES crop modules) and economics
TUBERPRO	Potato and disease
SIMPOTATO	Potato
WOFOST	Wheat and maize, Water and nutrient
WAVE	Water and agrochemicals
SUCROS	Crop models
ORYZA1	Rice, water

SIMRIW	Rice, water
CERES-Rice	Rice, water
EPIC	Erosion Productivity Impact Calculator
CERES	Series of crop simulation models
DSSAT	Framework of crop simulation models including modules of CERES, CROPGRO, CROPSIM
PERFECT QCANE	Sugarcane, potential conditions
AUSCANE	Sugarcane,potential and water stress conds.,erosion
CANEGRO	Sugarcane, potential and water stress conds.
APSIM-Sugarcane	Sugarcane,potential growth, water and nitrogen stress

Q.9 Write in brief about role of nanotechnology in plant protection. (4M)

Ans: 1) Currently spraying of pesticides involves either knapsacks that deliver large droplets (9-66 um) associated with splash loss or ultra light volume sprayers for controlled droplet application (CDA) with smaller droplets (3-28 um) causing spray drift. Constraints due to droplet size may be overcome by using NP encapsulated or nanosized pesticides that will contribute to efficient spraying and reduction of spray drift and splash losses.

2)Another practical problem faced during pesticide application in the field is settlement of formulation components in the spray tank and clogging of spray nozzles. Recent nanosized fungicide (100 nm, BannerM AXX, Syngent) prevented spray tank filters from clogging, did not required mixing and did not settle down in the spray tank due to the smaller sized particles. Furthermore, this fungicide did not separate from water for up to one year due to nanosize, whereas fungicides that contained larger particle size ingredients typically required agitation every two hours to prevent clogging in the tank.

3)Persistence of pesticides in the initial stage of crop growth helps in bringing down the pest population below the economic threshold level and to have an effective control for a longer period. a nanotechnology approach, namely nanoencapsulations can be used to improve the insecticidal value.

4) Nanoencapsulations comprises nanosised particles of the active ingredients being sealed by a thin-walled sac or shell (protective coating). Nanoencapsulation of insecticides, fungicides or nematicides will help in producing a formulation which offers effective control of pests while preventing accumulation of residues in soil. In order to protect, the active ingredient from degradation and to increase persistence, a nanotechnology approach of controlled release of the active ingredient may be used to improve effectiveness of the formulation that may greatly decrease amount of pesticide input and associated environmental hazards.

5)Nanopesticides will reduce the rate of application because the quantity of product actually being effective is at least 10-15 times smaller than that applied with classical formulations, hence much smaller than the normal amount could be required to have much better and prolonged management. Several pesticides manufactures are developing pesticides encapsulated in nanoparticles.

6)Clay nanotubes (halloysite) have been developed as carriers of pesticides at low cost, for extended release and better contact with plants and they will reduce amount of pesticides by 70-80 per cent, thereby reducing the cost of pesticides with minimum impact on water streams.

Q. 10 Write short notes on (Any Two) (4M)

a) ~~1.~~ **Yield monitoring**

Estimation of crop yield well-before the harvest at regional and national scale is imperative for planning at micro-level and predominantly the demand for crop insurance. Currently, it is being, done by extensive field surveys and crop cutting experimentation. In most of the developing countries, the crop yield estimation is, generally, based on traditional methods of data collection which is based on ground based field surveys.

Conventional methods have been found to be expensive, time consuming and are prone to large errors due to incomplete and inaccurate ground observations leading to deprived crop area estimations and crop yield assessment. In most of the developing countries, required data is, generally, available too late for any appropriate decision making. Different approaches and technologies used for crop inventory are briefly presented.

b) ~~2~~.**Nanofertilizers:**

Nanofertilizers are nutrient carriers of nanodimensions ranging from 30 to 40 nm (10^{-9} m or one billionth of a meter) capable of holding bountiful of nutrient ions due to their high surface area and release it slowly and steadily that commensurate with crop demand.These fertilizers can be used to control the release of nutrients from the fertilizer granules so as to improve nutrient use efficiency (NUE) while preventing nutrient ions from either getting fixed or lost in the environment.

As per the literature, it appears that nanofertilizers are more beneficial as compared to chemical fertilizers:

- Three-times increase in nutrient use efficiency (NUE).
- Around 80-100 times less requirement to chemical fertilizers.
- Nearly 10 times more stress tolerant by the crops.
- Complete bio-source, so eco-friendly.
- More nutrient mobilization by the plants.
- Aboutbl7-54 per cent improvement in the crop yield.
- Improvement in soil aggregation, moisture retention and carbon build up.

Nanoporous Zeolites, Encapsulation, nanoscale etc.

c) ~~3~~.**Nanotechnology In Weed Management**

Multi-species approach with single herbicide in the cropped environment resulted in poor control and herbicide resistance. Continuous exposure of plant community having mild susceptibility to herbicide in one season and different herbicide in other season develops resistance in due course and become uncontrollable through chemical. Developing a target specific herbicide molecule encapsulated with nanoparticles is aimed at specific receptor in the roots of target weeds, which enter into tools system and translocated to parts that inhibit glycolysis of food reserve in the root system, Tills will make the specific weed plant to starve for food and gets. One nanosurfactant based on soybean micelles has been reported to make glyphosate-resistant crops susceptible to glyphosate when it is applied with the 'nanotechnology-derived surfactant'.Excessive use of herbicides leave residue in the soil and cause damage to the succeeding crops. Continuous use of single herbicide leads to evolution of herbicide resistant weed species and shift in weed flora. Atrazine, an s-triazine-ring herbicide, is used globally for the control of pre-and post-emergence broadleaf and grassy weeds, which has high persistence (half life-125 "days) and mobility in some types of soils. Residual problems due to application of atrazine herbicide pose a threat towards widespread use of herbicide and limit the choice of crops in rotation. It appears that application of silver modified with nanoparticles of magnetite stabilized with Carboxy Methyl Cellulose (CMC) nanoparticles can degrade herbicide atrazine residue.

SECTION "B" (4M)

Q. 11. State True or False

1. Geodesy studies the shape of the earth and the determination of the exact position of Geographical points.
   Ans: True

2. The father of GIS is Roger Frank Tomlinson.

Ans: True

3. In precision farming high yield is obtained with high inputs.

Ans: False

4. Carboxy Methyl Cellulose (CMC) nanoparticles can not degrade/detixify herbicide atrazine residue.

Ans: False

Q. 12. Give abbreviation of the following. (1M)

1.	**DSSAT**	:	**Decision Support System for Agrotechnology Transfer**
2	**DGPS**	:	**Differential global positioning system**
3	**LCC**	:	**Leaf Colour Chart**
4	**NDVI**	:	**Normalized difference vegetation index**

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