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,

soil characteristics and machinery function.

V. Theory

Unit I

Soil condition and soil strength determining factors. General aspects of mechanical behavior of soil elements. Soil compaction, conditions for its occurrence. Methods of estimation of soil compaction by experimental stress distribution. Concept of soil distortion, deformation at constant volume. Expansion of soil at breaking.

Unit II

Occurrence of soil breaking fundamentals. Measures of resistance against breaking. Shear failure and Coulomb's law. Compaction v/s shear failure. Tensile failure of soil, idealized brittle failure, Griffith's Model. Loading rate and repeated loading effects. Draft calculation using mechanism of rigid soil bodies.

Unit III

Crop requirements: Root structure, Soil conditions and purpose of tillage, looseness of soil and depth of loosening. Structure of seed bed. Soil properties, properties affected by tillage and those not affected by tillage. Soil compaction, formation of clods and dust. Effect of tillage on erosion and water logging. Impact of climate factors on soil. Tillage requirement for various types of soils.

Unit IV

Tillage operations for special tasks. Preparation of soil for cropping and stubble management. Primary and secondary tillage. Ploughing and its effect on soil. Disc tillage: Appropriate conditions and effect. Requirement of seed bed and techniques of creating proper seed bed. Quality of sowing and sowing methods. Modern trends and objectives of soil tillage.

Unit V

Plough bodies: Generalized representation, intake main flow and output process. Main flow under different surface curvatures. Kinetic aspects of plough bodies with different shapes. Draft of plough bodies as affected by moisture, speed and attachments.

VI. Practical

Characterization of soil condition before and after tillage. Cone penetrometer resistance, bulk density, moisture content. Measurement of forces on tillage tools under soil bin condition/ field condition. Measurement of soil manipulation by different tillage tools: Pulverization, furrow profile, inversion and mixing. Measurement of energy required for soil breakup by different methods. Field study of crop root development in relation to soil compaction and hard pan. Measurement of moisture movement in different surface configuration: Ridges, furrows, raised bed and flat bed. Field evaluation of plant establishment in relation to planting parameters.

VII. Learning outcome

Ability to design tillage machinery based on engineering principles as applied tom tillage science.

VIII. Lecture Schedule

S.No.	Topic	Lecture No
	Unit I	
1.	Soil condition and soil strength determining factors.	**1**
2.	General aspects of mechanical behavior of soil elements.	**1**
3.	Soil compaction, conditions for its occurrence.	**2**
4.	Methods of estimation of soil compaction by experimental stress distribution.	1
5.	Concept of soil distortion, deformation at constant volume.	1
6.	Expansion of soil at breaking.	1
	Unit II	
7.	Occurrence of soil breaking fundamentals.	1
8.	Measures of resistance against breaking.	1
9.	Shear failure and Coulomb's law.	1
10.	Compaction v/s shear failure.	1
11.	Tensile failure of soil, idealized brittle failure, Griffith's Model.	1
12.	Loading rate and repeated loading effects.	1
13.	Draft calculation using mechanism of rigid soil bodies.	1
	Unit III	
14.	Crop requirements: Root structure, Soil conditions and purpose of tillage, looseness of soil and depth of loosening.	1
15.	Structure of seed bed. Soil properties, properties affected by tillage and those not affected by tillage.	2
16.	Soil compaction, formation of clods and dust.	1
17.	Effect of tillage on erosion and water logging.	1
18.	Impact of climate factors on soil.	1
19.	Tillage requirement for various types of soils.	1
	Unit IV	
20.	Tillage operations for special tasks.	1
21.	Preparation of soil for cropping and stubble management.	1
22.	Primary and secondary tillage. Ploughing and its effect on soil.	1
23.	Disc tillage: Appropriate conditions and effect.	1
24.	Requirement of seed bed and techniques of creating proper seed bed.	1
25.	Quality of sowing and sowing methods.	1
26.	Modern trends and objectives of soil tillage.	1
	Unit V	
27.	Plough bodies: Generalized representation, intake main flow and output process.	1
28.	Main flow under different surface curvatures.	1
29.	Kinetic aspects of plough bodies with different shapes.	1
30.	Draft of plough bodies as affected by moisture, speed and attachments.	1
	Total	**32**

IX. List of Practicals

S.No.	Topic	No of Practicals
1.	Characterization of soil condition before and after tillage.	2
2.	Cone penetrometer resistance, bulk density, moisture content.	1
3.	Measurement of forces on tillage tools under soil bin condition/ field condition.	2
4.	Measurement of soil manipulation by different tillage tools: Pulverization, furrow profile, inversion and mixing.	2

S.No.	Topic	No. of Practicals
5.	Measurement of energy required for soil breakup by different methods.	2
6.	Field study of crop root development in relation to soil compaction and hard pan.	2
7.	Measurement of moisture movement in different surface configuration: Ridges, furrows, raised bed and flat bed.	2
8.	Field evaluation of plant establishment in relation to planting parameters.	1
	Total	**14**

X. Suggested Reading

- Birkas M. 2014. *Book of Soil Tillage*. Szent Istvan University Press, Godollo, Hungary. ISBN-978-963-269-447-4 (Unit III & IV).
- Koolen AJ and Kuipers H. 1983. *Agricultural Soil Mechanics*. Springer-Verlag. New York, USA. ISBN 13:978-3-642-69012-9 (Unit I, II, V).

I. Course Title : Mechanics of Traction and its Application

II. Course Code : FMPE 611

III. Credit Hours : 2+1

IV. Aim of the course

Learning techniques of modelling soil traction device interaction under different states of wheel and under different soil conditions by analytical and empirical method.

V. Theory

Unit I

Tractor performance in soft soils, operational states of wheel: Wismer and Luth. Path traced by point on tyre periphery. Rolling resistance, conditions of wheel soil interaction, theoretical prediction, work on soil deformation, Bekke's model, derivation of resistance offered by flat rigid plate on soft soil. Measurement of sinkage parameters. Soft wheel on soft surface and rigid wheel on soft surface. Empirical prediction of tractive force: Bekker's model, stress deformation relation in soil, analysis of tractive performance of tracks.

Unit II

Empirical modelling of tractor performance, tractive performance modelling and mobility number. Empirical models for rolling resistance and traction by Gee-Clough. Derivation of equations for drawbar pull and drawbar power.

Unit III

Rigid wheel systems. Rigid wheel at rest: Soil bearing capacity, contact pressure and sinkage. Rigid wheel at driving state: Ground reaction on rigid wheel during driving action, force balance in soil reaction to driving wheel, determination of driving force, compaction resistance and effective driving force. Energy equilibrium under driving wheel.

Unit IV

Wheel under braking state: Slip velocity and amount of slippage under braked