



X. Suggested Reading

- Clay DE, Clay SA and Bruggeman SA. 2017. *Practical Mathematics for Precision Farming*. American Society of Agronomy, Madison, WI, USA.
- Ram T, Lohan SK, Singh R and Singh P. 2014. *Precision Farming: A New approach*. Astral International Pvt. Ltd., New Delhi, India. ISBN: ISBN 978-81-7035-827-5 (Hardbound) ISBN 978-93-5130-258-2 (International Edition).
- Shannon DK, Clay DE and Kitchen NR Newell. 2018. *Precision Agriculture Basics*. American Society of Agronomy, Inc., Madison, WI, USA.
- Singh AK and Chopra UK. 2007. *Geoinformatics Applications in Agriculture*. New India Publishing Agency, New Delhi, India.
- Van-Henten EJ, Goense D and Lokhorst C. (ed). 2009. *Precision Agriculture*. Wageningen Academic Publishers, Wageningen, Netherlands.

I. Course Title : Energy Conservation and Management in Production Agriculture

II. Course Code : FMPE 603

III. Credit Hours : 3+0

IV. Aim of the course

Detailed study of the hardware system used in precision agriculture (PA) and techniques of using them in precision agriculture.

V. Theory

Unit I

Global navigation satellite system (GNSS). Satellite ranging: Accuracy, standards, components of GIS, data layers, map component, attribute table component, function of a GIS, resolution. Data formats: Vector or raster. GIS for precision farming, data analysis, field calculator, convert to grid, interpolation, reclassification, image classification, band math, interpretation of analysis, farm management information systems, and crop intelligence.

Unit II

Yield Monitors: Components, Differential GPS Receiver, GNSS Receiver, mass flow sensors. Impact plates, measuring volume with a photoelectric sensor. Using microwave radiation, and Gamma rays to estimate volume, volumetric flow sensing and alternatives. Grain moisture sensor, fan speed sensor, elevator speed sensor, header position, yield monitor data, cotton yield monitors.

Unit III

Sources of soil variability, general soil sampling basics, systematic variability, selecting a soil sampling strategy. Parameters: Electrical conductivity, electromagnetic sensors, sensing mechanical impedance. Proximal plant sensing systems, crops canopy reflectance and fluorescence. Machine vision thermal sensors, mechanical sensors, acoustic sensors.

Unit IV

Remote sensing platforms: Aircraft or satellite. Sensors: Imaging or non imaging, active or passive. Making use of reflected energy or emitted energy. The spectral signature of vegetation, vegetation indices, application to agriculture, nutrient management, weed management, disease and insect management, water management.

VI. Practical

Simple programming for automating precision farming calculations. Mathematics of longitude and latitude. Spatial statistics, soil sampling and understanding soil testing results for precision farming, calculations. Supporting management zones, understanding soil, water and yield variability in precision farming. Developing prescriptive soil nutrient maps, essential plant nutrients, fertilizer sources, and application rates calculations. Deriving and using an equation to calculate economic optimum fertilizer and seeding rates cost of crop production.

VII. Learning outcome

Ability to understand design and operate PA systems.

VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Introduction	1
2.	Classification of energy	2
3.	Energy coefficients	2
4.	Energy requirements for wheat production	2
5.	Energy requirements for paddy production	2
6.	Energy requirements for maize production	2
7.	Energy requirements for cotton production	2
8.	Energy requirements for oil seeds production	1
9.	Energy requirements for pulse production	2
10.	Energy requirements for production of other crops	2
11.	Energy requirements for vegetable production	2
12.	Energy requirements for fruit production	1
13.	Energy requirements for fish production	1
14.	Energy requirements for meat and milk production	2
15.	Limits of energy conservation	1
16.	Energy planning, management and forecasting in agriculture	3
17.	Design of integrated energy supply system	2
18.	Energy conservation and returns	2
19.	Assessment of energy conservation technology	2
20.	Case studies on application of various techniques of energy conservation and management	2
	Total	36

IX. Suggested Reading

- Mittal JP, Panesar BS, Singh S, Singh CP and Mannan KD. 1987. *Energy in Production Agriculture and Food Processing*. ISAE and School of Energy Studies for Agriculture, PAU Ludhiana, ISAE Publication.
- Pimental D. 1980. *Handbook of Energy Utilization in Agriculture*. CRC Press. Boca Rotan, USA.
- Singh S and Singh RS. 2014. *Energy for Production Agriculture*. DKMA, ICAR, New Delhi, India.

I. Course Title : Mechanics of Tillage in Relation to Soil and Crop

II. Course Code : FMPE 604

III. Credit Hours : 2+1

IV. Aim of the course

To have deeper understanding of the tillage process in terms of crop requirement,