BASICS-I

2011-12

General Agriculture

for

ICAR'S JRF EXAM

Roop Singh Maitry, Panch Ram Mirjha & Pankaj Sinha

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For ICAR'S JRF Exams

(Based on Authorized and Current information)

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PREFACE

The competition in agricultural examination is increasing day by day as population is increasing. Therefore, now-a-days it is not easy job to get admission in any agricultural university for master degree especially through the ICAR's JRS exam. Along with big syllabus (looks short but its big) of JRF exam, higher completion makes it very tough. So, in this regards i am presenting this book to serve my junior plus friend for ICAR's JRF exam. The questions asked in ICAR' JRF entrance examination are genuine and very specially sieved by different types of intelligent and brilliant scientists. So, the competitors need to read lot of. Keeping all in view, I am tried to solve the problems of ALL FIGHTERS, by giving series of books on **"General Agriculture for ICAR's JRF Entrance Exam"**. It includes two part viz. BASIC-I, BASIC-II + Advance**. BASIC-I** covers only the syllabus of general agriculture for ICAR's JRF Entrance Exam given in prospectus of ICAR's JRF Entrance Exam-2011-12. It also includes the 8 years memory based question papers asked in ICAR's JRF Entrance Exam and the analysis on questions asking pattern. **Part-2 (BASIC-II + Advance)** covers additional part of general agriculture which can be asked but not given in syllabus. It also includes the advance information and facts that can be asked in ICAR's JRF Entrance Exam.

My own view on this book is to provide the readers the already cooked material for ICAR's JRF Entrance Exam so that they will get some relax by preparing notes. I found there is no such type of book specially made for ICAR's JRF Entrance Exam. Therefore, I have tried to compile this book.

Dear friends, I am just trying to help all of you, and to give some relax. I did my all efforts to make this book so convince with easy and feasible words. In this first edition, there may be some mistake in grammar, spelling and words formation. Please, you co-operate me to correct the material by sending me e-mail. After all, the objective of this book is to help each other. So readers are being apologized for their inconvenience.

Here, I would like to express my heartfelt thanks to the great person who taught me to do something for others. With the following his rules, I came to get all what I have today. I also thanks all who helped me to compile this book, especially to Mr. Panch Ram Mirjha, Mr. Pankaj Sinha, My college juniors and now class batch in IARI for his hard work to compile this. I am highly thankful to Mr. Sunil who always gave me good company and friendship. Finally, I wish to thank all the friends, who encouraged me to compile this book along with my all well wishers.

I dedicate this book to my father Late K. P. Maitry and whole family.

Author

RJ...

Dated: 11th Ferb., 2011

Roop Singh Maitry
IARI, New Delhi

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QUESTION PAPERS AND WRITING ANSWERS IN THE EXAMINATION

The examination shall have one question paper for each of the 20 major subject-groups, consisting of 150 multiple-choice, objective type questions, each with four options and also 10 cross-matching type questions, each having five sub-questions/pairings for every subject-group paper. In each subject-group, 150 multiple choice, objective type questions would be serially numbered from 1-150 whereas 10 cross-matching type questions would be serially numbered from 151-160. **Marking scheme**: Each correctly answered multiple-choice, objective type question will earn four marks whereas each correctly answered cross-matching type question will earn 5 marks (1 mark for each correct pairing) with a maximum of 650 marks for each major subject-group paper. For each incorrectly answered multiple-choice, objective type question, one mark would be deducted from the total score whereas for each incorrectly answered cross-matching type sub-question/pairing, 0.2 marks would be deducted from the total score. Question with no response indicated will not be awarded any mark and there will be no negative marking for that question. The candidates are advised not to attempt such questions in the OMR answer sheet, for which they are not sure of the correct answer. More than one answer indicated against a question will be deemed as incorrect answer and will invite negative marking.

Candidate will be required to choose the correct answer and mark in the OMR answer sheet by shading/ darkening the corresponding circle/bubble against the serial number of the question with HB pencil or with black ball-point pen at his/her choice.

General Agriculture Syllabi for ICAR'S All India Entrance Examination for Admission to Master Degree Programmes and ICAR-JRF (PGS) -2011-12

Code 01: MAJOR SUBJECT GROUP "A" - PLANT BIOTECHNOLOGY

Basic Sciences & General Agriculture: Importance of agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato, and mango. Major soils of India; role of NPK and their deficiency symptoms. General structure and function of cell organelles; mitosis and meiosis; Mendelian genetics. Elementary knowledge of growth, development, photosynthesis, respiration and transpiration; Elements of economic botany. General structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Organic farming; biofertilizers; biopesticides. Recombinant DNA technology; transgenic crops. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India. Elements of statistics.

Code 02: MAJOR SUBJECT GROUP "B" - PLANT SCIENCES

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato, potato and mango. Major soils of India, role of NPK and their deficiency symptoms. Structure and function of cell organelles; mitosis and meiosis; Mendelian genetics; elementary knowledge of photosynthesis; respiration, and transpiration; structure and functions of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management.

Code 03: MAJOR SUBJECT GROUP "C" - PHYSICAL SCIENCE

Importance of Agriculture in national perspective; basic principles of crop production, diversification, diversification of Agriculture, principle of nutrient and water management, package of practices for rice, wheat sorghum, maize, chickpea, pigeon pea, potato, sugarcane, groundnut, major vegetable crops. Role of essential plant nutrients, their deficiency symptoms and management options. Structure and function of plant cells, cell division, Basic concept of plant physiology relating to crop production- Biochemical compounds viz, carbohydrates, proteins, enzymes, fats, liquid vitamins and their function, developmental programmes relating to rural upliftment and livelihood security; organisational set up of agricultural education research and extension and future strategies for upgradation.

Code 04: MAJOR SUBJECT GROUP "D" - ENTOMOLOGY AND NEMATOLOGY

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato, cole crops, mango, grapes, banana, oilseeds other than groundnut, soybean and mustard. Major soils of India, role of NPK and their deficiency symptoms. Mendelian genetics; elementary knowledge of photosynthesis; respiration, and transpiration;
Major cropping systems (rice-wheat cropping, crop rotations, mixed cropping); soil degradation-soil salinity and acidity and management; some aspects of post-harvest technology; varietal improvement; importance of heterosis in crop production; crop protection principles in field and storage. Major insect pests and diseases of agricultural crops like rice, cotton, pulses, oilseed crops like groundnut, soybean and mustard, vegetables like tomato, cole crops; fruit crops like mango and banana and their management principles. Transgenic crops. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India; Elements of statistics.

Code 05: MAJOR SUBJECT GROUP "E" – AGRONOMY

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, rapeseed and mustard, potato. Major soils of India, role of NPK and their deficiency symptoms. Structure and function of cell organelles; mitosis and meiosis; Mendelian genetics: elementary knowledge of photosynthesis; respiration, photorespiration and transpiration; structure and functions of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Important rural development programmes in India; organisational set up of agricultural research, education and extension in India; Elements of statistics.

Code 06: MAJOR SUBJECT GROUP "F" - SOCIAL SCIENCES

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato and mango. Major soils of India, role of NPK and their deficiency symptoms. Structure and function of cell organelles, mitosis and meiosis; Mendelian genetics; elementary knowledge of photosynthesis; respiration, and transpiration; structure and functions of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Important rural development programmes in India; organisational set up of agricultural research, education and extension in India; Elements of statistics. Measures of central tendency and dispersion, regression and correlation; concept of probability, sampling techniques and tests of significance.

Code 07: MAJOR SUBJECT GROUP "G" - STATISTICAL SCIENCES

Agriculture: Importance of Agriculture/Forestry/Livestock in national economy. Basic principles of crop
production. Major diseases and pests of crops. Elementary principles of economics and agri-extension. Important rural development programmes in India. Organizational set up of Agricultural research, education and extension in India.

Code 08: MAJOR SUBJECT GROUP "H" – HORTICULTURE

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato and mango. Major soils of India, role of NPK and their deficiency symptoms. Structure and function of cell organelles; mitosis and meiosis; Mendelian genetics; elementary knowledge of photosynthesis; respiration, and transpiration; structure and functions of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India; Elements of statistics.

Code 09: MAJOR SUBJECT GROUP "J" - FORESTRY/AGROFORESTRY & SILVICULTURE

Importance of Agriculture/Forestry/Livestock in national economy. Basic principles of crop production. Important rural development programmes in India Elementary principles of economics and agri-extension. Organizational set up of Agricultural Research, education and extension in India. Major diseases and pests of crops. Elements of statistics.

Code 11: MAJOR SUBJECT GROUP "L" - WATER SCIENCE AND TECHNOLOGY

Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato and mango. Major soils of India, role of NPK and their deficiency symptoms. Structure and function of cell organelles; mitosis and meiosis; Mendelian genetics; elementary knowledge of photosynthesis; respiration, and transpiration; structure and functions of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Pests and diseases of major crops and their management, important rural

development programmes in India; organizational set up of agricultural research, education and extension in India.

Code 12: MAJOR SUBJECT GROUP "M" - HOME SCIENCE

Importance of agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato, and mango. Major soils of India; role of NPK and their deficiency symptoms. General structure and function of cell organelles; mitosis and meiosis; Mendelian genetics. Elementary knowledge of growth, development, photosynthesis, respiration and transpiration; Elements of economic botany. General structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins. Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Organic farming; biofertilizers; biopesticides. Recombinant DNA technology; transgenic crops. Natural Resources: forest, water, mineral, food, energy and land resources. Ecosystems. Biodiversity & its conservation. Environmental pollution. Environmental ethics. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India. Elements of Statistics.

ICAR'S JRF ENTRANCE EXAMS- 2003-04
General Agriculture (Memory based)

1. Which one of the following is not a legume crop?
   (A)Wheat (B) Peas
   (C) Beans (D) Groundnut
2. Total cultivated area in India is close to
   (A) 500 Mha (B) 400 Mha
   (C) 180 Mha (D) 60 Mha
3. Nitrogen deficiency in plants leads to
   (A) Chlolorosis (B) Excessive growth
   (C) Profuse flowering (D) Dark green colour
4. The two major races of rice are.
   (A) Europian and tropical (B) Indica and Japonica
   (C) Asiatic and American (D) Temperate and tropical
5. N:P:K requirement in legume is generally
   (A) 3:1:1 (B) 3:1:0
   (C) 1:2:2 (D) 4:2:1
6. Which of the following state has the largest geographical area
   (A) U.P. (B) Bihar
   (C) M.P. (D) Rajasthan
7. The highest production in terms of million tones per year in India is that of
   (A) Pulses (B) Groundnut
   (C) Potatoes (D) Sugarcane
8. Respiration in plant is essentially a process related to the following
   (A) Evaporation (B) Transpiration
   (C) Oxidation (D) None of these
9. Linkage between gene affects
   (A) Vernalization (B) Fertilization
   (C) Anaphase (D) Independent assortment
10. NPK are required in plant nutrition as
   (A) Trace element (B) Microelement
   (C) Micro nutrient (D) None essential
11. DNA contains following number of nitrogenous base
   (A)One (B) Two
   (C) Four (D) Ten
12. Animal and plant cell can be differentiated by
   (A) Conductivity (B) Size
   (C) Presence or absence of cell wall (D) Shape
13. In temperate countries, sugar is generally obtained from which of the following crops
   (A)Maple (B) sugar beet

(C) Wheat (D) Sugarcane

14. The idea of particulate nature of inheritance was given by
(A) Darwin (B) Mendel
(C) Jones (D) Bateson

15. Cultivated rice Oryza sativa has the following number of cromosomes
(A) 2n =32 (B) 2n =20
(C) 2n =24 (D) 2n =18

16. In the presence of sunlight CO_2 and H_2O (with the help of chlorophyll) and converted in to carbohydrate, this is known as
(A) Photosynthesis (B) Respiration
(C) Metabolism (D) Solar radiation

17. Soil productivity takes in to account the following
(A) Soil structure (B) Soil moisture
(C) Soil fertility (D) Soil fertility and productivity

18. If chromosome compliment of two diploid species is combined in one, the result species would be
(A) Amphidiploid (B) Haploid
(C) Monogenic (D) Polygenic

19. Alternate form of gene at the same locus are referred to as
(A) Allele (B) Plastid
(C) Dominant (D) Chromosome

20. Sequence of growing crops in a piece of land is known as
(A) Crop insurance (B) crop rotation
(C) Crop production (D) Crop management

21. India has to provide for its population
(A) 2 billion (B) 1 billion
(C) 600 million (D) 1 million

22. In diploid species generally a following number of the chromosomes are involved in the pollen mitosis
(A) 4n (B) 2n
(C) 1n (D) 3n

23. Sulphur fungicides can be freely used on all vegetable except the following
(A) Beans and peas (B) Okra
(C) Root vegetable (D) Cucurbits

24. Karnal bunt is a serious disease of
(A) Apple (B) Tomato
(C) Wheat (D) Mung

25. Zinc is required for the synthesis of
(A) Tryptophane (B) Sugar
(C) Fats (D) Proteins

26. Contour system of orchard planting is generally followed in
(A) Saline soils (B) U.P.
(C) Hills (D) Punjab

27. NARS refers to
(A) National Agricultural Research Streams
(B) National Agricultural ayurvedic System
(C) National Agricultural Review System
(D) National Agricultural Research System

28. Cryo-preservation is done in liquid nitrogen at a temperature of
(A) -196°C (B) 200°C
(C) 0 °C (D) 4°C

29. Crossing over during meiois results in
(A) Breaking linkage (B) Promoting linkage
(C)Help mutation (D) None of these

30. The simplest measure of variability in data set is
(A) Range (B) Mean
(C) Mode (D) Median

ICAR'S JRF ENTRANCE EXAMS- 2004-05
General Agriculture (Memory based)

1. *Triticum aestivum* is a
(A) **Hexaploid** (B) Diploid
(C) Tetraploid (D) Euploid

2. Gregor John Mendal worked on the crop
(A) Sweet Pea (B) Field pea
(C) Beans (D) **Garden pea**

3. t-test is applicable when the numbers of treatments are
(A) **2** (B) 6
(C) 8 (D) 12

4. The first Director General of ICAR
(A) **Dr. B. P. Paul** (B) Dr. R. S. Paroda
(C) Dr. M.S. Swaminathan (D) Dr. B. Vishwanath

5. Red and purple colour of maize (*Zea Mays*) is due to deficiency of
(A) Ca (B) N
(C) F (D) **P**

6. Geographical area of India is
(A) **328 Mha** (B) 148 Mha
(C) 428 Mha (D) 392 Mha

7. Most common method of irrigation in India is
(A) Border irrigation (B) **Check basin irrigation**
(C) Sprinkler irrigation (D) Drip irrigation

8. Global warming is attributed to increase in concentration of green house gases like
(A) CO_2 (B) CFCs
(C) CH_4 (D) **All of these**

9. The cropping intensity of India during 2004-05 is about
   (A) 125% (B) **135%**
   (C) 145% (D) 155%
10. The net gain of ATP during glycolysis is
   (A) 1 (B) 4
   (C) **2** (D) 8
11. The error degree of freedom for a RBD design with 10 treatments and 4 replications is
   (A) 20 (B) **27**
   (C) 40 (D) 36
12. Absorption of solute ions is regulated by
   (A) Nucleus wall (B) Cell organelles
   (C) Vacuoles (D) Plant cell membrane
13. One gram of glucose produces how much fat or oil
   (A) 0.25 g (B) 0.35 g
   (C) **0.45 g** (D) 0.32 g
14. Total number of State Agriculture University in India in the year 2004 was
   (A) 25 (B) 44
   (C) **34** (D) 30
15. Growth of plant towards light is called?
   (A) Phototropism (B) Photorespiration
   (C) Photocromatism (D) **Photoperiodism**
16. The CO_2 content of soil air is
   (A) 3% (B) **0.3** %
   (C) 0.03% (D) 0.003%
17. The C: N ratio of humus is
   (A) 20: 1 (B) 100: 1
   (C) **10: 1** (D) 400:1
18. Densest part of atmosphere strata is
   (A) **Troposphere** (B) Thermosphere
   (C) Stratosphere (D) Mesosphere
19. The plants which open their stomata during night for taking CO_4 are known as
   (A) C_3 (B) **CAM**
   (C) C_4 (D) All of above
20. Plants absorb phosphorus in the form of
   (A) **H_2PO_4** (B) PO_4
   (C) SSP (D) P
21. Principle of Experimental design is given by
   (A) **R A Fisher** (B) Wilcox
   (C) Cox and Cochran (D) WG Cochran
22. An acid derived from green leaves of chickpea prescribed for intestinal disorders is
   (A) Citric acid (B) Sulphuric acid
   (C) **Oxalic acid** (D) Prussic acid

23. Which one of the plant is the C_4 plant?
(A) **Maize** (B) Potato
(C) Pea (D) Papaya

24. Atmosphere extends above mean sea level to a height of about
(A) 160 km (B) **1600 km**
(C) 1600 meter (D) 1600 miles

25. Criteria for the essentiality of nutrients for plants was given by
(A) **Arnon** (B) Wilcox
(C) Liebig (D) None

26. The Oleoresin compounds occurs in
(A) Cotton (B) Maize
(C) **Chilli** (D) Ginger

27. The law of tolerance was introduced by
(A) Milvert (B) Shelford
(C) Hilaire (D) **Ear- net Haeckel**

28. End product of glycolysis is
(A) ATP (B) **Pyruvate**
(C) PEP (D) Glucose

29. Plants capable of growing in rocks crevices are called
(A) Calciphytes (B) Chosmophytes
(C) **Lithophytes** (D) Helophytes

30. Plant cells are connected with the help of
(A) **Plsmodesmata** (B) Cellwall
(C) Plasma membrane (D) Plasmoderma

ICAR'S JRF ENTRANCE EXAMS- 2005-06
General Agriculture (Memory based)

1. Saffron (kesar) belong to the family
(A) Apiaceae (B) Iridaceae
(C) Orchidaceae (D) Lauraceae

2. The 5- carbon compounds produced during dark reaction of photosynthesis is
(A) Ribose phosphate (B) Xylulose phosphate
(C) **Ribulose bis phosphate** (D) Seda heptulose phosphate

3. Most suitable design for experiment involving varying number of tillage and nitrogen levels is
(A) Latin square (B) RBD
(C) Strip plot (D) **Split plot**

4. In a RBD experiment having 9 treatments and 4 replications, the error degree of freedom will be
A) **24** (B) 32
(C) 27 D) 36

5. The plants with male and female flowers on different plants are called
(A) Dicot (B) Dichogamy
(C) Dicliny (D) **Dioecious**

6. The contribution of Agricultural sector to the gross domestic product (GDP) in India in the year 2004-05 has been nearly
(A) **25 %** (B) 45 %
(C) 35 % (D) 55 %

7. Which one of the following process results in release of energy ?
(A) Metabolism (B) **Catabolism**
(C) Anabolism (D) Physiology

8. Which one of the following element is a constituent of protoplasm?
(A) Sulphur (B) **Calcium**
(C) Iron (D) Potassium

9. Which one of the following element is mobile in plants but immobile in soil ?
(A) Sulphur (B) Zinc
(C) Boron (D) **Phosphorus**

10. Which of the following is non-climacteric fruit?
(A) Litchi (B) Mango
(C) Banana (D) **Apple**

11. Which of the following process is not takes place in evolution of plants?
(A) Crossing over (B) Mutation
(C) **Linkage** (D) Coupling

12. Solar constant is equal to (in cal/cm^2/min)
(A) **1.94** (B) 194
(C) 19.4 (D) 0.194

13. Khaira disease in rice is due to the deficiency of
(A) Boron (B) Mn
(C) S (D) **Zn**

14. Which one of the following is a C3 plant?
(A) **Wheat** (B) Maize
(C) Pearlmillet (D) Sorghum

15. Criteria for the essentiality of nutrients for plants was given by
(A) Arnon (B) Wilcox
(C) Liebig (D) None

16. Which one of the following is sulphur-containing amino acid?
(A) Tryptophan (B) **Cystine**
(C) Proline (D) Lysine

17. Horse latitude lies in between north and south latitudinal belt of equator
(A) 0 to 50 (B) **30 to 35**
(C) 20 to 250 (D) 10 to 15

18. The splitting up of water molecules in plant cells in the presence of sunlight is called
(A) Photophosphorylation (B) Photosynthesis
(C) **Photolysis** (D) Phosphorylation

19. What does the stomata open?
(I) When the guard cells are in flaccid condition
(ll) When there is an accumulation of K ions in the guard cells
(III) When water enters into the guard cells
(IV) When the water potential of guard cells is lower than that of adjacent cells
(A) **II, III and IV** I and IV (B) I and III
(C) (D) None

20. The number of Agro-climatic zones of India is
(A) 17 (B) 7
(C) 15 (D)**10**

21. Norin - dwarf gene was introduced in which cereal?
(A) **Wheat** (B) Oat
(C) Rice (D) Maize

22. The centre of origin of *Triticum aestivum* is
(A) Chilean centre (B) South Mexican centre
(C) **Mediterranean centre** (D) Near eastern region

23. Which state of India leads in area under wheat crop?
(A) Punjab (B) MP
(C) **UP** (D) Rajasthan

24. The process of use of microorganism to remove salts from soil is referred as
(A) Chelation (B) **Bioremediation**
(C) Oxidation (D)Phyto - remediation

25. Economic part of Isabgol is
(A) Leaf (B) **Seed and husk**
(C) Seed (D) Husk

26. Which part of the plant cell is known as power house?
(A) Golgi bodies (B) Ribosomes
(C) **Mitochondria** (D) Lysosomes

27. Which one of the following clay mineral has the highest CEC?
(A) **Vermiculite** (B) Montmorillonite
(C) Kaolinite (D) Illite

28. The light generated reducing power is
(A) ATP (B) **$NADPH_2$**
(C) $FADH_2$ (D) $NADH_2$

29. Under seventh approximation soil classification, the number of soil orders is
(A) 15 (B) 14
(C) 8 (D) **11**

30. The grand period of rainfall in India is
(A) Post monsoon (B) North-east monsoon
(C) Cold weather period (D) **South - west monsoon**

ICAR'S JRF ENTRANCE EXAMS- 2006-07

General Agriculture (Memory based)

1. Agroclimatic zones in India are
   (A) 18 (B) **15**
   (C) 20 (D) 17
2. Law of Minimum was given by
   (A) **Liebig** (B) Blackman
   (C) Shelford (D) Oement
3. Sulphur containing amino acid
   (A) Lysine (B) **Methionine**
   (C) Glutamine (D) Glycine
4. Contribution of agriculture in GDP is
   (A) 23% (B) 30%
   (C) 40% (D) 60%
5. The specific heat of water is
   (A) 0.5 Cal/g (B) 2 Cal/g
   (C) 1 **Cal/g** (D) 4 Cal/g
6. Disease caused by Zn deficiency is
   (A) **Khaira** (B) Mosaic
   (C) Die-back (D) Whip tail
7. Mat nursury is related to
   (A) Papaya (B) Tobacco
   (C) Rice (D) Wheat
8. ANOVA' was given by
   (A) AL. Bowley (B) Horace Secrist
   (C) R A Fisher (D) Karl Pearson
9. Karnal bunt is caused by
   (A) Albugo candida (B) **Nevosia indica**
   (C) Phytophthora infestans (D) None of these
10. Bonneville, Early Badger, Arkel are the improved varieties of
    (A) Frenchbean (B) **Pea**
    (C) Sunflower (D) Soybean
11. Most of the wheat varieties are
    (A) Quantitative long day plants (**B) Short day plants**
    (C) Day neutral (D) None of these
12. The simplest measure of variability in a data set is
    (A) Mean (B) **Range**
    (C) Median (D) Mode
13. The crop having the highest pesticide use is
    (A) **Cotton** (B) Oilseeds
    (C) Rice (D) Wheat
14. Double cross hybrid maize production technique was introduced by
    (A) G.H. Shull (B) Mendel

(C) **D.F.Jones** (D) E.M.East

15. 'Vertisol' is related to
    (A) Laterite soil (B) Red soil
    (C) Alluvial soil (D) **Black soil**
16. The square of standard deviation is
    (A) Coefficient of variance (B) Standard deviation
    (C) **Variance** (D) Mean deviation
17. The principle of making use of greater homogeneity in groups of experimental units reduce the experimental error is
    (A) **Local control** (B) Experiment
    (C) Replication (D) Experiment Error
18. Sugarcane inflorescence is
    (A) Racemose (B) **Spikejet**
    (C) Compound (D) Capitulum
19. Country having the maximum area of hybrid rice is
    (A) **China** (B) India
    (C) Indonesia (D) U.S.A.
20. Transgenic crop having maximum cultivated area in the world is
    (A) Maize (B) Rice
    (C) **Soybean** (D) Cotton
21. Rice grain is deficient in
    (A) **Lysine** (B) Alanine
    (C) Glycine (D) Isoleucine
22. An ideal type of rice with small, thick and erect leaf was proposed by
    (A) **Yoshida** (B) Tsunoda
    (C) Murata (D) Tanaka
23. Net cultivated area in India is
    (A) **143 Mha** (B) 150 Mha
    (C) 180 Mha (D) 328 Mha
24. Soil air contains CO_2 (%)
    (A) 0.03 (B) 2.50
    (C) **0.25** (D) 3.0
25. When the fertility gradient of the field is in two directions, the most appropriate experimental design is
    (A) CRD (B) RBD
    (C) Split (D) **LSD**
26. Biurate content in urea is
    (A) 1.5% (B) 4%
    (C) **2%** (D) 5%
27. Maximum productivity of sugarcane in India is
    (A) Punjab (B) Uttar Pradesh
    (C) Haryana (D) **Tamil Nadu**
28. Greenhouse gas having largest contribution to global warming

(A) **Carbon dioxide (60%)** (B) Nitrous oxide (5%)
(C) Methane (15%) (D) CFC

29. Non-edible plant suitable for biodiesel
(A) **Jatropa** (B) Castor
(C) Coconut (D) Rapeseed

30. Total geographical area of India is
(A) **328.9 Mha** (B) **328.9 ha**
(C) 328.9 sq.km (D) 328.9 Mile

ICAR'S JRF ENTRANCE EXAMS- 2007-08
General Agriculture (Memory based)

1. PAR (Photo-synthetically active radiation) is measured in
(A) Photon (B) Watts
(C) **Einstein** (D) Quantum

2. The study of relationship between properties and plant production is as
(A) Agronomy (B) Pedology
(C) **Edaphology** (D) Soil chemistry

3. Triticale is a cross between:
(A) **Wheat x Rye** (B) Wheat x Barley
(C) Barley x Oat (D) t x Oat

4. Maximum number of treatment accommodates in RBD without loss of efficiency is
(A) **20** (B) 60
(C) 40 (D) 10

5. Photo-respiration rate is highest in which group of plants?
(A) **C_3 plants** (B) CAM plants
(C) C_4 plants (D) None of these

6. The first maize hybrid in India was
(A) **Ganga-l** (B) Kisan
(C) Vijay (D) Vikram

7. Aflatoxin contamination generally found in
(A) Arher (B) **Groundnut**
(C) Chickpea (D) Soybean

8. Which crop is also known as white gold?
(A) Maize (B) Opium
(C) Soybean (D) **Cotton**

9. Required seed rate for raising tomato nursery is
(A) 1000 gm (B) 400 Kg
(C) **400 gm** (D) 2.0 Kg

10. In Indo-gangatic plains, rice-wheat cropping system covers about
(A) 5 m ha (B) **10** m ha
(C) 15 m ha (D) 20 m ha

11. Test between two population variance is done by
(A) **F - test** (B) Z test
(C) t – test (D) Arithmetic mean
12. Which test is used for comparing two means from independent samples?
(A) F - test (B) t – test
(C) Chi - square – test (D) Z - test
13. CO_2 accepter in C4 plants is
(A) PGA (B) RuBP
(C) **OAA** (D) All
14. The chemical responsible for lathyrism in mammals is
(A) BOAA (B) HeN
(C) 2,4- DB (D) NAA
15. Which element is involved in bio- synthesis of IAA ?
(A) Nitrogen (B) Boron
(C) **Zinc** (D) Copper
16. The area under Bt - cotton in India is about
(A) 6.4 mha (B) 5.4 mha
(C) 4.4 mha (D) 3.4 mha
17. The dwarfing gene in rice is:
(A) Opaque – 2 (B) Tift - 23 A
(C) Dee - Gee - Woo – Gen (D) Norin -10
18. The net gain of ATP in glycolysis is
(A) 12 ATPs (B) 24 ATPs
(C) 1 ATP (D) **2 ATPs**
19. The precursor of ethylene is
(A) Histidine (B) Glycine
(C) Tryptophane (D) **Methionine**
20. Which state contributes maximum pulse production?
(A) U. P. **(B) M.P.**
(C) Punjab (D) Maharastra
21. Which of the following crops has the largest area under transgenic globally?
(A) Cotton (B) Soybean
(C) Tobacco (D) Maize
22. Sugar-beet is an indicator plant for
(A) Sodium (B) Molybdenum
(C) Zinc (D) Phosphorus
23. Which of the following gases contributes maximum to global warming?
(A) CFC (B) CO2
(C) Methane (D) NO_2
24. In India, area under rice is about
(A) 25 Mha (B) 28 Mha
(C) 45 Mha (D) 57 Mha
25. Sunflower is also known as an individual plant for the deficiency of

(A) Nitrogen (B) Zinc
(C) Boron (D) Potash

26. Soil air contains CO_2 (%)
(A) 0.03 (B) 2.50
(C) **0.25** (D) 3.0
27. When the fertility gradient of the field is in two directions, the most appropriate experimental design is
(A) CRD (B) RBD
(C) Split (D) **LSD**
28. Plants capable of growing in rocks crevices are called
(A) Calciphytes (B) Chosmophytes
(C) **Lithophytes** (D) Helophytes
29. The C: N ratio of humus is
(A) 20: 1 (B) 100: 1
(C) **10: 1** (D) 400:1
30. Densest part of atmosphere strata is
(A) **Troposphere** (B) Thermosphere
(C) Stratosphere (D) Mesosphere

ICAR'S JRF ENTRANCE EXAMS- 2008-09
General Agriculture (Memory based)

1. Dangerous gas for depletion of ozone layer is:
(A) Ethane (B) Methane
(C) **CFC** (D) Carbon-dioxide
2. Which of the following is not a biopesticide?
(A) Bioneem (B) **Carbaryl**
(C) Biolap (D) Dipel
3. Major cropping system of trans-gangatic plains is
(A) Soybean – wheat (B) Rice – rice
(C) **Rice –wheat** (D) Maize – wheat
4. Photosynthetic inhibition by 02 is called:
(A) Reaction (B) **Warburg's effect**
(C) Back inhibition (D) Competitive effect
5. Crop logging is done in
(A) **Sugarcane** (B) Maize
(C) Tobacco (D) Cotton
6. Blue revolution is related with:
(A) Crops (B) Energy source
(C) **Fish** (D) Oilseeds
7. Inflorescence in rice is known as

(A) Ear (B) Raceme
(C) Spike (D) **Panicle**

8. Alluvial soils are found in :
(A) Deserts (B) Forests
(C) **River delta** (D) Mountains

9. Weight of one cotton bale is
(A) **170 Kg** (B) 160 Kg
(C) 180 Kg (D) 190 Kg

10. Hybrid cotton in India was evolved for the first time in
(A) 1975 (B) 1980
(C) **1970** (D) 1985

11. Net cultivated area in India during 2004- 05 was
(A) 138 million hectare (B) **141 million hectare**
(C) 135 million hectare (D) 144 million hectare

12. The relative proportion of sand, silt and clay is called
(A) **Soil texture** (B) Soil aggregation
(C) Soil structure (D) Soil taxonomy

13. Which of the following crops is thermo-insensitive?
(A) **Sunflower** (B) Wheat
(C) Rice (D) Jowar

14. The IARI was established in : 24.
(A) 1907 (B) 1909
(C) 1904 (D) **1905**

15. In which of the following crops GM varieties are available for cultivation in India
(A) Mustard (B) **Cotton**
(C) Soybean (D) All of the above

16. Photo-periodically rice is a
(A) Day neutral plant (B) Long day plant
(C) **Short day plant** (D) None of these

17. The present level of carbon-dioxide in atmosphere is :
(A) 190 ppm (B) **295 - 300 ppm**
(C) 420 - 460 ppm (D) 490 ppm

18. Maize belongs to the category :
(A) Bisexual (B) **Monoecious**
(C) Dioecious (D) None of these

19. Pheromone trap attracts:
(A) Female moths (B) Female bugs
(C) **Male moths** (D) Caterpillars

20. Origin place of soybean is
(A) Brazil (B) Mexico
(C) **China** (D) Peru

21. India rank first in the production of the following crops in the world:
(A) Rice (B) Wheat

(C) Soybean (D) **Pigeon-pea**

22. In plants, enzyme responsible for the synthesis of the malic acid is :
(A) **Rubisco** (B) PEP carboxylase
(C) Kinase (D) Urease

23. Which soil has highest efficiency?
(A) Loamy soil (B) Sandy soil
(C) **Clay soil** (D) None of these

24. Which of the following insecticides may be recommended for the control of termites?
(A) **Chlorpyriphos** (B) Nimbicidine
(C) Dimethonate (D) Methyl- 0 - demetone

25. Correct order of rice producing countries is
(A) **China> India> Indonesia> Thailand** (B) India> China> Indonesia> Thailand
(C) Indonesia> Thailand> China> India (D) None on these

26. The depth of seeding in wheat is depends on
(A) Length of mesocotyl (B) Length of radical
(C) **Length of coleoptiles** (D) None of these

27. IGFRI is located at:
(A) **Jallandhar** (B) Jodhpur
(C) Jhansi (D) Jorhat

28. The photosynthetically active (PAR) falls in the range of
(A) **400 - 700 nm** (B) 100- 400 nm
(C) 700- 1000 nm (D) None of the above

29. Missing data are calculated by using
(A) Field plot technique (B) **Missing plot technique**
(C) ANOVA (D) None of these

30. Soil mulch is useful in:
(A) **Minimize evaporation losses** (B) Improving aeration
(C) Improving drainage (D) Removing weeds

ICAR'S JRF ENTRANCE EXAMS- 2009-10
General Agriculture (Memory based)

1. The average concentration of carbon dioxide in the atmosphere is :
(A) 0.03 ppm (B) 30 ppm
(C) 0.3 ppm (D) **300 ppm**

2. Agrostology is the study of:
(A) Root (B) **Grasses**
(C) Flower (D) Fruit

3. Atmospheric layer nearest to earth Surface is
(A) **Biosphere** (C) Exosphere

(B) Thermosphere (D) Troposphere

4. Plant that grow on extremely dry soil are classified under :
   (A) Thalophytes (B) Hydrophytes
   (C) **Xerophytes** (D) Hydroponics

5. Ground water table is measured by :
   (A) Tensiometer (B) **Piezometer**
   (C) Pressure plate (D) Neutron probe

6. Mycorrhiza is associated with what part of plants?
   (A) **Roots** (B) Leaf
   (C) Stem (D) Fruits

7. The most Suited N fertilizer for tea is:
   (A) Urea (B) Calcium nitrate
   (C) Ammonium chloride (D) Ammonium sulphate

8. Which food is designated as "Boneless meat"?
   (A) Banana (B) Potato
   (C) **Soybean** (D) Tapioca

9. Which of the following control the root initiation, cell elongation and apical dominance?
   (A) **Auxins** (B) ABA
   (C) Gibberellins (D) Ethylene

10. Study of soil from the stand point of higher plant is known as :
   (A) Pedology (B) Physiology
   (C) **Edaphology** (D) Geo physics

11. Pruning is most essential for:
   (A) Cauliflower (B) Rubber
   (C) **Tea** (D) Chinchona

12. The progeny of breeder seed is:
   (A) **Formation seed** (B) Nucleus seed
   (C) True seed (D) Certified seed

11. The basis of farm budgeting is:
   (A) production function analysis (B) Linear programming
   (C) **Cost - benefit analysis** (D) Farm planning

13. The largest tea production state in India is:
   (A) Tamil Nadu (B) **Assam**
   (C) Meghalaya (D) Kerala

14. The plant nutrient which help in translocation of sugars and starch is :
   (A) Mg (B) Mo
   (C) **K** (D) Na

15. Saffron is largely produced in:
   (A) **J & K** (B) Kerala
   (C) Himachal Pradesh (D) Uttarakhand

16. A crop that can supply oil for petrochemicals is:
   (A) Neem (B) Rubber

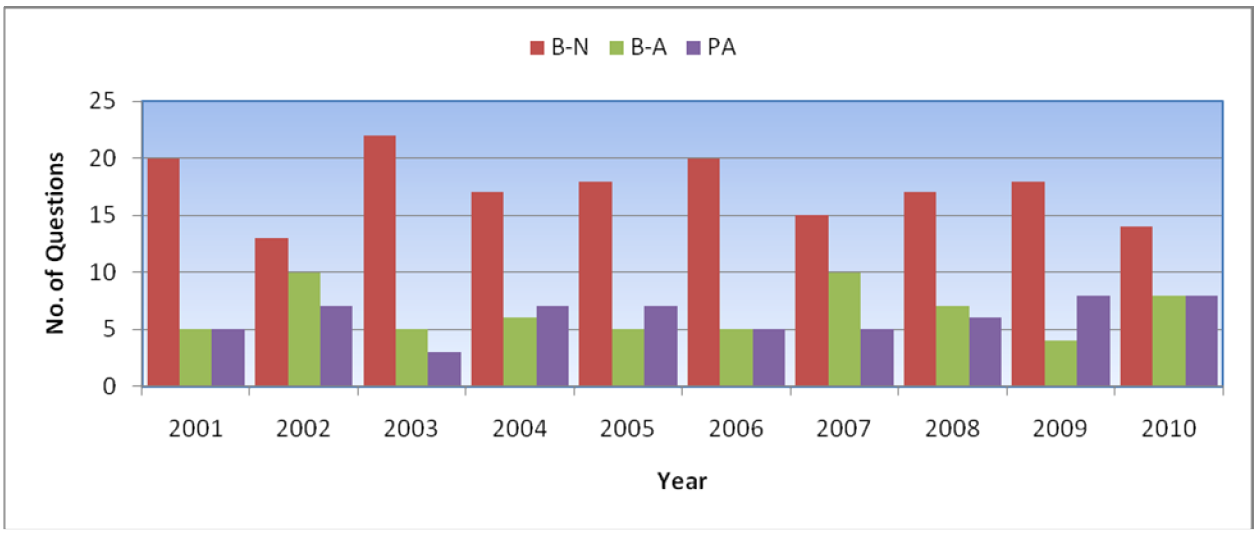
(C) Macadamia (D) **Jatropha**

17. IA market guided by rules and regulation is called :
    (A) Perfect market (B) **Regulated market**
    (C) Seasonal market (D) Terminal market
18. Most widely cultivated mustard type in India is:
    (A) Yellow / brown sarson (B) Black mustard
    (C) Toria (D) **Indian mustard**
19. C4 plant normaly produce more biological yield than C3 plant because of:
    (A) More photorespiration (B) **Less photorespiration**
    (C) Less photophosphorylation (D) More photophosphorylation
20. Absolute zero is:
    (A) - 273 °C (B) 273 ° C
    (C) **273 °K** (D) 273 °F
21. In India maximum area under wheat is occupied by the Species?
    (A) ***Triticum aestivum*** (B) *Triticum dicoccum*
    (C) *Triticum durum* (D) *Triticum vulgare*
22. Which among the following colures absorbs more radiation?
    (A) Blue (B) **Black**
    (C) Red (D) White
23. Impect of green house effect is:
    (A) **Global warming** (B) Ice melting
    (C) Sea formation (D) Sea level rise
24. Which of the following elements is most mobile in soil ?
    (A) Ca (B) K
    (C) Mg (D) **N**
25. The most deficient micro - nutrient in Indian soil is :
    (A) Cu (B) Mn
    (C) **Zn** (D) B
26. Magnesium is a constituent of :
    (A) Nucleic Acid (B) Enzyme system
    (C) Cell wall (D) **Chlorophyll**
27. The C : N ratio of arable soil commonly ranges from :
    (A) 6 : 1 to 7: 1 (B) 18: 1 to 19: 1
    (C) **8 : 1 to 15:1** (D) 3 : 1 to 4: 1
28. Dwarfing gene in wheat is :
    (A) Nif – gene (B) **Norin**
    (C) Dee - gee - woo – gen (D) Proteina
29. Which of the following element immobile in soil but mobile in plants?
    (A) S (B) B
    (C) Zn (D) **P**
30. Which soil has highest efficiency?
    (A) Loamy soil (B) Sandy soil
    (C) **Clay soil** (D) None of these

Analysis on questions asking pattern for ICAR's JRF Exams (General Agriculture)

With the analysis of 10 year question paper on General Agriculture asked in examination of IARI Ph.D Entrance, following results and interpretation has been made.

1) The General Agriculture asked in examination of IARI Ph.D Entrance includes three types of questions **BASIC-Normal** (these includes the very basic knowledge on agriculture and can be solve by almost 90 % of competitors), **BASIC-Advances** (it includes the advance knowledge on basics of agriculture and can be solve by almost 50 % of competitors) and **Pure Advances** (these questions are being newly introduced and have taken first time in exam, these includes advance knowledge on general agriculture and it test the competitor's awareness on current and advance facts of agriculture. It actually determines the scoring marks for admission in IARI. If you are able to solve at least 50% of these type of question along with full of BASIC-Normal and BASIC-Advances types of questions, it is almost assure to get admission in IARI on the basis of General Agriculture).
2) It is found that the percentages of these three types of questions are approximately fixed for each year. But in some year, there is an abrupt change in the question asking pattern. An analysis has made to test the change in the question asking pattern and the result are explained by following graph (Fig. 1). The graph shows the percentages of the Pure Advances types of question is approximately increasing every year. So, the facts say the keeping Advance knowledge on agriculture facts is much helpful to get command in General Agriculture part of IARI Ph. D exam. And thus, these are helpful in admissions.



01. Importance of Agriculture in national economy

Indian Agriculture: Present Economic View

- A record production of 233.88 Million tons of food grains is found in year **- 2008-09**
- Contribution of Indian agriculture to Growth rate in GDP in 2008-09 (at constant rate of 2004-05) **–1.6%**
- Contribution Indian agriculture to GDP in 2008-09 (at constant rate of 2004-05) **–15.7%**
- Share of agriculture to total imports in 2008-09 **– 2.74%**
- Share of agriculture to total exports in 2008-09 **–10.23%**
- Contribution of Indian agriculture to total Employment in 2008-09 **- 52%**
- Highest MSP increase in 2008-09 over last year for crop **- Ragi-58%**
- Lowest MSP increase in 2008-09 over last year for crop **-Wheat-8%**
- India supports total geographical area of world **-2%**
- India supports population of world **- 18%**
- India supports livestock of world **- 15%**
- India supports forest of world **- 1.5 %**
- Total Geographical Area (TGA) of India **- 329 Mha**
- Potential for Biological Production of India **- 265 Mha**
- Per Capita land availability in India (1991-92) **- 0.37 ha**
- Per Capita Agri. land availability in India (1991-92) **- 0.16 ha**
- Net cultivated area available in India (2004-05) **- 143 Mha**
- Irrigated area available in India (2004-05) **-56.3 Mha**
- National Commission on Farmers established in year **-2004**
- Chairman of National Commission on Farmers (NCF) **- M.S. Swaminathan**
- National Horticulture Mission (NHM) started in year **- 2005**
- National Bamboo Mission (NBM) started in year **- 2006-07**
- National Rain fed Area Authority (NRAA) started since **-03/11/2006**
- National Food Security Mission (NFSM) started since **- Rabi, 2007**
- Rain fed Area Development Programme (RADP) started since **- 20 March, 2008**
- Average fertilizer consumption in India during 2008-09 **- 128.8 Kg/ha**
- Highest average fertilizer consumption in India during 2008-09 **-Punjab (212Kg/ha)**
- Lowest average fertilizer consumption in India during 2008-09 **– Arunachal Pradesh (5 kg/ha)**
- Nutrient consumption ration (NPK) during 2007-08 **- 5.5:2.1:1**
- National Project on Management of Soil Health & Fertilizer (NPMSF) established in year **- 2008-09**
- Integrated Scheme of Oilseeds, Pulses, Oil palm & Maize (ISOPOM) started since **- 1st April, 2004**
- Kisan Call Centre(KCC) started since **- 21st Jan 2004**
- Toll free No. of Kisan Call Centre **- 1551**

- DMRI- Directorate of Marketing Research and Inspection established at **- Nagpur , Maharashtra**
- First livestock census conducted in India during **- 1919**
- Rank of India in Silk production **- 2nd** (1st-China)
- Silk production in India during 2008-09 **- 18,320 MT**
- Indian agriculture provides about ..... % of the livelihood **- 65%**
- Agricultural growth Rate in production **- 5.8%**
- About .....% people are living in rural areas and are still dependent on Agriculture **- 75%**
- About .....% of India's geographical area is used for agricultural activity **- 43%**
- Father of Hybrid rice in India **- Dr. E.A. Siddiqe**
- Milk production in India during 2008-09 **- 108 Mt.**
- Milk production is highest over World in **- India**
- India rank in Milk production **- 1st rank**
- Milk Availability (g./person/day) in India during 2008-09 **- 258**
- Food grain production (Mt.) in India during 2008-09 **-233 Mt**
- Fruit production in India during 2007-08 **- 63 Mt**
- India rank in Fruit production **- 2nd rank**
- Vegetable production in India during 2007-08 **- 125 Mt**
- India rank in Vegetable production **- 2nd rank**
- Agriculture accounts …….% of National work force **- 52**

Nanotechnology in Agriculture:

- The term "Nanotechnology" is coined by **- Nario Taniguichi** (1974), at Univ. of Tokyo, Japan
- Nanotechnology is Understanding and control of matter at dimension of **1-100 nm**
- Example of Nano based Smart Delivery System **- Halloysite**
- Nano Particles(NPs) of ZnO, SiO_2 and TiO_2 used for Bacteria & Green Algae are - **Nano Pesticide**
- Nano Particles used for reclamation of heavy Particles
  -**Amphiphylic Polyurethane**, **Zeravalent Iron** (nZVI), and Nano sized **Zeolite**.

Crop Biotechnology in Agriculture:

- First transgenic plant in the world is **-Flavr Savr™ tomato**
- First transgenic plant Flavr Savr™ tomato is for **- delayted ripining**
- First transgenic plant Flavr Savr™ tomato was released for commercial cultivation in 1994 by **- Calgene (Compony)**
- Final Approval Committee for release of transgenic crops in India **- GEAC (Genetic Engineering Approval Committee)**
- Area under transgenic plant in World during 2008 **- 125 Mha**
- Area under transgenic plant in World during 2009 **- 139 Mha**
- Rank of India for transgenic plant **-4th** (1st-USA, 2nd-Mexico, 3rd- Argentina)

- Crops having highest transgenic plant cultivation area - **Soybean>** Corn>Cotton
- Area under Bt-cotton in India **- 7.5 Mha** (2008), **8.4 Mha** (2009)(86% of cotton area)
- First genetic engineering company is **- Genentech,** 1976
- First transgenic crop **- Tobacco**

Irrigation in India-2010:

- National water awards (2007) are given to **-Hiware Bazar Gram Panchayat, Ahmadnagar, Maharashtra**
- Area under micro irrigation system in India (2008-09) **- 3.88 Mha**
- Area under Drip in India (2008-09) **- 1.42 Mha**
- Highest area under Drip in India (2008-09) **- Maharashtra**
- Area under Sprinkler in India (2008-09) **- 2.45 Mha**
- Highest area under Sprinkler in India (2008-09) **-Haryana**
- Year announced as the "Water year" **-2007**
- Artificial Recharge of Ground Water Advisory Council (ARGWC)- constituted in year **- 2006**
- National Institute of Hydrology is situated at **- Roorkee, Uttarakhand**
- World Congress on conservation Agriculture held at **- New Delhi** (2009)

Informatics in Agriculture:

- E-*chaupal* estabilished by **- Indian Tobacco Comp. (ITC)** for M.P.
- Soya-Chaupal is for weather, farming practice and Market price of Soybean in **- M.P.**
- ARIS- Agricultural Research Information System, est. by **- ICAR, 1995**
- VERCON (Vitrual Extension, Research and Communication Network) developed by **-FAO,2001**
- "Indian Agriculture on-line" was established by - **Ministry of Agriculture** in 1997
- AGMARKNET-**Agricultural Marketing Information Network**
- NADAMS-**National Agricultural Drought Advisory and Management Systems**
- APHNET-Animal Production and Health Informatics Network
- ARISNET-**Agricultural Research and Information System**
- ACINET: Agricultural Credit Informatics Network
- ICT- **Information and Communication Technology**

ITK in Agriculture:

- Bael fruit can be used to contol **–rice blast**
- Cow urine used for **– wheat termite control , sorghum smut control**

India's position in world Agriculture Rank

- Total Area : **Seventh**
- Irrigated Area : **First**
- Population : **Second**

- Economically Active population : **Second**
- Total Cereals : **Third**
- Wheat : **Second**
- Rice : **Second**
- Coarse grains : **Fourth**
- Total Pulses : **First**
- Oil Seeds : **Second**
- Fruits and Vegetables : **Second** (first-China)
- Implements (Tractors) :**Third**
- Milk : **First**
- Live Stock (cattle, Buffaloes) : **First**
- Rice : **Second** (1st China)
- Maize : **5th** (USA >China >Brazil)
- Wheat : **Second** (China > India >USA)
- Groundnut : **Second** (China > India)
- Sugarcane : **Second** (Brazil > India)
- Total Cereals : **3rd** (China > USA > India)
- Coarse Cereals : **4th** (USA > China > Brazil)
- Total Pulses : **1st**
- Mustard & Rapeseed : **3rd** (China > Canada > India)
- Fruits & Veg : **Second** (China > India)
- Cotton : **3rd** (China > USA > India)
- Tobacco : **3rd** (China > Brazil > India)
- Tea, Jute & Allied Fibers : **1st**
- Coffee : **6th**
- Cattle Population : **1st** (16.5%)
- Buffalo Population : **1st** (56.7%)
- Milk Production : **1st** (15%)
- Egg Production : **4th** (China>USA>Japan>India)
- Total Geographical Area : **7th** position (2.4% of world)
- Total Arable Land : **2nd** (1st USA) 162 Mha
- Total Irrigated Area : **1st** position (21% of world)
- Human Population : **2nd** (1st China) 17% of world

Indians who secured 'World Food Prizes':

- 1987 -Dr. M. S. Swaminathan For - **India's green revolution**
- 1989 - Dr. Verghese Kurien - **Milk cooperatives**
- 1996 - Dr. Gurudev S Kush - Improved yield potential of rice
- 1998 - Mr. B. R. Barwale - **Founder of MAHYCO**
- 2000 - Dr. Surinder K Vassal - **Quality Protein Maize (QPM)**
- 2005 - Dr. Modaduga V Gupta - **For Aquaculture**

Current World Food Prizes awardees:

- 2008-09 - Dr. Gebisa Ejecta
  For- **First Sorghum hybrid resistant to Drought and Striga weed**
- 2009-10 -Dr.

Some important years:

- International year of rice **- 2004**
- International year of micro credit **- 2005**
- International year of desert and desertification **- 2006**
- International year of water (theme-more crop per drop) **- 2007**
- International year of potato **- 2008**
- International year of fibre **- 2009**
- International year of Biodiversity **- 2010**

Per Capita Availability (2009-10)

- Cereals (gm/ per capita/day) **- 409.9**
- Pulse (gm/ per capita/day) **- 29**
- Milk (gm / per capita/day) **- 245**
- Minimum requirement of milk (gm/ per capita/day) **- 240**

Crop Production Scenarios in Indian Agriculture (2008-09):

- Total food grains production in India during 2008-09 **-233.88 Mt**
- Total food grains production in India during 2007-08 **- 230.78 Mt**
- India is ..... largest economy in terms of GDP during 2008-09 **-10th**
- India's rank in world plant biodiversity **-10th**
- India's rank in Asia plant biodiversity **- 4th**
- India's rank in Purchasing Power Parity (PPP) **- 4th**

Leading state in production and area of crops during 2008-09:

- Rice production and area **- WB> UP**
- Rice Productivity **- Punjab**
- Wheat production and area **- UP> Punjab**
- Wheat productivity **- Haryana**
- Pulse s production **- MP**
- Pulse productivity **- Haryana**
- Oilseed production **- MP>AP**
- Oilseed productivity **- TN**
- Groundnut production **- Gujarat**
- Groundnut productivity **- TN**
- Mustard production **- Rajasthan**

- Cotton production - **Maharashtra**
- Jute production - **West Bengal**
- Coffee production - **Karnataka**
- Tea production - **Assam**
- Rubber production - **Kerala> Tripura**
- Potato production - **UP**
- Onion production - **Maharashtra**
- Sugarcane production - **Uttar Pradesh**
- Sugarcane productivity - **Tamil Nadu**
- Maize production - **Karnataka**
- Soybean production - **MP**
- Soybean productivity - **AP**

Production of major crops:

CROPS	2006-07	2007-08	2008-09
Rice	93.43	96.69	**99.15**
Wheat	75.80	78.57	**80.58**
Coarse cereals	30.66	40.76	**39.48**
Cereals	199.89	216.02	**219.21**
Total pulses	14.20	14.76	**14.66**
Total food grains	214.09	230.78	**233.88**
Total oilseeds	24.29	29.75	**28.15**
Sugarcane	355.52	258.84	**231.56**
Cotton	226.3 lakh bales	246.84 lakh bales	**231.56 Lakh bales**

Crop Production 2009-10 (Based on Advance Estimate)

- Kharif food grains production - **98.83 Mt**
- Kharif rice production - **71.65 Mt**
- Total kharif production of coarse cereals - **22.76 Mt**
- Total production of Kharif pulses - **4.42 Mt**
- Total kharif production of the nine Oilseeds - **15.233 Mt**
- Sugarcane production - **249.48 Mt**
- Cotton production - **23.66 Million bales** (of 170 kg each)
- Production of jute and mesta - **10.243 Million bales** (of 180 kg each)

Highest/Lowest production year-

Crop	Year (highest)	Year (lowest)
• Food grain	2008-09	2002-03
• Wheat	2008-09	2002-03
• Rice	2008-09	2002-03

• Pulse	2003-04	2002-03
• Nine Oilseed	2007-08	2002-03
• Sugarcane	2006-07	2003-04
• Cotton	2007-08	2002-03

Allied sector Production figure in 2008-09:

- Milk Production **- 108.5 million tonnes**
- Eggs Production **- 55.6 Billion**
- Wool Production **- 42.7 Million kg**
- Meat Production **-3.8 Million tones**
- Fish production **- 7.6 million tones**
- Silk production **-18, 324 Kg**

MSP-2009-10 (Rs.per Quintal)

- Paddy- Rs.1000/-
- Jowar- Rs.860/-
- Arhar- Rs.2300/-
- Cotton - Rs.2500/-
- Wheat- Rs.1100/-
- Gram- Rs.1760/-
- Sugarcane -Rs. 129.8/-
- Barley- Rs.750/-

Leading state in production & area of crops: 2008-09

Crops	Prod. (Mt)	Leading Prod. state	Area (Mha)	Productivity (Kg/Ha)
• Rice	99.15	WB>AP>UP	45.35	2186
• Wheat	80.58	UP>PNJ>HR	27.88	2891
• Maize	19.29	AP>KN>RJ	28.19	2355
• Jowar	7.31	MH>KN>MP	7.68	-
• Bajra	8.83	RJ>UP>GJ	8.74	-
• C. Cereal	39.48	RJ>MH	27.62	-
• Cereal	219.21	-	22.37	-
• T. Pulses	14.86	MH>MP>AP	7.97	655
• Chickpea	7.0	MP>MH>AP	7.97	-
• Lentil	0.81	UP>MP	1.31	-
• Pig.pea	2.3	MH>KN	3.4	-
• T. Food Grain	233.8	UP>PNJ>AP	123.22	-
• T.oilseed	28.16	MP>MH>GJ	27.46	-
• Soybean	9.9	MP>MH	9.52	-
• G. nut	7.34	GJ>AP	6.22	-

• Mustard	7.37	RJ>UP	6.19	-
• Sunflower	1.25	KN>AP	1.83	-
• Sugarcane	273.93	UP>MH	4.4	-
• Potato	28.43	UP>WB	-	-
• Cotton*	23.6	GJ>MH	9.41	419
• Jute*	10.41	WB>BHR	0.91	-
• Coffee	-	KN	-	-
• Tea	-	Assam	-	-
• Rubber	-	Kerala	-	-
• Onion	-	MH	-	-

***Million Bales**

Important facts:

- FCI Buffer stock during 2009 **- 16.2 Mt**
- MSP is determined by **- CACP (Commission on Agriculture cost and Prices)**
- 'Swaljaldhara' drinking water project is run since year **- 2002**
- 'Hariyali' watershed development program established in year **- 2003**
- NAREGA changes to MAREGA (Mahatma Gandhi Rural Employment Guaranty Act) in year **- 2005**
- The Protection of Plant Varieties and Farmers' Rights (PPV&FR) Authority, established in year **- 2005,** Nov. at **New Delhi** (Chairaman- S. Nagrajan)
- India's rank in fertilizer consumption **- 3rd**
- Per hectare NPK consumption **-128 kg**
- Coefficient of Variation of South west Monsoon in 2009 **- 10%**
- Total No. of Soil Testing Laboratories (STLs)in India in 2008-09 **-750**
- Total irrigation potential in India by March 2007 **- 102.77 Mha**
- Accelerated Irrigation Benefit Programme (AIBP) started since **-1996-97**
- Full form of NAFED
  -National Agricultural Cooperative Marketing Federation of India Limited
- Full form of CCI **- Cotton Corporation of India**
- The Macro Management of Agriculture Scheme (MMA) was formulated in **-2000-01**
- National Food Security Mission (NFSM) has been launched from the **rabi 2007-08** to enhancing the production of **rice, wheat and pulses** by 10, 8 and 2 million tonnes respectively by the end of the Eleventh Plan
- Kisan Credit Card Scheme (KCC) was introduced in **- August 1998**
- Rashtriya Krishi Vikas Yojana (RKVY) - launched in **- August 2007**
- National Bamboo Mission (NBM)- commenced in **- 2006-07**
- Chairman of Planning Commissions **- M. S. Ahuliwalia**
- Chairman of National Commission for Farmers **- Dr. M.S. Swaminathan**
- India's Rank is first in production of
  - **Milk, Coconut, Tea, Banana, Mango, Cashew nut (export, import and processing) and Pulses**

- India's Rank is 2nd in production of - **Rice , Wheat, Cotton, Fruit and vegetable**
- India's Rank is 3rd in- **Tobacco, rubber, Egg and fertilizer**
- Maximum Consumption of Imported Pesticide is
  - Carbaryl followed by Cholorpyriphos
- Maximum Consumption of Indigenous Pesticide
  - BHC followed by Monocrotophos & Endosulfan
- Maximum export of agro chemicals (in terms of rupees)
  - Cypermethrin followed by Endosulfan, Phosphide & Lindane
- The top Agrobusiness company: **Novartis** (Hindustan Ciba-Geigy & Sandoz)
- Total production of pesticides in India during 2007-08 **-95,000 tones**
- Number of pesticides registered in India by 31/12/1999 **- 155**
- Number of technical grade pesticides manufactured in India -
- Plant Protection adviser to GOL **- Dr. R. L. Rajak**
- Insecticides Act formulated in year
  - 1968 (with recommendation of **Thakur committee**)
- Insecticides rules formulated in year **- 1971**
- Brown revolution is for promotion of **- Agro Industries development**
- Pink revolution is for promotion of **- Onion production**
- Yellow revolution is for promotion of **- Oilseeds production**
- The word green revolution was coined by **- William Gaudd**
- Father of Green revolution **- Dr. Norman E. Borlaoug**
- Father of Green revolution in India **- Dr. M.S. Swaminathan**
- Father of hybrid rice production **- Yuvan long ping**
- First laureate of the "world food' prize **- Dr. Swaminathan**
- World Food prize to Dr M S Swaminathan for his contribution is in year– **1986**
- Dr. H. M. Beachell and Dr. Gurdev singh khush are **-Rice breeders**
- National Centre for Integrated Pest Management (NCIPM) situated at
  – IARI, New Delhi
- Central Plant Protection Training Institute (CPPPTI) situated at **– Hyderabad**
- The largest per hectare pesticide consuming country is **– Taiwan**
- Total number of pesticides banned in India **- 29**
- Recently banned pesticides in India is **- Phosphamidon**
- Highest consumption of pesticide is in crop **– cotton** (54%) 2nd- paddy (22%)
- The country has the maximum arable land per person - **Australia** (approx 200 acres).
- The Indian Food grains storage management and Research Institute is located at
  - Hapur, UP.
- The world first agricultural census was conducted in year **- 1930**
- The headquarters of Directorate of marketing and Inspection (DMI) established in 1935 is located at **– Faridabad, Haryana**
- The Agricultural produce (Grading and Marking) Act was passed in **– 1937**
- Agriculture Price Commission (presently, CACP) declared prices every year

– Minimum support price

- The Govt. determines the support prices of crop products on the recommendation of **- Commission for Agricultural Costs and Prices.**
- The demand for agricultural products in general is **- Inelastic**
- The apex body for institution finance for agriculture in India is **-National Bank For Agriculture and Rural Development (NABARD)**
- The earlier name of WTO was **- GATT**
- AGMARK is established in **- 1937**
- AGMARK is an indicator of **–Purity**
- The Govt. of India set up planning commission in **- March, 1950**
- The price below which the producers are not ready to sell is known as **– Reserve price**
- The highest per capita income of farmers is in **– Punjab**
- The scheme of Regional Rural banks (RRBs) was launched in India on **– 2nd October, 1975**
- The Reserve Bank of India Act for its establishment was passed in the year **– 1934**
- The Kisan Credit Card Scheme (KCCS) was introduced in **- 1998-99**
- The new national Agricultural Insurance Scheme (NAIS) was introduced in the country from **- Rabi, 1999-2000**
- The minimum wages act was enacted by the govt. of India on **- 1948**
- NABARD was established on 12th July, 1982 on the recommendation of **- Shivaraman Committee**
- Cooperative movement in India was started in **– 1904**
- The headquarters of Asian Development Bank (ADB) is at **- Manila**
- The National Agriculture Policy (NAP) was announced on **– 28th July, 2000**
- The Commission for Agricultural Costs and Prices (CACP) recommends the minimum Support Prices for..... important crops **- 24**
- The period of 11th five year plan in India is **- 2007-2012**
- The chairman of National Development Council (NDC) is **- Prime minister**
- Value added tax (VAT) is a **- Indirect tax**

Recent insecticide data (updated up to nov, 2009)

- Number of insecticide included in insecticide schedule **- 787**
- Pesticides Banned for manufacture, import and use **- 27**
- Pesticide / Pesticide formulations banned for use but their manufacture is allowed for export **- 2**
- Pesticide formulations banned for import, manufacture and use **- 4**

- Pesticide Withdrawn **- 7**
- No. of pesticides refused registration **- 18**
  - Pesticides restricted for use in India **– 13**
  - Insecticides approved by the registration committee for protecting buildings from termites
    - **Chlorpyriphos** 50% EC, **Ethion** 50% EC, **Imidacloprid** 30.50% SC, **Lindane** 20% EC.
  - Insecticides approved by the registration committee to control termites in agricultural crops under the insecticides act, 1968
    - Chlorpyriphos 20 EC, **Endosulfan** 35 EC, **Imidacloprid** 17.8 % SL
  - No. of Insecticides approved by the registration committee to control household pests in houses under the insecticides act, 1968 **- 39**

Recent Horticulture Data (2009-10)

- Percentages share of horticulture crops in production
  – Vegetable (60%) < **fruits** (31%) < **Plantation** crops (5%)
- Percentages share of horticulture crops in Area
  – Vegetable (40%) < **fruits** (30%) < **Plantation** (15%)
- Fruits crops leading in Area **- Mango>citrus>Banana**
- Fruits crops leading in Production **- Banana> Mango>citrus**
- Fruits crops leading in Productivity **- Papaya> Banana>Grape**
- State leading in fruits crops area **- MH>AP>UP**
- State leading in fruits crops production **- AP>MH>TN**
- Vegetable crops leading in area **- Potato>Onion>Tomato**
- Vegetable crops leading in production **- Potato>Onion>Tomato**
- Vegetable crops leading in Productivity **- Tapioca> Cabbage >Potato**
- State leading in vegetable crops Area - WB>UP>Bihar
- State leading in vegetable crops Production - WB>UP> Bihar
- India's rank in the fruits production – 2nd (1st - Brazil)
- India's rank in the vegetables production - 2nd (1st -China)
- India is the largest producer of
  - 1. **Mango**, 2. **Banana**, 3. **Sapota**, 4. **Acid Lime**, 5. **Cauliflower**
- India is the 2nd largest producer of - 1. **Onion**, 2. **Potato**
- Per capita fruit recommended in India **- 120 gm/day/person**
- Per capita fruit availability in India **- 70-80 gm/day/person**
- Per capita vegetables recommended in India **- 275 gm/day/person**
- Per capita vegetables availability in India **- 120 gm/day/person**

2. Basic principles of crop production

1. Climate and its influence on crops:

- A condition of atmosphere at a given place at a given time is called - **Weather**
- A weather condition over a given region during a longest period is called- **Climate**
- Structure of atmosphere is in sequences of (from lower to upper)
  - Troposphere- Stratosphere- Mesosphere – Ionosphere
- All weather phenomenons like rain, fog occur in -**Troposphere**
- Energy falling in one minute is a surface area of one square cm at the outer boundary of atmosphere and is called -**Solar constant**
- Solar constant is equivalent to **- 1.94 cal/cm^2/min**
- PAR stands for **- Photosyntheticaly Active Radiation**
- Influence of crop growth by the relative length of day and night especially for floral initiation is called **- Photoperiodic effect**
- Long day plant is the plants require …….day for floral initiation
  - Long day (>14 hrs.)
- Wheat, Barley and Oat are the example of **- Long day plant**
- Short day plant is the plants require …….day for floral initiation - shorter day (less than 10 hrs)
- Rice, Sorghum and Maize are the example of **- Short day plant**
- Cotton, Sunflower and Buck wheat are the example of **- Neutral plants**
- Average rainfall in India **- 120 cm**
- Rain bearing clouds is **– cumulonimbus, cumulus**
- A particular day is called as rainy day if the rainfall received is
  - More than 2.5 mm
- Instruments used to measure Radiation - **Pyranometer**
- Instruments used to measure Pressure - **Barograph**
- Instruments used to measure PAR - **Quantum sensor**
- Instruments used to measure Temperature - **Thermograph**
- Instruments used to measure Dew - **Darosometer**
- Instruments used to measure water table - **Peizometer**
- Instruments used to measure rain - **Raingauge**
- Instruments used to measure Soil moisture - **Tensiometer**
- Instruments used to measure Leaching and ET - **Lysimeter**
- Instruments used to measure Direct solar radiation - **Pyrheliometer**
- Instruments used to measure Humidity **- Psychrometer** (or) **hygrometer**
- A chemical used for cold cloud seeding - **Silver iodide**
- A chemical used for warm cloud seeding - **Sodium chloride**
- Indian Meteorological Organization situated at **-New Delhi (earlier Pune)**
- Lines of equal temperature is called - **Isotherm**
- Lines of equal pressure is called - **Isobar**
- Line of equal rainfall is called - **Isohyets**
- Lines of equal wind speed is called - **Isotach**

- Kharif season crops is cultivated since **- June to September**
- Rabi season crops is cultivated since **– October to March**

2. Growth and development

- Example of C_3 plant **– Rice, Wheat , Cotton, Soybean**
- Example of C_4 Plants **- sugarcane, maize, sorghum pearl millet**
- Example of CAM Plants **- Pine apple, sisal** and **agave**
- Plant growth regulator used as Cotton defoliant **- Abscisic acid**
- Plant growth regulator used as Sugarcane ripener **- Glyphosate**
- Plant growth regulator used for Seed less grape **- Gabbroic acid**
- Plant growth regulator used for fruits thinner and flower initiator **- NAA**
- Plant growth regulator used for Sucker control in tobacco - **MH**
- Plant growth regulator used for ripening of fruits - **Ethylene**

3. Soil & Fertilizer

- Inherent capacity of soil to supply adequate nutrients for plant growth is called **- Soil fertility**
- Capacity of soil to produce in terms of yields is called - **Soil Productivity**
- Soil fertility+ management includes in **- Soil productivity**
- Relative proportion of soil particles is called **- Soil texture**
- The arrangement of soil particles is called **- Soil structure**
- Size of Sand Particle **- 0.2 to 0.02**
- Size of Silt Particle **- 0.02 to 0.002**
- Size of Clay Particle **- < 0.002**
- Size of gravel **- > 2mm**
- Which structure is better for crop cultivation - **Crumby**
- Pore space is occupied by **- water and rain**
- Total pore space is more in - **clay soil** (50-60%)
- Total pore space is low in - **sand soil** (30-40%)
- Weight of soil per unit volume is called - Bull density
- The Bull density of common soil is - 1.5g/cm^3
- Particle density is also known as - true density
- Weight of solid portion of soil per unit volume is called – Particle density
- The Particle density of common soil is - 2.6 g/cm^3
- % pore space can be calculate by formula - (PD – BD) x 100/PD
- CO_2 concentration in soil air is - over 0.3%
- CO_2 concentration in soil air is ……..time higher than atmosphere **- 10**
- Well decomposed organic matter is called as - **Humus**
- Humus is also known as - **Lingo protein**
- Carbon: Nitrogen (C:N) ratio for organic matter – 12:1
- C:N ratio for Legume – 23:1
- C:N ratio for cereals –90:1

- C:N ratio for FYM -100:1
- The soil moisture held by the soil against gravitation at energy status of -0.1 to 0.33 bar is called - **Field Capacity**
- The soil moisture held at energy status of - 0.33 bar to –15 bar (= 1569 g) is called - Available soil moisture
- Urea is a - Organic fertilizer
- CAN (calcium ammonium nitrate) is a - Neutral fertilizer
- Recommended ratio of NPK for cereal crops is - 4:2:1
- Present NPK consumption ratio in India - 9:3:1
- **Deficiency disorders**
- Gray speck in oat is due deficiency of - Mn
- Marsh spot in pea is due deficiency of - Mn
- Pahala blight in sugarcane is due deficiency of - Mn
- Reclamation disease in cereals is due deficiency of - Cu
- Kharif in rice is due deficiency of - Zn
- White bud in maize is due deficiency of - Zn
- Trenching on citrus is due deficiency of - Zn
- Whiptail is cauliflower is due deficiency of - Mo
- Mg is a constituent of - Chlorophyll
- Browning of cauliflower is due deficiency of - Bo
- Symbiotic nitrogen fixing bacteria is - Rhizobium
- Gene responsible for N fixation – Nif genes
- Micro element needed for N fixation - Molybdenum
- Micro element which is constituents of NR - Mo
- Free living N fixing bacteria is **- *Azotobactor*, clostridium (Actinomycetes)**
- Conversion of ammonia to nitrite is occurs in the present of – Nitrosomonas
- Conversion of nitrite of Nitrate is occurs in the present of - Nitrobacter

4. TILLAGE

- A physical condition of soil at which tillage operation can perform better to obtained good seed bed is called - Tilth
- Implements used for primary tillage are - country plough , Mouldboard, Plough, Bose plough
- Implements used for secondary tillage – blade harrow, disc harrows tractor drawn cultivator
- Breeding sub soil is done by – chisel plough
- For Pudding use machine are – Wet land puddler, tractor drawn cage wheel
- Sowing is done by – Mechanical seed drill
- Weeding is done by – Japanese rotary weeder

5. IRRIGATION

- Project covering …….of command area is called Major irrigation project **- More than 10,000 ha**
- Project covering …….of command area is called Medium irrigation project **– 2000 to 10,000 ha**
- Project covering …….of command area is called Minor irrigation project **– Less than 2000 ha**
- 1 ha cm of water = **– 1000 litre**
- 1 cu feet of water = **– 28.32 liters**
- Number of hectare irrigated by constant flow of one current of water is called **- Duty of water**
- Total depth of water irrigated by one ha is called - **Delta**
- Gaseous loss of water from the surface leaf is called - **Transpiration**
- Ratio between yield and Evapotranspiration or WUE is called **- Water use efficiency**
- Water use efficiency can be obtain from the formula **- WUE= Y/ ET**
- Field water use efficiency can be obtain from the formula **- FWUE= Y/WR**
- **Type of irrigation**
- Flooding is done for the for **- rice**
- Check basins is done for the for **- wheat, finger millet**
- Basin method is done for the for **– Fruit crops**
- Furrow irrigation is done for the for **- Cotton, sugarcane, tobacco, vegetables**
- Soil moisture is measured by - **Tensiometer**
- Drip irrigation was discovered in - **Israel**
- The country has 100 % cultivate area under irrigation - **Egypt**
- Method of irrigation can provide protection against frost - **Sprinkler**
- The method of irrigation suitable for row crops is - **Furrow method**
- The method of irrigation suitable for undulated areas - **Sprinkler**
- The most common method among the surface methods of irrigation is **- Check basin**
- The country having the highest area under drip irrigation- **USA**
- State having the highest area under drip irrigation - **Maharashtra**
- State having the highest area under sprinkler irrigation - **Haryana**
- Water requirement of Rice **– 1250 mm**
- Water requirement of wheat **- 300-400 mm**
- Water requirement of Groundnut **- 550-600**
- Water requirement of Sugar cane **- 2250-2500 mm**
- **Important river project:**

River	Name of the project	States benefited
1. Damodar	Damodar Valley project	West Bengal
2. Sutlet	Bhakra Nangal (Indira Gandhi)	Punjab, HP, Rajasthan

3. Kosi	Kosi Dam	Bihar
4. Mahanadi	Hirakund (largest dam in the world)	Orissa
5. Krishna	Nagaarjuna sagar	Andra, Karnataka
6. Tungabhadra	Tunga bhadra project	KN, AP
7. Chambal	Gandhi sagar, Kota Borrage (Ranna pratap sagar)	MP. Rajasthan

Critical stages of Irrigation:

Name of Crops		Critical growth stages
• Sorghum	:	Primordial initiation, flag leaf, flowering and grain development
• Maize	:	Tasseling, Silking and grain development
• Rice	:	Tillering, panicle initiation, milk stage
• Wheat	:	Crown root initiation, tillering, boot leaf stage, dough stage
• Pearl millet	:	Tillering, Flowering
• Gram	:	Branching, Pod development
• Soybean	:	Flowering, Grain development
• Groundnut	:	Branching, peg penetration, pod development
• Sunflower	:	Seedling, Bud initiation, flowering
• Cotton	:	Square formation, ball formation, ball development
• Sugarcane	:	Seedling, tillering, ground growth

6. DRY FARMING

- The practice of crop production entirely with rainwater received during the crop season in low rainfall (<800mm) areas is called **- dry or dryland farming**
- Extremely dry climate with an annual average precipitation usually less than 250 mm is called **- Arid climate**
- Process of subjecting seeds before sowing to alternate cycle of wetting and drying to induce tolerance to drought is called **- Seed hardening**
- Chemicals which is increased in plants during drought **- Proline**
- Collecting and storage of water on the surface of soil for subsequent use **- Water harvesting**
- Any material applied to transpiring plant surfaces for reducing water loss **- Anti-transparent**
- Example of Stomatal closing type Anti-transparent **- Phenyl Mercuric Acetate**
- Example of Film forming type Anti-transparent **– Mobileaf**
- Example of Reflectant type Anti-transparent **- Kaoline spray**
- Example of Growth retardant **– Cycocel** (CCC)

7. HERBICIDES

- A herbicide that kills only targeted plants on weeds while crops are not affected is called **- Selective herbicide**
- Example of Selective herbicide are **- Atrazine, 2,4-D, Butachlor**
- A herbicide that kill all vegetation that they come in contact is called **- Non Selective herbicide**
- Example of Non Selective herbicide are **- Paraquat, Diquat**
- A herbicide that move within the plant to effect as herbicide is called **- Systemic herbicide**
- Example of Systemic herbicide are **- Atrazine 2,4-D, propanil**
- A herbicide that kills plants when they come in contact with plants is called **- Contact herbicide**
- Example of Contact herbicide are **- Diquat, Paraquat**
- Pre-emergence application herbicide **- Paraquat, Diquat, 2,4-D**
- Pre Planting incorporation herbicide **- Fluchloralin**
- Example of Soil sterilenths are **- Diuron, Atrazine, Methyl bromide**
- Effective herbicides on mono cotyledons weeds are - **Delapon**, **Fluchloalin**
- Herbicides which have low residual toxicity **- Diquat paraquat**
- Herbicides which have high residual toxicity **- Diuron, Atrazine**
- Weeds which derives foods directly from the host plant is called **- Parasitic weeds**
- Example of Total stem parasite - **Cuscuta** (associated with Lucerne crop)
- Example of Partial stem parasite -**Loranthus** (associated with tree crops- mango)
- Example of Total root parasite - Orabanche associated with Tobacco
- Example of Partial root parasite - Striga associated with sorghum
- Weeds growing in water bodies is called **- Aquatic weeds**
- Water hyacinth, hydrilla, Salvania, cattail weeds Example of **- Aquatic weeds**
- One plant having detrimental effect on other plants by releasing root chemical through roots **- Allelopathy**

8. CROPPING SYSTEM

- Growing of only one crop on a piece of land year after year is called
  - Mono Cropping
- Growing two or more crops on the same piece of land in one calendar year is called **- Multiple cropping**
- Growing 2 or more crops simultaneously with definite row arrangement is called **-Inter cropping**
- Growing at low or more crops in sequate on the same piece of land in a farming year **- Sequential cropping**
- Ratio between grass sown area and Net sown area is called- **Cropping Intensity**
- Cropping Intensity can be obtained from the formula
  = (Gross Sown Area/ Net sown areas) X 100
- Growing of crops in between Kharif and rabbi season is called **- Zaid cropping**

- The slash and burn type of cultivation in the hill treats of North Eastern Region is called **- Jhum/ shifting cultivation**
- Quick growing crop incidentally planted and harvested in between two major crops, mainly to utilize residual fertilizer is called **- Catch crop**
- Example of Catch crop is **- Toria**
- Crops which are grown primarily to cover the soil and to reduce the loss of moisture and erosion is called **- Cover crop**
- System of growing together crops of different heights at the same time on the same piece of land is called **- Multy storey cropping**
- Example of Multy storey cropping is **- Coconut + Pepper + cocoa + Pineapple**

9. WEED MANAGEMENT

- An unwanted plants, a plant out of place is called **- Weed**
- The term weed was firstly used by **- Jethro Tull**
- Weed is plant **- out of place**
- Example of Relative weed is **– rice in wheat field**
- Example of Absolute weed is **- *Cyperus rotundus***
- Example of Mimicry weed is **- Phalaris in wheat field** and **wild rice in the field**
- Example of Noxious weeds is **- Parthenium**
- National Research Centre for weed science located at **- Jabalpur (1988)**
- 2,4-D used for **- Broad leaved weeds**
- A weed that complete their life eyclein one year is called **- Annuals weeds**
- Example of Annuals weeds is **- Phaloris monr, Echinocloa colonum, Amaranthus**
- A weed that complete their life cycle in five years is called **- Binneal weeds**
- Example of Binneal weeds is **- Alternanithra echinata; Eichorrutim intybus**
- A weed that complete their life cycle in More than 2 years is called **- Perennial weeds**
- Example of Perennial weeds are **- cynodam dactylon, cyperus rotundus**

10. AGROFORESTRY

- Agro forestry is a form of **- multiple cropping**
- The systemic research in agro-forestry is taken by **- ICRAF**
- International Centre for Research in Agro-Forestry (ICRAF) situated at **- Nairobi, Kenya**
- National Research Centre for Agro-forestry situated at **– Jhansi (1988)**
- The most important agro-forestry practice is known from the - **"kangeyan tract of Tamil nadu"** (*Acacia leucophloea* + *Cenchrus setigerus*)
- Agri-silviculture is **- trees + crops**
- Alley cropping is **- perennial hedges + crops**
- Agri-horticulture is **- fruit trees + crops**
- Agri – Silvi – horticulture is **- trees + fruit trees + crops**
- Agri-silviculture is **- trees + crops + pasture or animals**
- Silvi- olericulture is **- trees + vegetables**

- Horti – pasture is **- fruit trees + pasture/animals**
- Silvi – pasture is **- trees + pasture/animals**
- Horti-apiculture is **- fruit trees + honeybees**
- Aqua forestry is **- trees + fishes**
- ''Taungya" originated from - **Myanmar**
- ''Taungya" it meant for - **hill cultivation**
- *Alnus nepalensis* is - **non-leguminous nitrogen fixing tree**
- Process of inhibition of growth of one plant by chemical compounds from the neighbouring plants is called - Allelopathby
- Agro-forestry tree species having allelopathic effect on crop:

Tree species	**Effect on:**
• Alnus nepalensis	- Glycine max
• Casuarina equisetifolia	- Cowpea, sorghum, sunflower
• Eucalyptus tereticornis	- Cowpea, Sorghum, sunflower, potato
• Gliricidia sepium	- Maize, rice, tropical grasses
• Leucaena leucocephala	- Maize, cowpea, sorghum, sunflower

**********X**********

3. Cultivation of Major Crops

(Rice, Wheat, Pigeon pea, Sugarcane, Tomato, Cauliflower, Mango and Rose)

1. RICE

- Botanical name of rice **- *Oryza sativa***
- Highest production and productivity of rice in India **- West Bengal**
- Protein content in rice **- 7%**
- Gene responsible for dwarf varieties of rice **- dee-gee-woo-gene**
- Long stem which had lodging tendency found in rice type - **Indica**
- Short stem which has no Lodging Tendency found in rice type **- Japonica**
- Wild type of rice **- Javanica**
- Three types of rice culture – Upland, Low and Deep water rice
- Rice culture in which Seeds are sown directly of the main field, is called **-Upland**
- ……..% of area is under upland **- 60%**
- Seed rate for Upland culture **- 100 kg**
- Nursery area in Wet or transplanting system is ……..area of main field **- 1/10th (OR)** 1000 m^2 per ha
- Dapog method of Nursery is developed from **- Philippines**
- Area enough for planting one hectare under Dapog method of nursery **-30-40 m^2**
- Under Dapog method of Nursery, Seedling become ready for transplanting within **- 11-14 days**
- Optimum Seed rate for the short duration variety of rice **- 40-50 kg/ha**
- Optimum spacing for the short duration variety of rice **– 20x10**
- Optimum spacing for the medium duration variety of rice **- 20x15**
- Fertilizer rate for rice cultivation **– 100:50:50 kg NPK/ha**
- Zn application rate in rice cultivation **– 25 kg/ha**
- Aman season of rice, sown in month of…….and harvested in …….. **- May -June and October -December**
- AUS season of rice, sown in month of…….and harvested in …….. **- March- April and August/ September**
- Boro season of rice, sown in month of…….and harvested in …….. **- December-January and April/ May**
- Most familiar Weeds of rice are **– *Echinocloa colonum, E. crusgalli***
- *Sanwa (Echinocloa colonum)* of rice can be controlled by using the herbicides **- Butachlor/Machete**
- Herbicide, Butachlor, can be applied as **-Pre emergence**
- First developed dwarf variety in rice **- Taichung Native (TNI)**
- Drought tolerant variety of rice **- Bala, Bhavani**
- Blast resistant variety of rice **- Jaya, Rasi, CO-14**
- BLB resistant variety of rice **- TKM-6**
- Salt resistant variety of rice **- Jaya, Ratna**

- Super rice variety is **- Lunisree**
- Super rice variety is developed by **- CPRI**
- Super rice concept given by **- G. S. Khush**
- Deep water rice variety **- Pankaj, Jaganath**
- National average Yield of rice for India **-1750 kg/ha**

2. WHEAT

- Botanical name of wheat ***- Triticum aestivum***
- Highest production of wheat in India - UP
- Highest productivity of wheat in India **- Punjab**
- Protein content in wheat is **- 11%**
- Protein of wheat is called **- Gluten**
- Bread wheat is scientifically called ***- Triticum aestivum***
- Macroni wheat is scientifically called ***- Triticum* durum**
- Emmer wheat is scientifically called ***- Triticum* dicoccum**
- Percentage of area under the Bread wheat in India **- 87%**
- Percentage of area under the Macroni wheat in India **- 12%**
- Percentage of area under the Emmer wheat in India **- 1%**
- Normal sown varieties of wheat are **- Kalyansona, Sonora 64; Lermaroja**
- Mutant varieties of wheat are **- Sabarmathi sonora**
- Late Sown variety of wheat are **– Sonalika**
- Sowing of wheat under normal sown **-I fortnight of Nov.**
- Sowing of wheat under Late sown **- II**
- Normal seed rate of wheat cultivation **- 100 Kg**
- Normal Spacing for wheat cultivation **- 22.5 cm between rows, No spacing between plants**
- Normal depth of sowing dwarf varieties of wheat **- 5 cm**
- Depth of wheat sowing depends on **- coleoptiles length**
- Most critical stage for irrigation on wheat **- Crown Initiation Stage (20-25 DAS)**
- Most known weed of wheat is **- wild oat *(Phalaris minor)***
- *Phalaris minor* can be controlled by using herbicides - Isoproturon/ **2, 4 -D**
- Normal Fertilizer rate for wheat cultivation **- 120:60:40 kg NPK/ha**
- National average Yield of wheat for India **- 2900 kg/ ha**
- Gene responsible for dwarfness in wheat **- Rht 1 and Rht 2**
- First dwarf variety of wheat is **- Norin- 10**

3. REDGRAM/ARHAR/PIGEONPEA

- Botanical name of Pigeonpea ***- Cajanus cajan***
- Normal season of sowing Pigeonpea in India - June/July
- Normal seed rate for Pigeonpea cultivation is -12-15 kg/ha
- Normal spacing for extra early variety of Pigeonpea cultivation is **- 50 x30 cm**
- Normal spacing for early variety of Pigeonpea cultivation is **- 75 x30 cm**

- Normal spacing for Long day variety of Pigeonpea cultivation is **- 90 x30 cm**
- Important pegionpea varieties **- Pusa Ageti, prabhat**
- Wilt resistant varieties of pegionpea **- Mukhta**

4. SUGARCANE

- The sugarcane flowering is called **- Arrowing**
- The sugarcane flower is called **- Arrow**
- Wild type sugarcane is *- Sacharum Spontoneum*
- Noble sugarcane is *- Sacharum officinarium*
- Noble can used for chewing purpose is *- Sacharum officinarium*
- Sugarcane which takes 18 months for harvesting and usually planted in June-July (Kharif) is called **- Adsali sugarcane**
- Sugarcane which takes 12 months for harvesting and usually planted in Dec-January in south India is called **- Eksali sugarcane**
- Eksali sugarcane is usually planted in south India during **- Dec- January**
- Eksali sugarcane is usually planted in North India during **- Feb-April**
- Eksali sugarcane is usually planted in North India during Feb-April due to **- Late harvest of Rice**
- Instrument used to the maturity of sugarcane is **- Brix Meter**
- Ideal reading Brix meter for optimal maturity of sugarcane is **-18-22**
- State for largest area and highest production of sugarcane is **- U.P**
- State for highest productivity of sugarcane is **- Tamil Nadu**
- Normal Seed rate for sugarcane production **-25-30000 sets of 3 budded, 45-50000 sets of 2 budded and 1, 25000 sets for single budded**
- Normal Spacing for sugarcane production **- 90 cm between the rows**
- Normal Fertilizer rate for sugarcane production **-270:150:120 kg NPK/ha**
- Sugarcane ripener used is **- Glyphosate (5 kg / ha)**
- Important weeds of sugarcane are ***-Sorghum halapense, Cynodan dactylon***
- Red rot resistant variety of sugarcane are **– CO-1148, CO-19, B-17**
- Smut resistant variety of sugarcane are **– CO-527, CO-449**
- 'Variety famous as a 'Wonder cane' is **- COC-671 (highest sugar %)**
- National average yield of sugarcane in North India **- 60-100 t/ha**
- National average yield of sugarcane in South India **- 120-140** t/ha

5. BENGAL GRAM (CHICKPEA)

- Botanical name of Bengal gram *- Cicer arietinum*
- The crop known as king of pulse is **- Chickpea**
- Area under Bengal gram production **- 7.87 Mha**
- Production of Bengal gram **- 4.5 Mt**
- Bengal gram occupies …… % of area under pulses **- 33%**

- Leaf of Bengal gram contains **- Malic acid**
- Normal Sowing Season of Bengal gram **-II fortnight of October**
- Normal Spacing for cultivation of Bengal gram **- 30x10**
- Normal seed rate for cultivation of Bengal gram **- 100kg**
- Normal fertilizer rate for cultivation of Bengal gram–**20:60:10 NPK Kg /ha**
- Normal depth of sowing for cultivation of Bengal gram **- 7-10 cm**
- Plucking of apical buds on 30 DAS to encourage lateral branching in Bengal gram is called **- Nipping**
- Bengal gram harvested after **- 150 days**
- National average yield of Bengal gram from irrigated area **– 1500 kg/ha**
- National average yield of Bengal gram from rainfed area **- 400-500 kg/ha**

6. Ground nut

- Botanical name of groundnut **- Arachis hypogeal**
- Origin of groundnut **- Brazil**
- Largest producer of groundnut **- Gujarat**
- Oil content of groundnut **- 40-50%**
- Protein content of groundnut **- 26%**
- Best soil for groundnut cultivation **- Sandy loam**
- Normal sowing season for groundnut cultivation **–June-July**
- Normal Seed rate for cultivation of spreading type groundnut **– 120 kg**
- Normal Seed rate for cultivation of bunch type groundnut **- 110kg**
- Normal Spacing for cultivation of spreading type groundnut **- 45x10 cm**
- Normal Spacing for cultivation of bunch type groundnut **- 30x10 cm**
- Normal Fertilizer rate for cultivation of groundnut **– 20-40:40-90:20-40 kg NPK/ha**
- Gypsum rate for cultivation of groundnut **- 400 kg/ha**
- Which ground nut shows dormancy **- Spreading type**
- Chemical used to break dormancy in Spreading type groundnut is **- GA_3**
- Which ground nut tends to germinate in the field itself before harvest **-Bunch type**
- Chemical used to arrest germination of Bunch type ground nut, in the field itself before harvest is **- Malic hydrazide**
- Chemical used for floral initiation in groundnut **- NAA @ 40 ppm on 40 DAS**
- The fungi which affect kernel during shortage in ground nut - ***Aspergillus flavus***
- Bitter taste of groundnut kernel is due to **- Afalotoxin**

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CROP PRODUCTION UPDATES

RICE

- Chromosome no. of rice (*Oryza sativa*) **– 2n = 24**
- Origin of rice **– South- East Asia** or **Indo-Burma**
- Rice occupies …….area over the world **- 150 Mha**

- The largest producer country of rice - **China**
- India's rank in rice production - **second**
- The country which is the largest growing country in the world (44.6 m ha)- **India**
- No. of species identified under Genus Oryza -21
- cultivated species of Genus Oryza are **- *O. sativa* (Asia) and *O. glaberrema* (Africa)**
- Varietal group of O. sativa
  - Indica (tropical), **Japonica** (temperate), **Javanica** (Intermediate)
- Country having the richest rice germplasm collection in the world **- India**
- The process of tillering start in Rice…… Days After Planting **-10**
- Rice grain is a …….type of fruit **- Caryopsis**
- Rice inflorescence is called **- Panicle**
- Optimum temperature for rice seed growing is **- 20-35˚C**
- Rice is a **- Short day plant**
- Three system of rice cultivation
  1. Dry cultivation – Rainfed
  2. Semi dry cultivation – After 45-60 days treated as wet crop
  3. Wet cultivation – 3-5 cm standing water
- 45 % of rice grown is under **- Irrigated condition**
- There are 3 type of nursery
  1. Wet nursery: 25-30 days (age of seedlings)
  2. Dry nursery: 20-25 days
  3. Dapog nursery:
- Dapog nursery gives seedling ready for transplantation within **- 14 days**
- Area required in Dapog method of nursery **- 30 m^2 for 1 ha**
- Seed rate in Dapog method of nursery **- 1 kg/m^2**
- Dapog method of nursery is introduced from **- IRRI, Philippines**
- …… % yield loss caused by weeds in rice **- 10** %
- Traditional basmati cultivating area in the country
  - Punjab, Haryana, and western U.P
- World first high yielding and also semi-dwarf Basmati variety - **Pusa Basmati**
- Rice hybrid technology based on **- 3 line breeding** (A line, B line & R line)
- Paddy harvested at …… % moisture and stored at ……% **- 20** % and **14** %
- Khaira disease in rice cause by deficiency of **- 'Zn'**
- Disease which is major problem in rainfed upland, rainfed lowland and hill area
  - Blast disease
- Neck blast damage is severe in ……..varieties **- Basmati**
- Chlorophyll meter method and leaf colour chart used for …….... determination
  - leaf 'N' status (crude method)
- Rice protein is called **- Oryzein**

Wheat (*Triticum aestivum*)

- Chromosome no. of wheat **– 2n = 42**

- Origin of wheat is – **Asia minor/ South West Asia/ Central Asia**
- Wheat revolution in india occurs in year 1967, due to variety **-'HD 2329'**
- India is ……in terms of area and production of wheat (after China) **- second**
- Before green revolution all varieties in India were **- tall** type
- In wheat most critical stage is **- CRI**
- *Phalaris minor* is major weed in **- Wheat** fields
- Zinc and sulphur deficiency in wheat field reported in **-Punjab**
- Mn deficiency in wheat field reported in **- Punjab**
- Causal organism of Leaf/Brown rust of wheat is ***- Puccinia recondita***
- Causal organism of Stripe / Yellow rust of wheat is ***- P. striiformis***
- Causal organism of Stem / Black rust of wheat is ***- P. graminis tritici***
- Wheat grains stored well in …..% moisture content **- less than 10 %**
- Wheat protein is called **- Glutenin**

Barley (*Hordeum vulgare*)

- Lugri is a fermented drink developed from **- Hull less barley grains**
- 'Pearl barley' is suited for **- Kidney disorders**
- Seed rate of barley is **– 75-80 kg/ha**
- Critical stage in barley is **-Active Tillering Stage**(30-35 DAS)
- Molya disease Resistance variety of Barley is **- RD-2052**
- Malting quality is high in this variety **- Rekha**

Maize (*Zea mays*)

- Quality protein maize (QPM) varieties released by using **-Opaque-2 genes**
- Quality protein maize (QPM) varieties are **– Shaktiman 1 & 2, HQPM 1, Sakti 1**
- Hybrid varieties of maize are **– Ganga 1, Deccan 107, 109**
- Composites varieties of maize are **– Parbhat, pratap, Pusa comp.2, Pusa comp1**
- Normal seed rate of maize is **-20 kg/ha**
- Maize grain contains ……. %protein & ……..% oil **- 8-10 %and 4-5%**
- Sweet maize variety is **– African tall**
- Sweet corn variety is **– Composite madhuri and priya**
- Pop corn variety is **– Amber, V L Amber, Pearl popcorn**
- Baby corn is **– VL 42, Prakash**
- Maize protein is called **- Zein**
- Two most critical stages of maize is **– Tasseling & Milking stage**

MILLETS

- Millets belongs to …….group of plants **- C_4**
- Higher productivity among the millet **- Finger millet**

Sorghum (*Sorghum bicolor)*

- 2n = 20
- Seed rate = 18 kg / ha
- Hybrids : CSH 1 to 6, CSH 9,10, 11, 13, 16, 17,18
- Major pest: Shoot fly, stem borer, midge, ear head bug
- HCN (Dhurrin, synthesized in roots) present in early stage (40-50 days)

Pearl millet (*Pennisetum glaucum)*

- 2n = 14
- Seed rate = 5 kg/ ha
- 80 % phosphorus in grain stored in the form of 'phytate'
- Productivity high in UP>Gujarat> Haryana

Others

- Finger millet (*Eleusine coracana*), 2n = 36
- Kodo millet (*Paspalum scrobiculatum*), 2n = 40
- Fox tail millet (*Setaria italia*), 2n = 18
- Proso millet (*Panicum millaceum*), 2n = 36
- Little millet (*Panicum sumatranse*), 2n = 36
- The inflorescence of sugarcane is called Arrow

PULSES

- It is important dietary protein
- Bengal gram (*Cicer arietinum*), 2n = 16
- Pigeon pea *(Cajunus cajan),* 2n = 22, highly sensitive to frost
- Green gram *(Vigna radiata*), 2n = 22. Very sensitive to water logging
- Black gram *(Vigna mungo*), 2n = 22
- French bean (*Phaseolus vulgaris*), 2n = 22
- Cow pea (*Vigna unguiculata*), 2n = 22
- Lentil *(Lens culinaris)*
- Field pea (*Pisum sativum)*
- Lathyrus *(Lathyrus sativus)*

4. Fundamentals of Soil Science

General Soil Science

- A-value is proposed by **- Fried and Dean (1952)**
- An available soil nutrient, determined in terms of a standard fertilizer used is called- **A-value**
- A-value is used for the assessment of available **- P and S in soils.**
- A fertilizer that leaves an acidic effect in the soil is called **- Acid forming fertilizer**
- Example of Acid forming fertilizer **- Ammonium, sulphate, ammonium chloride, anhyhdrous ammonia, urea *etc.***
- Acid forming fertilizer fertilizers Mostly lack **- a metallic cation**
- Rain water containing excessive concentration of acidic compounds, primarily NO^{-}_{2}, SO_4^- and H^+ is called **- Acid rain**
- Usually Acid rain has a pH of **- 5-7**
- Acid rain received where atmospheric pollution through - **industrial activity/vehicular exhaust is high**
- A soil having pH below 7.0, for practical purposes less than 6.6, is called **- Acid soil**
- Very acid soil (pH<4) in which sulphuric acid is formed by the oxidation of S-bearing ferrous pyritre minerals is called **- Acid sulphate soil**
- Acid sulphate soil found primairly in ……..areas of the humid tropics - ***coastal, deltaic*** and ***estuarine***
- Acid sulphate soil also called ***- cat clays***
- Acid sulphate soil are difficult to reclaim because - acid production is regular
- Sludge which has been subjected to microbial action, hence improved for use on land is called - *Activated* sludge
- Typical nutrient content of *Activated* sludge is - 5.8% N, 3.2% P_2O_5 and 0.6%K_2O
- Nutrient absorption mechanism for which energy is needed is called - Active uptake
- The force of attraction that binds the molecules of different kinds is called – Adhesion
- Clods and crumbs formed by binding together of sand, silt and clay particles is called - Aggregate
- Unit of soil structure. The process of aggregate formation is called - **aggregation**
- Material containing oxides, hydroxides and/or carbonates of Ca and/ or Mg, used for neutralizing soil acidity is called - *Agricultural lime*
- The study of applied phases of soil science and soil management is called - Agrology
- The quantity of air present in the soil at fleld capacity is called - ***Air capacity*** **of soil**
- The flooded soils where hydrogen sulphide is formed due to sulphate reduction and anaerogic decomposition of organic matter is called - *Akiochi* soils
- Soil order representing soils having moderately high base saturation and accumulation of clay in the sub surface (B horizon) is -- ***Alflsols***
- Red soils of Hyderabad and Bengaluru are example of - - ***Alflsols***

WEATHERING OF ROCKS AND SOIL FORMATION

- Earth crust consists of the elements
  - Oxygen (46.6%), silicon (27.7%), aluminum (8.1%), iron (5.0%) etc
- Rocks are basically divided into 3 types **- Igneous Rocks, Sedimentary rocks and Metamorphic rocks**
- Example of Igneous Rocks are **- Granite, Basalt (Deccan Trap),**
- Acidic igneous rocks contain ……..% quartz **- 60-75%**
- Example of Acidic igneous rocks **- granite**
- Basic igneous rocks contain ……..% quartz **- less than 50%**
- Example of Basic igneous rocks **- Basalt**
- Example of Sedimentary rocks are **- Limestone, sandstone, Dolomite**
- Metamorphic rocks are formed from **- Igneous and sedimentary rocks**
- Example of Metamorphic rocks **- Marble, Gneiss, Schist, graphite, slate**
- Gneiss is formed from **- Granite**
- Marble is formed from **- Limestone**
- Graphite is formed from **- Coal**
- Slate is formed from **- Shale**
- Quartzite is formed from **- Quartz or Sandstone**
- The chief sources of soil parent materials over which soils are formed **- Rocks**
- Soil is formed from **- Weathering of rocks**
- Weathering is **= Disintegration + Decomposition**
- Process which breaks consolidated rocks into unconsolidated parent materials, which on further breaking and chemical decomposition forms soil**- Disintegration**
- Physical weathering involves agents such as temperature, **Water, wind, Plant and animals and processes such as exfoliation (surface peeling off of rocks), alternate wetting and drying, freezing and thawing, burrowing of animals, root penetration, etc.**
- Water, on freezing, expands % by volume **- 9%**
- Chemical weathering reactions are- **Solution, hydration, Hydrolysis, carbonation, Oxidation and reduction.**
- The most important chemical weathering process **- Hydrolysis**
- The weathering taking place at the layers down below whereas pedo-chemical or pedogenic weathering is the one taking place at the surface and subsurface layer is called **- Geo-chemical weathering**
- Soil found at the site of formation- sedentary soils, whereas soils found far away from the site of formation are called **Cumulous or transported soils**
- Name of the soil formed by transport of the River water **-Alluvium**
- Name of the soil formed by transport of the Lake water **- Lacustrine**
- Name of the soil formed by transport of the Seawater **-Marine**
- Name of the soil formed by transport of the coarse Wind **- Aeolian**
- Name of the soil formed by transport of the fine wind **- Loess**
- Name of the soil formed by transport of the Gravity **-Colluvium**

- Name of the soil formed by transport of the Ice **-Moraine.**
- The study of origin, formation and geographic distribution of soils in nature is called **- Pedology**
- The study of soil in relation to crop growth **- Edaphology**
- The vertical section of soil through all its horizons and it extends up to its parent materials is called **- Soil profile**
- The smallest volume that can be recognised as a soil individual and it is 3-dimensional **- A pedon**
- The horizontal layers in a soil profile are called **- Horizons**
- Typically there are 4 horizons **–O, A, B and C.**
- A horizon is below O horizon out of which A_2 layer is called **illuvial horizon**.
- B-horizon is found below **- A horizon**
- B-horizon is mostly called **- illuvial horizon**
- One layer wherein soil materials are removed whereas illuvial layer is one wherein soil materials removed from other layers are deposited is called **- Elluvial layer**
- C- Horizon consists of **- Unconsolidated parent materials**
- Below the C-horizon is found the R-layer, which is known as the **Bed Rock**
- A and B horizons is combindly called **- Solum**
- A+B+C horizons are called **- Regolith**
- The study of the soil in the field condition with the help of various morphological characteristics is called **- Soil Morphology**
- The father of Soil science **- Dokuchave**
- Dokuchave gave the factors of **- Soil formation**
- The five factors of soil formation are **S= f(CLORPI) –** Climate and organism (Active factors), Relief or topography, parent material and time (passive factors), given by Jenny
- Who gave the active and passive factor concept **- Jenny**
- There are various processes of soil formation out of which two are important - **Laterisation and Podzolisation.**
- Laterisation occurs in **- warm humid tropical conditions**
- Podzolisation occurs in the **- cold humid temperate conditions.**
- Process of soil formation in which Silica (SiO2) is removed from the A horizon and sesquioxides are left out in the A-horizon is called **- Laterisation**
- Process of soil formation in which sesquioxides are leached from the A horizon and silica is left out in upper layers is called **- Podzolisation**

Major soils of India

1. **Red Soils (Alfisols**)j
   - Red colour in red soils due to the presence of various oxides of iron
   - Light texture, porous structure, deficient in organic matter
   - Absence of lime and low soluble salts
   - Slightly acidic to neutral in reaction
   - pH ranging from 6.0 to 7.5

- Rich in Kaolinite (1:1) type of clay minerals
- Formed from ancient crystalline and metamorphic rocks
- The parent material for red soils is mostly granite
- It covers an area of 117.2 m ha (36 %)
- Distribution – Areas of Madras and Mysore, part of A.P, M.P, Orissa, Bihar, Santhal paragana (Bihar) , Mirzapur, Jhansi district of U.P
- Red soil in Tamil Nadu occupies the largest area.

2. Black soils (Vertisols) :

- Covers an area of about 74 m ha accounting for 24 % of the total geographical area
- Generally rainfed
- The soils are dark or dark brown in colour
- Developed from Basaltic rock under semi arid condition
- The soils are locally known as 'Regur' or black cotton soil, deep black soil, and medium black soil.
- The texture ranges from sandy loam to heavy clay.
- One of the characteristics of the swells on wetting during the season and shrinks and cracks in summer season
- The base exchange capacity of deep black soil is quite high
- The pH varies from 7.5 to 8.5
- The soils are deficient in nitrogen and phosphorus and they are rich in potash and lime
- The clay content ranges from 40-69 % and occasionally upto 80 %
- Cation exchange capacity is 35-50 meq/100g soil
- Rich in montmorillonite and beidelithoc group of clay minerals
- **Occurrence** – Maharashtra, Gujarat, M. P, Rajasthan, U.P, A.P and Madras

3. Alluvial soils (Entisols):

- Soils of recent origin
- It is grey or greyish- brown in colour and texture of alluvial soils is sandy loam to clay loam
- Most fertile soil
- Base exchange capacity is comparatively low and pH varies from 7.0 to 8.0
- Occupies the largest area i.e. 75 m ha
- The alluvial soils are found in the areas of Rajasthan, Punjab, U.P, Bihar and West Bengal
- Sufficient in P and K but deficient in Nitrogen and organic matter

4. Laterite and lateritic soils (Ultisols):

- Occupy 25 mha of the total geographic area
- Texture of top soil is loamy or clayey.
- Associated with undulating topography in region with a relatively high annual rainfall

- It is deficient in lime and are slightly to moderately acid in reaction
- The pH values from 5.0 to 6.0
- They are low in base exchange capacity
- Laterites are the oldest or most weather soils
- Predominate in Kaolinite type of clay minerals
- Deficient in P, K, Ca, Zn, B etc
- Shifting cultivation is mainly practised in these areas

5. Desert soils (Arid soils):

- Covers an area of about 29 m ha
- Developed in Arid regions. It is mostly sandy
- Desert soils contain large amount of soluble salts and varying proportion of lime
- They have a high pH and are very poor in fertility constituents
- Composed of Quartz but feldspar and horn blend grains also occur with a fair grains also occur with a fair proportion of calcareous grains
- Desert soils are largely found in parts of Rajasthan, South Punjab and in the range of Kutch.

6. Saline and Alkaline soils:

- Developed in the arid and semi arid regions
- Poor drainage is also responsible for their development
- Saline are called Alkali soils and are said to cause Boron toxicity. Treated by leaching
- Alkali soils are reclaimed by applying Gypsum
- Pulses and oilseeds are very sensitive to this soils
- Saline soils occupies 7.2 m ha and alkali soils – 2.8 m ha
- Highest in Uttar Pradesh
- pH is greater than 8.5
- Difficult to manage
- Exchangeable sodium percentage is more than 15
- Electrical conductivity is more than 4 mm hos/cm
- Occurrence- Indo-gangetic alluvium in the north and the deltic region

7. Forest and Hill soils:

- Estimated to be 75 m ha
- Occurrence –Himachal Pradesh, J& k, U. P, Uttarakhand, Bihar , Maharashtra, Kerala and North Eastern Region

Soil erosion and its control

- The loss in soil productivity due to physical, chemical and biological deterioration is called **- Soil degradation**

- Causes are excessive pressure on land to meet the growing demands of population . They are in the form of over exploitation of natural resources like overgrazing, excessive deforestation, faulty methods of agricultural practices, shifting cultivation or Jhuming.
- There are 2 types of soil erosion Normal erosion (geological erosion) and Accelerated erosion.
- In normal erosion, rate of soil loss = rate at which soil is formed.
- Accelerated erosion is one where rate of soil of loss is far greater than the rate at which it is formed.
- Area affected by soil degradation is 187.9 Mha (57.1%) of the total geographical area.
- Deterioration in the form of water erosion (148.9 Mha), Wind erosion (13.5 Mha), chemical deterioration – 13.8 Mha, Physical deterioration like water logging (11.6 Mha) and Biological deterioration.
- Type of Water erosion: Erosion by water – splash erosion, sheet, rill, gully, stream bank and landslide erosion
- The splashing effect of raindrops on soil particles results in **- Splash erosion**
- Sheet erosion is not clearly recognised but can be seen as muddy run-off.
- Erosion leads to formation of finger like rills is **- Rill erosion**
- The severe form of rill erosion wherein grooves form deep channels called gullies are formed - gully erosion
- **Size of gullies:**

Symbol	Description	Specifications
G_1	Very small	Up to 3 m deep and 18m bed width. Side slopes vary
G_2	Small	Up to 3m deep and greater than 18m bed width. Side slope very
G_3	Medium	Depth between 3 and 9m. Bed width greater than 18m. Side slopes uniformly sloping between 8 and 15%
G_4	Deep and Narrow	(a) 3m-9m deep. Bed width less than 18m. Side slope vary. (b) Depth greater than 9m. Bed width varies. Side slope vary, mostly steep or even vertical, with intricate and active branch gullies.

- The mechanism of water crosion is *detaching effect* of raindrops and surface flow of water *carries* the detached soil particles to far places.

Wind erosion:

- Wind erosion normally occurs in **- arid and semi-arid regions.**
- 3 types of soil movement are seen in wind erosion : **saltation, suspension and surface creep.**
- **Saltation** is the most important process in wind erosion and control of wind erosion is mainly based on elimination of movement in saltation. Particles of size 0.1 to 0.5mm are lifted.

- Major portion of soil carried by wind is moved in a series of bounces called **saltation**.
- **Suspension**: Very fine particles less than 0.1mm in diameter are carried into suspension over long distances. They are kicked up into air by action of particles in saltation.
- **Surface creep**: Particles larger than 0.5mm but smaller than 1.0mm are pushed and spread along the surface by impact of particles in saltation to form a surface creep.
- The mechanism of wind erosion is **Initiation, transportation and deposition.**

Factors affecting soil loss:

- Universal soil loss (USLE) was given by **- Weischmeir and Smith.**
- A= RKLSCP where A denotes soil loss in the, R-Rainfall erosivity, K-soil erodibility, L-slope length, S-slope%, C-crop management factor, P-Soil Management factor.
- Soil loss is calculated by comparing soil loss with an ideal plot of **22m long (72 ft) and 9% slope.**

Rainfall crosion index = Kinetic energy of the storm x Max 30 minute intensity

- Intensity of the rainfall is more important than duration and frequency of rainfall in causing soil loss.
- Soil texture, structure, infiltration, permeability, organic matter content etc affects soil erosion.
- Lateritic soils are less erodible than black soils.
- Speed and extent of run-off is decided by slope% and length.
- Velocity of water flow is proportion to square root of slope% or vertical drop.
- Hence if land slope% is increased 4 times then velocity is doubled.
- If velocity is doubled, erosive power of How is increased by 4 times *i.e.* erosive power is proportional to square of the velocity.
- Size of the particles carried by the flow is proportional to the 6^{th} power of the velocity of flow. If velocity is doubled, size of the particles carried is increased by 64 times.
- Quantity of soil transported is proportional to the 5^{th} power of the velocity of flow. If velocity is doubled, then quantity of soil transported is increased by 32 times.
- So erosion is geometrically increasing with **slope%.**
- Loss of plant nutrients increases with increase in **degree of slope.**
- Soil loss is less when land is left undisturbed under a natural cover and soil loss increases steeply when vegetation is removed and land is cultivated.
- **Legumes and grasses** are stronger in preventing soil loss.
- Monoculture of cereals should be avoided.
- Some important *e.g.* of order of soil loss.
-

Cultivated > bare fallow > Maize – wheat under > Natural grasses

Fallow land up and down cultivation

Cultivated fallow > Jowar > natural cover

Overgrazed fallow or Maize > Natural fallow

Soil and Water Conservation Measures

- The key to soil and water conservation is to follow land capability classification
- Land capability classes are based on intensity of hazards and limitations. As class increases, the intensity of limitations increases.
- Class V has no crosion hazard but it is placed in class V only due to the fact that it limitations are practically difficult to remove.
- Class VIII includes Bad Lands rock outcrops, sandy beaches, marshes, deserts, river washes, mine spoils and other nearly barren lands.
- The colours for the various classes from I to VIII are Green, yellow, Brown, Pink, Grey, Orange, Red and Purple.
- Sub class indicates dominant limitation and is denoted by e, w, s, c – e for erosion, w for wetness, s for soil limitations and c for climate.
- If two limitations are found, the dominant limitations are written first.
- The order of priority in case of equal extent of limitations is e, w, s, and c.
- Arid lands start with class IV, semi-arid with class III or IV, sub-humid where crop yield is affected frequently by drought with II or III, Humid climate with occasional dry spells with II and humid climate with well distributed rainfall with CLASS I.
- Soil and water conservation measure are divided into Agronomic and Engineering measures.

Agronomic measure:

- The principles are to intercept raindrops and stop splash effect, to increase intake rate and to stop overland flow.
- ***Contour farming:*** It is farming across the slopes along the contour bunds within 6% slope, Important examples of soil loss: Maize + cow pea (Contour cultivation) < maize (up and down cultivation).
- Potato (contour cultivation) < Potato (up and down cultivation)
- ***Mulching:*** synthetic and natural.
- ***Selection of crops:*** crops selected should provide maximum cover of soil. Legumes are very effective particularly cowpea and mung. Crops can be divided into crosion resistant (Ground Nut) and crosion permitting crops (URAD).
- Important *e.g.* of soil loss: Urad > Maize > Gora paddy > G. Nut.
- Jowar > Black gram > G. Nut.
- Biditobacco- fallow > Sun hemp- Biditobacco-fallow> Bajra-fallow> Bajra-Mung.
- ***Strip cropping:*** Alternate strips of erosion resisting and erosion permitting crops.
- Wind strip cropping is growing alternate rows of tall and short crops across the direction of wind.
- ***Mixea cropping:*** Better protection and yield than strip cropping.

Engineering measures:

- To increase the opportunity time and to divide the long slopes into short ones so that the velocity of flow is reduced.
- The methods are basin listing using basin leister (excavate some soil to allow rain water to enter), sub-soiling (to remove the surface hard pans),contour bunds upto 6% slope, graded bunds in rainfall areas with a vertical interval of 0.3 (s+3) where S is slope %, Bench terracing (series of benches or platforms, Grassed waterways using Pannicum repans, Brachaeria mutical or cyanodon.
- Gully control measures: Check dams, sodding, Gully plugging with brush woods, wire meshes, sand bags, boulders, live hedges (Vetiver), bricks masonry items, etc earthen plugging.
- In case of small gullies, diversion check bunds and in case of medium gullies, cheek dams at vertical interval of 1.2m and terracing the side slopes are done.

ROLE OF NPK AND THEIR DEFICIENCY SYMPTOMS

Θ Nutrient deficiencies in plants:

Symptoms/diseases		Due to deficiency of
* Whip tail in cauliflower	:	Mo (Molybdenum)
* Downward cupping in radish	:	Mo
* Scald of leaves	:	Mo
* Yellow spot in citrus	:	Mo
* Drying black tips of shoots	:	K (Potassium)
* Grey speck of oats	:	Mn (Manganese)
* 'Speckled yellows' of sugar beet	:	Mn
* Marsh spots of peas	:	Mn
* Pahala blight of sugarcane	:	Mn
* Frenching of Tung trees	:	Mn
* Die back of shoots in citrus	:	Cu (copper)
* Little leaf in citrus	:	Cu
* Rough bark and cracking in apple	:	Cu
* Browning or hollow stem of cauliflower	:	B (Boran)
* Heart rot of sugar beet and Marigold	:	B
* Top sickness of tobacco	:	B
* Snake heads in walnuts	:	B
* Internal necrosis in mango	:	B
* Hen and chicken disorder of grape fruit	:	B
* Corking and pitting of fruits in tomatoes	:	B
* Internal necrosis in aonla	:	B
* Brown heart of turnip	:	B
* Fruit cracking of tomato and pomegranate	:	B
* Crown choking in coconut	:	B
* White bud of maize	:	Zn (Zinc)
* Khaira disease of rice	:	Zn

*	Leaf bronzing in litchi	: Zn
*	Little leaf in mango, litchi, cashew	: Zn
*	Jonathan spot of apple	: Water
*	Bitter pit of apple	: Ca (Calcium)
*	Interveinal chlorosis in apple and citrus	: Mg (Magnesium)
*	Black heart of potato	: O_2(Oxygen)
*	Buttoning in cauliflower	: N (Nitrogen)
*	Leaf scorch in mango	: Excess of Cl ions in water/ or excess of MOP
*	Tip burn of rice	: O_2 deficiency and excess of zinc

Θ Mineral nutrients and their available forms:

	Nutrients	Plant part where symptoms first appeared	Available forms
*	Nitrogen	: Older leaves	: NO_3^-, NH_4^+ ions
*	Phosphorus	: Older leaves	: $H_2PO_4^{2-}$, Po_4^{3-} ions
*	Potassium	: Older leaves	: K^+ ions
*	Calcium	: Young leaves	: Ca^+ ions
*	magnesium	: Older leaves	: Mg^{2+}
*	Sulphur	: First in new leaves	: SO_4^{2-}, SO_2 from air
*	Iron	: New leaves	: Fe^{2+}, Fe^{3+}, $FeSO_4$ with EDTA
*	Manganese	: Older leaves	: Mn^{4+}, Mn^{3+}, and Mn^{2+}
*	Zinc	: Small yellow new leaves	: Zn^{2+}, $ZnSo_4$ with EDTA
*	Copper	: New leaves	: Cu^{2+} or Cu^+, $CuSO_4$ with EDTA
*	Molybdenum	: Older / younger leaves	: MO^{3+}, Molybdate ions
*	Boron	: New leaves	: BO_3^{3-}, H_2BO_{3-}, HBO_3^{2-}

(Hint:- Older leaves-NPK Mg Mn Mo ;Younger leaves- others)

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Manures (FYM, Compost and Green manure) and Fertilizers (Urea, DAP, SSP and MOP)

Soil Fertility, manures and fertilizers:

- Soil productivity and fertility are synonymous terms. Soil productivity is soil fertility + something.
- There are 16 essential elements for plant growth. There are divided into Macro and micronutrients based on the amount of plant uptake.
- Major nutrients consist of Primary elements. Beneficial elements are I, Se, Ga, AI.
- Ballast elements are AI and SI.

- Arnon gave the criteria for essentiality of the nutrients
- Nicholas gave the term functional or metabolic nutrients.
- Law of minimum was given by Father of Agricultural Chemistry Leibig
- Law of Diminishing Returns was given by Mitscherlich.
- Nutrient such as nitrate, chloride and sulphate are not absorbed by the soil colloids and remain mainly in the soil solution.
- Diffusion mechanism enables nutrient movement *without* the movement of water.
- It is the mechanisms predominant are supplying most of the P and K to plant roots.
- Nitrogen role: greenish colour, efficient utilization of P and K. Its deficiency symptoms (yellowing) occur in the older leaves because of its high mobility, deficiency hastens maturity whereas toxicity delays maturity because of prolonged vegetative flush, succulent, leathery growth and also causes lodging. Toxicity also impairs the quality of barley, tobacco, sugarcane and fruits.
- Nitrogen is available both in anionic and cationic form.
- Phosphorus promotes root growth, new cell formation, formation of grains and maturation of crops, influences the vigour of plants and improves the quality of the crops, increases resistances to diseases, N fixing in legume crops. Its deficiency causes reddish or purplish discolouration of stem and foliage due to abnormal increase in the sugar content and formation of anthocyanin.
- Potassium: to resist pest and diseases, cold and adverse conditions, starch production and production and translocation of sugars, improves the quality of tobacco and citrus. Luxury consumption is noticed. Deficiency symptoms ringing of alfalfa leaves with rows of small white spots: reddish brown discolouration of cotton leaves, drying, scorching and curling of leaf margins in potato and 'interveinal chlorosis and 'firing' along the edges of maize leaves.

Nitrogenous fertilizers:

- Sodium Nitrate: 1st nitrogenous fertilizer.
- Chilean Nitrate; 16% N in nitrate form. Particularly useful in acid soils
- Ammonium sulphate: 20.6% and 24% S. When close to seeds affects seed germination
- Anhydrous Ammonia contains highest N content of 32%.
- Urea contains 46% N and non-proteined organic form of N, amide form of N.
- Ammonium nitrate: 33-35% N (half as nitrate form and other half as Ammonical form), acidulating and explosive.
- Nitro-chalk is obtained by mixing Ammonium nitrate with about 40% limestone or dolomite. It has 20.5% (50% in Ammonical form and 50% in Nitrate form).
- Ammonium Sulphate Nitrate: Ammonium Nitrate + Ammonium sulphate. Contains 26% N ($3/4^{th}$ in Ammonical form and $1/4^{th}$ in nitrate form.

- Ammonium chloride: 26% N, possesses good physical condition, similar in action to ammonium sulphate, not recommended for tomatoes, tobacco and other such crops.
- CAN: Calcium Ammonium Nitrate Kisankad 25-28% N (1/2 ammonical and ½ nitrate).
- Slow release N fertilizers: Neem coated urea, Tar coated urea, urea formaldehyde (urea form), Urea super granules, etc.
- Dried bone meal – 10-12% highly available N.

Phosphatic fertilizers:

- Rock phosphate: 25-35% water insoluble phosphoric acid. Bone meal contains 20-25% P_2O_5.
- Super Phosphate: Most widely used water-soluble P fertilizer in India. SSP: 16-18% P_2O_5,DSP-32% P_2O_5, TSP-44-49% P_2O_5.
- Citrate soluble P: Dicalcium phosphate- 35-38% P_2O_5, Basic slage –6-20% P_2O_5 and byproduct of steel industries.
- Gypsum: 20% S and 23% Ca.

Potassic Fertilizers:

- India imports K fertilizers mainly from Germany and France.
- MOP: KCI 50-63% K_2O.
- SOP:K_2SO_4 48-52% K_2O.
- Wood ash – 5-6% Potassium carbonate.

Complex fertilizer:

- Diammonium Phosphate: (DAP) – 18:46:0
- Suphala: Nitro phosphate – 20:20:2, 15:15:15, 18:18:9.

Manures:

- FYM has 0.3%, 0.15%, 0.3% N, P_2O_5 and K2O.
- 1 tone of cattle dung can give only 2.95 Kg of N, 1.59 Kg of Phosphoric acid and 2.95 Kg of potash.
- Night soil is also called Poudrette.

IMPORTANT POINTS TO REMEMBER:

- Soil profile – A vertical section of the soil body which shows different distinct layers (horizon)
- Soil texture – The relative proportion of sand, silt and clay
- Soil structure – Arrangement of soil particles e.g., granular, columner, compact
- Solum – A+B horizon
- Regolith – A+B+C horizon
- A well developed soil have : A, B andC horizon
- The most abundant soil found in India is alluvial soil
- Anion exchange capacity is found maximum in the case of – Kaolinite
- Cation exchange capacity is found minimum in the case of –smectite
- Black soil is the second largest group of Indian soils
- Cation exchange capacity is highest in – Montmorillonite

- Denitrification is more in water logged soils
- In no tillage systems, the surface soil layers have high bulk density
- Lime is used for reclamation of acidic soils
- Maximum absorption of water by roots takes place through the root hairs
- Maximum population of microorganisms found in soils is – Bacteria
- Most resistant mineral present in soil is – Quartz
- Montmorillonite (2:1), illite and Kaolinite (1:1) are clay minerals
- Pedology – study of soil development
- Gypsum or sulphur is used for reclamation of alkaline soils
- The most abundant mineral present on the earth is Feldspar
- pH – the negative logarithm of hydrogen ion activity in the soil
- Tolerance of soil salinity in crops – Barley> wheat > Beans>Upland paddy
- Igneous rock- Granite, Basalt; Sedimentary rocks – sandstone, Limestone, Dolomite; Metamorphic Rocks – marble, slate
- Check basin irrigation method is best suited for undulating topography
- Red soils are best suited for irrigated agriculture
- Carbon: Nitrogen (C:N) ration of normal soils -10-12:1
- The maximum moisture is available to plants at field capacity
- The main source of heat for soils is solar radiation
- Number of master horizons in soil are -5
- Micronutrient deficient in Indian soils – Zinc
- Fertilizers not produced in India – Muriate of Potash
- Degree of soil salinity is indicated by its Total soluble salt content
- Maximum saline and alkali soils are found in Uttar Pradesh
- Alkali soils are generally found in Arid and semi-arid climate
- **Gravitational water** is less available or not available for plant (-0.1 to –0.3 bar)
- **Capillary water**- water held between –0.1-31 bars, most available for plant growth, capillary water held between –15 bar is easily available to crop production
- **Hygroscopic water**- water is held below permanent wilting point, except few microbes, all plants fail to absorb hygroscopic water.
- Dark colour of soils is due to presence of Titanium and Mn
- Total essential nutrients – 17. Recently added nutrient is 'Ni'.
- Ultra micro nutrient – Molybdenum
- Among the soil fauna, protozoa are the most abundant
- Edaphology – Study of relationship between plant and soil
- Petrology – study of Rocks

Nature and composition of soil:

- Soil is a *3-phase, particulate, disperse, porous, open and heterogeneous system.*
- Ideal soil contains 50% solid matter (45% mineral matter and 5% organic matter) and 50% pore space (25% air and 25% water).
- Out of the 3 phases, Solid phase is the constant phase in terms of composition.

- There are basically 3 soil separates *viz.,* sand, silt and clay. There are two systems of classifying the sizes of these separates.
- International System given by *Atterberg* – Coarse sand 2mm – 0.2 mm, Fine sand 0.2mm to 0.02, silt – 0.02mm to 0.002mm and clay – less than 0.002mm or less than 2 microns.
- USDA system – Gravel – 2mm and more, Very coarse sand 2-1mm – 0.2mm, coarse sand – 1.0 to o.5mm, medium sand – 0.5 to 0.25mm, fine sand 0.25 to 0.1mm, very fine sand 0.1 to 0.05mm, silt 0.05 50 0.002mm and clay – less that 0.002mm.
- India follows International system of particle size classification.

Physical properties of soil:

- The relative proportion of the various soil separates is called soil texture. There are 12 textural groups.
- Light textured or coarse textured soils are easy to plough whereas heavy textured or fine textured soils are difficult to plough.
- The 12 textural groups from light or coarse textured to heavy or fine textured soils is sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay and clay.
- Gravel is neither a soil separate nor one of the soil textures.
- Particles greated than 2mm are not considered soil.
- Textured is determined by International Pipette and Bouycous Hydrometer method.
- Stoke's law is applied in the determination of soil texture.
- Silt has intermediate characteristics between sand and clay.
- Clay is called the active fraction of the soil. It is made up of alumino-silicates.
- Soil texture is a static property *i.e.* it cannot be changed.
- Soil structure is the arrangement of soil aggregates or primary and secondary particles.
- Grade of soil structure denotes the durability or stability of the aggregates – structureless, weak, moderate, strong and very strong.
- Class of soil structure denotes size of the aggregates: very fine, fine, medium, coarse and very coarse.
- There are 4 types soil structures: platy, prismatic or columnar, angular or sub-angular blocky and spheroidal (granular and crumb structure).
- Structure is denoted in the order of GRADE-CLASS-TYPE. (GCT)
- Structure of the soil can be easily changed by management practices.
- Loamy texture and granular or crumb structure is best suited for agriculture crops.
- Bulk density (Apparent density of soil is the mass of unit volume of soil including the pore space.
- Particle density (True Density) is the mass of unit volume of soil without pore space.

- Bulk density (ρ_b) is approximately half that of particle density. So bulk density is always lower than particle density.
- Value of Bulk Density is 1.4 to 1.8 Mg/m^3. Bulk density increases on compaction whereas it decreases on addition of organic matter.
- The particle density (ρ_s) of soils is around 2.65 Mg/m^3 due to dominance of quartz whose density is also of the same value.
- Porosity percentage pore space is given by the formula $100 \times (1- \rho_b / \rho_s)$.
- Porosity % in Sandy soil = 30%, clay soils = 50-60% and loamy soil = 40-50%
- Macropores are greater in coarse textured soil and are occupied by air while micropores are greater in fine textured soils and are occupied by water.
- Micropores size <0.06mm & macropores >0.06mm

Soil colour:

- It can be found out using Munsell Colour chart. Three variables are used to denote soil colour .They are hue-dominant Wavelength, Value-relative lightness of the colour and chroma-purity of the colour.

Plasticity and cohesion:

- Plasticity is the capacity of the soil to change its shape under moist conditions.
- Cohesion is the capacity to stick together.
- Plastic soils are cohesive.

Soil Colloids:

- The two phases are the dispersed phase (clay and humus) and dispersion medium/water).
- Soil colloid is made up inorganic colloid-clay and organic colloid-humus.
- Particles smaller than I micron are said to exhibit colloidal activity.
- Colloidal property increases with decrease in diameter.
- Colloids exhibit the property of sacrificial activity such as the capacity to hold solid, gases, salts and ions.
- Soil colloids have high exchange capacity, which increases with silica sesquioxides ratio.

Soil water:

- Water has maximum density at 4^0 C. One molecule of water is attached to four molecules in the neighborhood. The diameter of water molecule is 3^0A ($3x10^{-10}m$). Water has high dielectric constant of 80. Its surface tension is $7.2x10^{-2}N/m$.
- Structure of water molecule is hexagonal lattice and the angle is $104^0\ 5^0$.
- Soil moisture constants: Hygroscopic water, capillary water and gravitational water.
- Water held at tension of more than 31-atm is called hygroscopic water. It is not available to the plants.
- Water held below $1/3^{rd}$ –atm is called gravitational water and it is drained from the soil due to gravity.
- Water held at tensions beyond 15- atm is not available to the plants. 15 atm represents the wilting point.

- If water is allowed to drain by gravity after supplying water, some water remains even after drainage due to gravity. It is called field capacity. Water at field capacity is held at 1/3red atm.
- Water held between 1/3rd and 15 atm is called available water
- Water in soil moves in response to difference to tension or pressure.
- More water means less tension and less water is held at more tension. So water moves from low tension to high tension.
- Darcy's law in soil deals to hydraulic gradient.

Soil air:

- Soil air contains 10 times carbon dioxide as that of air.
- Ideally 2/3rd of soil pores are filled with water and 1/3rd with air.
- Fick's law deals about the diffusion of gases in soils.
- Submerged soils contain less oxygen.
- Soil air is characterised by ODR-Oxygen Diffusion Rate.

Soil temperature:

- In soils, heat is mainly transferred through conduction
- Fourier's law deals with heat conduction in soils.
- Sandy soils absorb more heat than clayey soils because the specific heat of water (heat required to heat a substance) is 4-5 times that of soil particles.
- Soil temperature is used at family level categorization in soil taxonomy.

Chemical properties:

- pH is the negative logarithm of H ion concentration. Sorenson gave pH scale.
- There are two types of acidity in soil-active acidity and potential acidity.
- pH measure only active acidity.
- Potential acidity forms the bulk of the soil acidity. It is greater than active acidity.
- Soil pH is also soil reaction.
- Soil with pH less than 6.5 are acidic 6.5 to 7.5 are neutral and above 7.5 are alkaline.
- One unit change in pH changes H ion concentration by 10 times, 2 units by 100 times and so on.
- Electrical conductivity: Measure of soluble salts in mmhos/cm or dS/m in solubridge or conductometer or EC meter.
- Ion exchange:
- Most important process occurring in soil Ion exchange is a reversible process. Soil colloids are the seat of ion exchange.
- CEC is measured at pH 7 & expressed as meq/100 g of soil. CEC varies greatly with nature and amount of clay and OM.
- Kaolinite has 3-10, Illite – 10-30, Montmorillionite – 80-150 and Organic matter – greater than 200.

Base saturation:

$$BS = \{(Na^{+} + K^{+} + Ca^{++} + Mg^{+} +)/CEC\} x 100$$

- Fertile soils are saturated with Ca^{++} and Mg^{++} ions.
- If soil is saturated with more than 15% exchangeable sodium, than that soil is called Alkali soil. If soil is saturated with H^{+} ions, Then the soil is said to be base unsaturated or acidic.

Organic matter:

- OM on decomposition by humification process gives humus. Humus is amorphous in nature. In India OM is very less because of tropical and sub-tropical climate.
- In hilly and altitudes, OM is above 1% and in in mangroves it is 10-30%.
- CN ratio of OM is 10:1 whereas that of Indian soils is 5:1 to 25:1 with an average of 14:1
- Histosols are called Organic soils.
- Organic matter decomposition stages: First sugars & starches followed by proteins followed by hemicelluloses, cellulose and fatty acids and finally_lignin and waxes.

Biological properties:

Bacteria > Actinomycetes> Fungi > Algae

- The smell of soils after fresh showers is due to Actinomycetes.
- Bacteria occur in neutral to alkaline pH. Fungi in acid pH and Algae in shade areas.
- Symbiotic N fixer – Rhizobium in Legumes, Non-symbiotic or Free living is Azotobacter.
- In paddy algae or Azolla fixes N.
- The amount of N fixed is 50-150 Kg.
- In plant N is fixed as R-NH2, which is converted to ammonia. The ammonia is converted so nitrite first by Nitrosomonas or Nitrosococcus, followed by Nitrite to nitrate by Nitrobacter. This process is called Nitrification.
- Some of the nitrification Inhibitors are N-Serve and AM.
- Optimum condition for nitrification process is field capacity and pH above 5.

Mineralogical Properties:

- There are primary, secondary, accessory and amorphous minerals.

Primary mineral: Order of occurrence

Feldspars> Quartz> Mica> Limestone> Hornblende and augite> Olivine and serpentine

- Serpentine is hydrated silicate of Mg.

Secondary minerals:

- 1:1- one silica and one alumina layer. Kaolinite, Halloysite and Dickite
- 2:1 – Two silica and one alumina layer: Montmorillionite (expanding), Vermiculite (Slightly expanding) and Illite (Non-expanding and 15% of silica is replaced by $Al^{3-}$and K^{+} ions) Illite is also called as hydrous mica.
- 2:1:1 or 2:2 – Chlorite. The crystal unit is composed of one 2:1 unit (like mica and Montmorillionite) and one octahedral unit, Brucite {$(Mg_3 (OH)6$}.

Accessory minerals:

- B- Tourmaline, F-Topaz, P-Apatite, Ti-Rutile and Anatase.
- Amorphous clay mineral: Allophane. (Found in Soil order Andosols.)
- Negative charge is due to exposed surface of clay and isomorphous substitution.

Soil survey, classification and soils of India:

- There are two types of soil survey- Reconnaissance soil survey and detailed soil survey.
- In RSS_1 $1^{'}$ = 1 mile. Toposheets of 1:50,000 to 1:1,00,000 or aerial photo of 1:25,000 or 1:50,000 is used. Observations are once at 3-6 Kms.
- DSS: $1^{'}$ = 8 mile or $1^{'}$ = 16 mile.
- Cadastral maps of 1:5000 to 1:8000 or Aeria: photo of 1:10,000 is used Observation are once at ¼ - ½ Km (250-500m)
- Forest area is surveyed by RSS.

Soil classification:

- India, from 1969, follows USDA's Comprehensive system of soil classification called soil Taxonomy. It is type of multi-category classification wherein there are 6 categories: soil order, suborder, great group, sub-group, family and series.
- There 12 order and the lastly added 11^{th} and 12^{th} orders are Andosols and Gelisols respectively, Andosols are found in volcanic cruption areas and contains high content allophane. Gelisols are found in arctic regions.
- The two largest orders in India are Inceptisols followed by Entisols.
- Soil of India:
- Largest area is occupied by alluvial soils 75 Mha.
- Black soils (Vertisols mostly), 72 Mha, are characterised by Gilgai (shining surface), Micro- relief (ups and down), self-churning, smectite (expanding clays) and they are the Russian equivalent of Chernozems.
- $2/3^{rd}$ of TN is of red soil. the parent material for red soils is mostly granite.
- Laterite is older than lateritic soils. Laterites are the oldest or most weather soils.
- Laterite means brick.
- Desert soils come under Aridisols.
- Problem soils occupy 10 Mha. Saline soils- 7.2 Mha and alkali soils- 2.8 Mha.
- Problem soils are highest in UP.
- Saline soils are formed mainly in aird and semi-arid regions due to rising of salt level in the water table. Also it is due to secondary salinisation due to poor quality irrigation water.

Type of soil	pH	EC(dS/m)	ESP (%)
Saline	< 8.5	> 4	< 15
Alkali	> 8.5	< 4	> 15
Saline-Alkali	< 8.5	> 4	> 15

- Saline soils are called white alkali soils and are said to cause boron toxicity. Treated by leaching.
- Alkali soils are called black soils and are reclaimed by applying **Gypsum**
- Saline tolerant varieties: rice, wheat, barley, maize, sorghum and millets.

- Sensitive crops: Pulses and oilseeds.
- Acid sulphate soils: pH less than 3.5 due to Hydrogen Sulphide gas production, found in Kerala and Sunderbans. Causes Akiochi disease. Cat clays are associated with these soils.
- Acid soils have very low pH. Reclaimed by liming with limestone or calcite ($CaCO_3$), Dolomite $CaCO_3$. $MgCo_3$. $2H_2O$. slaked lime Ca (OH_2) and Burnt lime or quick lime CaO.

- SAR= $Na^+ \;/\; \sqrt{(Ca^{++} + Mg^{++})/2}$

Soil Management:

- The optimum physical condition of the soil for crop growth is called soil tilth.
- Other practices are choice of crops, following land capability classification, conserve soil and water, avoid salinity, alkalinity and water-logging, adopt crop rotation especially with legumes, apply soil amendments and follow balanced fertilization.

Soil Testing:

- Mainly to test the fertility status of the soil that is to find out the nutrient deficiencies and soil amendments.
- Half a Kg soil sample is taken and analysed for pH, total soluble salts by EC, Organic Carbon by Walkley and Black Method, Available N by alkaline permanganate method, available by Olsen's or Bray's Method, avai K by Neutral Normal Ammonium Acetate method.
- pH below 6 is termed acidic, 6-8.5 neutral to saline, 8.6 to 9 tending to be saline and pH above 9 is termed as alkaline.
- Total soluble salts: EC in dS/m: Below 1 is normal, 1-2 critical for germination, 2-4 critical for growth of sensitive crops, above 4 injurious to most of the crops.
- Soil test report gives soil texture, pH, EC, OC, Avai NPK, Gypsum and Lime amount to be added, Green Manure/Compost in the Flooding and draining.

Status of available NPK in soils

Nutrient	LOW	MEDIUM	HIGH
Organic carbon	Below 0.5%	0.5 – 0.75%	>7.5
Available N (Kg/ha)	<280	280-560	>560
Available P (Kg/ha)	10	10-25	>25
Available K (Kg/ha)	<110	110-280	>280

**********$$$$$$$$$$**********

5. Fundamentals of Genetics and Plant Breeding

STRUCTURE AND FUNCTION AND CELL ORGANELLES

- The term 'Chromosome' named by - **Waldayer**
- The organelles of cell called as Power house of the cell is - **Mitochondria**
- The lines are homozygous and homogenous in nature called as - **Pure line**
- Crops in which Allo Hexaploidy is found - **Wheat**
- Crops in which Autotetra ploidy is found in - **Potato, coffee**
- Crops in which Autotriploidy is found - **Banana**
- Two lines different for a single locus is called - **Isogenic line**
- If Embryo originates from unfertilized egg process is called - **Parthogenesis**
- If the development of fruit without fertilization the process is called -**Parthenocapry**
- Change in the genome with reference to individual chromosomes called as - **Aneuloidy**
- Repeated crossing of hybrid progeny back to one of its parents called as- **Back cross**
- If a single gene governing multiple traits it is called as - **Pleiotrophy**
- Embryo development without fertilization will be called - **Apomixis**
- Ploidy level in seeds - **Embryo - 2n, Endosperm - 3n, Testa - 2n, A)euren -2n**
- Autopol1yploidyfoundin - **Sugarcane, cotton, Brassica**
- Neucleus was discovered by - **Robert Brown (1993)**
- Lipid – bilayer model was given by - **Sanger & Nicholson (1935)**
- Endoplasmic reticulum (ER) was discovered by - **Porter (1948)**
- Mitochondria was discovered by - **Benda**
- Golgi body apparatus/ dictyosome in plants was discovered by - **Camillo golgi**
- Lysosome was discovered by - **Duve (1955)**
- Largest Organelle in Eukaryotic cell - **Nucleus**
- Term Protoplast was coined by - **Purkinje in the year 1839**

Organelles	Structure	The chief function
Cell wall	- Found between middle lamella and plasma lemmas - Have primary cell wall, secondary cell wall (3 layers) - Made up of cellulose micro-fibrils	- Shape: strength and Rigidity
Plasma -membrane	Lipid Bi-layer model where protein molecule arranged outside	To regulate the movement of various molecules into & out of cytoplasm
Nucleus		Contains genetic material
Nuclear membrane	Double membrane with pores	Connected with Cytoplasm (ER)
Chromatin	Thread like (DNA + Nucleoprotein)	DNA-genetic material
Nueleolus	Globular synthesis	With material for building

		DNA + MRNA
Ribosome	- 80s size (Animal & Plant) - 70s size (eukaryotic organelles) & prokaryotic	Site of protein Synthesis
Endoplasmic reticulum (ER)	-Network like in cytoplasm rough (ER) with Ribosome - Smooth (ER)-without Ribosome	- Protein Synthesis aid in protein modification - Lipid synthesis site
Mitochondria	-Cylindrical body dia: 0.2-1p length 3-10p -Inner folded membrane (Cristae) -Matrix inside	-Production of ATP through the kreb's cycle & electron transport chain - β-exudation of long chain fatty acids
Plastid when Differentiated Chloroplast (With chlorophyll) (Colourless plastid leucoplast)	-Biconvex lens shaped (5m*dia) -Have membranes (grana and stroma lamellae)	-Chlorophyll photosynthesis -Grana & storma lamellae with thousands of quasta comes (Electron transport & photophosphorylation) *Storma consists of enzymes of dark reaction
Golgi body apparatus	Membranes	Shipment in transport vesicles (Packaging) & transport
Lysosome	Sac of digestive enzyme / Digestive vacuoles	Cell destruction if captured
Vacuole	-Membrane (Tonoplast) bound	-Storage deposit for water metabolites and product - Turgidity of cell
Centriole	Present in animal. Rare in Plants	Form poles of spindle apparatus
Cytobsol/ hyaloplasm	The fluid protein of cytoplasm exclusive of organelles	Have compounds for building macro molecules

MITOSIS AND MEIOSIS

- The process of reproduction of new cells from pre-existing cell is called **- Cell division**
- The cell which undergoes division and gives rise to new cells is called -**Mother cell**
- New cells which are formed by the process of cell division are termed as **- Daughter cells**
- In bacteria, cell division takes place by **- Fission (cleavage)** of pre-existing cell

- In higher organisms, the cell division occurs in a - **Specialized manner**
- In eukaryotes, the cell division takes place by - **Mitosis and meiosis**
- The spindle using nuclear division which produces two identical daughter cells from a mother cell is called - Mitosis
- The terms also used for mitosis : (i) Somatic cell division, (ii) Homotypic cell division, (iii) Equational division and (iv) Non-segregational division
- The term mitosis was coined by - **Flemming** (1882)
- In plants, mitosis takes place in - **somatic organs** (root tip, stem tip and leaf base)
- The period in which one cycle of cell division is completed is called **Cell cycle**
- Cell cycle consists of **- Inter-phase and mitotic phase**
- A stage in spindle using cell division during which DNA synthesis takes place is called - **Interphase**
- Interphase lies between **- telophase and prophase**
- Interphase consists of substages **- GI, S and G2**
- Interphase is also known as **- Resting Phase**
- The term interphase was first used by - **Lundergardh in 1912**
- Interphase is a **- Pre-DNA replication phase**
- The post DNA replication phase during which protein and RNA synthesis take place is called **- G2 phase**
- A phase of separation of replicated DNA into two identical douobter nuclei without recombination is called - **Mitotic phase**
- Mitotic phase consists of **- prophase, metaphase, anaphase and telophase**
- A stage of spindle using cell division when chromosomes become shorter and thicker **- Prophose**
- A stage of spindle' using cell division during which chromosomes are arranged at the equatorial plate is called - **Metaphase**
- A stage of spindle using cell division during which chromosomes/chromatids move towards opposite poles **- Anaphase**
- A stage of spindle using cell division in which the chromosomes reach opposite poles is called - **Telophase**
- The longest phase of mitosis - **Prophase** **(**followed by metaphase, telophase and anaphase)
- The longest phase of cell cycle - **Interphase**
- Terms prophase, metaphase and anaphase were coined by – **Strasburger** in 1884.
- The term telophase was first used by - **Heldenhoin** in 1894.
- Nucleolus disappears at the end of - Prophase
- Nucleolus reappears at the end of - **Telophase**
- The process of the division of nucleus is called - **Karyokineses**
- The term Karyokinesis was first used by - **Schleicher** in 1878.
- The term Equational Division was frst used by - **Weismann (**1887)
- The process of division of cytoplasm is known as - **Cytokinesis**
- The term cytokinesis was coined by - **Whitman** in 1887

- Two successive spindle using divisions which reduce the chromosome number from diploid to haploid **- Meiosis**
- The term meiosis was coined by **- Farmer and Moore in 1905**
- In plants, meiosis takes place in **- Anthers and ovaries**
- Gamete is a **- Sexual unit**
- The term gamete was first used by - **Strasburger in 1877**
- The term meiotic drive was first used by **- Sandler and Novitski** in 1957
- The term karyoplasm was coined by - **Flemming in 1882**
- The second stage of meiotic prophase in which homologous chromosomes begin to pair **- Zygotene**
- The third stage of meiotic prophase in which chromosomes look like bivalent **– Pachyten**
- The fourth stage of meiotic prophase in which separation of homologous chromosomes begins - **Diplotene**
- The fifth or final stage of meiotic prophase in which bivalents are distributed throughout the cell **- Diakinesis**
- The term diakinesis was first used by - **Haeckel in 1897.**
- Who coined terms leptotene, zygotene, pachytene and diplotene - **Winiwarter in 1900.**

Stages	**Mitosis (*Equational division)**	**Meiosis (*Reduction division)**
1. Prophase:	Chromatin condensation Chromosomes visible Nucleolus & Nuclear envelop disappear at the end.	1. Meiosis I 2. Meiosis II **I. Meiosis I :** A. Prophase 1
2. Metaphase :	Chromosomes are arranged in equational plate	a. Leptotene : Chromosome look thin thread (of loose ball shape because of condensation b. Homologous chromosome begins to pair (synapsis).
3. Anaphase:	Move to opposite pole	c. Zygotene: synaptonemal complex found
4. Telophase:	Chromosomes form into two groups	d. Pachytene: complete bivalent tetrad. Crossing over Chiasmata can be seen as the result of spearation of homologous Chiasma terminilization
5. cytoplasmic division		e. Diakinesis: Chromosomes reach

		maximum condensation, nucleolar membrane disappear, spindle begin to form **Metaphase I:** Bivalents orient at random on the equatorial plane.
		Anaphase I: The centromeres do not divide continue to hold sister chromatids together - Because of cross over, sister chromatids no longer be genetically identical. Homologues more to opposite pole - This movement reduces the chromosome number from the diploid condition (2n) condition to Haploid (n) state. **Telephase I:** This divides the diploid cytokinesis mother cell into 2 haploid daughter cell. **Meiosis II** (educational division similar to Mitosis 1. Haploid cells mitosis (Meiosis-ll) 4. Haploid cells.

Significant difference between Mitosis and Meiosis

S. N.	Mitosis		Meiosis
1.	Educational division separation sister chrmatids	:	Relational division- separation of homologues Equational division- Separation of sister chromatics
2.	One cytokines is per karyokinesis	:	Two cytoplasmic division
3.	No synopsis: No chiasmata form No genetic exchange between homologues (crossing over) & gastric recombination	:	These do occur
4.	2 daughter cells/ cycle	:	4 gametes/ spores per cycle
5.	Genetic content of product identical to mother cell.	:	Not identical in terms of 1) Chromosome No. (Haploid) 2) Consent (crossing over-recombination
6.	Occur in somatic cell	:	Specialized cells of germ line

GAMETOGENESIS, FERTILIZATION AND EMBRYOGENESIS ; CHROMOSOMAL AND EXTRA-CHROMOSOMAL BASIS OF INHERITANCE; MUTATION AND POLYPLOIDY; SELECTION METHODS, HYBRIDIZATION, BACKCROSS

- Term genetics was given by **- Betson (1905)**
- Rediscovery of mendelian principles in the year **- 1900**
- Chromosomal theory of inheritance (1903) by **- Suttan & Bovery**
- First hybrid of rice was developed by **- Y.L. Ping (China)**
- First transgenic plant was developed by **- Fraley (1983) Tobacco**
- Laws of heredity were first discovered by **- Mendel**
- Tift 60 is an important source of male sterility in **- Sorghum**
- The term Germplasm was first used by **- Weismann (1834-1914)**
- Centers of origin were first given by **- Vavilov**
- Vavilov recognized ……main centres of origin **- Eight**
  (China; 2. Hindustan; 3. Central Asia; 4. Asia Minor; 5. Mediterranean; 6. Abyssinya; 7. Central America; 8. South America)
- Origin of cultivated plants **- Alphonse de can dolle (1863) Swiss botanist**
- NBPGR established in **- 1976**
- The term genetic resources was coined by **- Aris. Frankel**
- The term parthogenesis was coined by **- Owen**
- Development of seed by self pollination refers to **- Autogamy**
- Often cross pollinated crops are **- Cotton, Sorghum, Pigeon Pea**
- Concept of pure line theory was developed by **- Johansen**
- Term heterosis was coined by **- Shull (1914)**
- Jagannath is a mutant variety of **- Rice**
- A nullisomic individual is represented by **- 2n-2**
- Chromosome was discovered by **- Strasburger**
- Microtubules were discovered by **- De Robertis & Franchi (1953)**
- DNA was first synthesized by **- A Kornberg (1953)**
- RNA was first synthesized by **- S. Ochoa in 1969.**
- Longest Phase of Mitosis is **- Prophase**
- First use of X-rays as mutation **- Muller**
- First inter-specific cross was made by **- Thomas fairchild**
- N.E. Borlaug was awarded Noble Prize in year **- 1970**
- Father of the Hybrid cotton **- C.T.Patel**
- Name of Post-mendalian gentian **- de-Vries, Karl Correns, Tschemark**
- Rediscovery of Mendelian principles was done by **- de-Vries, Karl Correns, Tschemark**
- Rediscovery of Mendelian principles was done in year **- 1900**
- Ploidy Level in Embryo Seeds - 2n

- Ploidy Level in Endosperm Seeds - 3n
- Ploidy Level in Testa Seeds - 2n
- Ploidy Level in Aleuron Seeds - 2n
- Who term the 'Genetics - **Bateson** (1905)
- Epitasis inter-allelic interaction is discovered in - **1909**
- Chromosome was named by - **Waldayer**
- Chromosome is a **– Neucleoprotein**
- Chromosome was discovered by - **Strasburger (1875)**
- Parts of chromosome **– (1) Centromere (2) Telomere (3) Nucleolar organising region (4) Arms**
- Sources of new variation : **(1) Independent assortment (2) Mutation (3) Recombination cause of C. over (4) Poly-Ploidy (5) Somoclonal variation**
- DNA Replication is presented by **- Semiconservative model**
- DNA double helicle structure was proposed by **- Watson and Crick**
- Nucleoside is - Base + Sugar ; e.g.- A= T; G=C
- Nucleotide is - Base + Sugar + PO_4 ; e.g.- A + G = T + C
- Triplet sequence found in m RNA - Codon
- Codes for single amino acid - anti-codon
- Corresponding (complementary) triplet seq in t RNA start + codon: AUG stop/ Non sense/ termination codon: UAA, UAG, UGA.
-

Mutation
- Gene mutation
  - Addition of a base
  - Deletion of bases } Frame shift mutation
  - Substitution of bases
- Chromosomal Mutation

- Who first used X-rays as mutagen - **Muller**
- Natural mutation is of low frequency upto **- 10^{-6}**
- The unit in which mutation occurs - Muton
- Progeny of a single cross fertilized heterozygous individual - **Inbred**
- Effect of pollen on endosperm expression is called - **Xenia**
- Effect of pollen on seed coat colour is called - **Metaxenia**
- Pure lime are ……in nature **- homozygous and hemogenons**
- Clone group of individuals descending from a single plant through several reproduction.
- X = Basic chromosome number = Monoploid number = Genome number
  n = Haploid number = Gametic number ex.: Triteum aestinum, 2n = 6x = 42 n = 21 (42/2), X = 7 (42/6)
- All the chromosomes of a diploid species that are distinct from each other with reference to gene content and morphology - **Genome**
- Superiority of F_1 hybrids over both of its parents is called - **Heterosis**
- Two lines differing for a single locus is called **- Isogenic lines**
- Embryo originates from unfertilized egg is called - **Parthenogenesis**
- Development of fruit without fertilization is called - **Parthenocarpy**

- Example of Parthenocarpy - **Banana**
- Changes in the genome with reference to individual chromosomes – **Aneuloidy**
- Example of Aneuloidy - Monosome (2n-1), Trisomy (2n=1), Tetrasomy (2n=2)
- Changes in the genome with reference to a set of chromosomes genome - **Euploidy** Ex.: Triploid-3x, Tetraploid- 4x
- F_1 x homozygous recessive parent **- Test cross**
- Repeated crossing of hybrid progeny back to one of its parents - **Backcross**
- Single gene governing multiple traits - **Pleiotrophy**
- A type of asexual reproduction in which embryo development and seed formation take place without fertilization and with or without meiosis - **Apomixis**

Important points:

- The first artificial hybrid popularly is produced by - Thomas Fairchild (1717)
- The first artificial hybrid popularly known as - Fairchild's mule
- The first artificial hybrid is by crossing - **carnation** with **sweet William**
- Dwarfing gene in rice **– Dee-Gee-Woo-Gen** (Japonica rice, Taiwan)
- Dwarfing gene in wheat **– Norin 10** (Japanese variety)
- Tift 23 A is source of Cytoplasmic male sterility in **- Pearl millet**
- Kafir 60 is source of CMS in **- Sorghum**
- Non-traditional area of wheat cultivation **– West Bengal**
- Non-traditional area of Rice cultivation **– Punjab**
- Gregg 399 is an important source of genetic male sterility in **- cotton**
- Exotic varieties of wheat **– Sonara 64 and Lerma Rojo**
- Wheat variety resistant to all the three rust **– Sparrow**
- Wheat variety susceptible to all the three rust **– Agra Local**
- Exotic varieties of Rice **– Taichung Native 1 (TN-1)**
- IR 8 introduced in India in - **1966** (primary introuction)
- Example of Autotriploid (3x) **–Banana**
- Example of Triploid **– Apples, Watermelons, sugar beets**
- Example of Autotetraploid **– Potato, Groundnut, alfalfa**
- Example of Autopolyploid **– Ornamental plants, sweet potato, oat, alfalfa**
- Example of Allopolyploids **– Wheat, tobacco, cotton, sugarcane, rapeseed etc**
- Example of Allohexaploid **– Common bread wheat (*Triticum aestivum*)**
- Example of Allotetraploids **– Cotton and tobacco**
- Example of Man made cereal **– Triticale (rye ×wheat)**
- Which crop is called Drosophila of crop plants - **Maize**
- Examples of secondary introduction **– Wheat: Kalyan Sona and Sonalika**

6. Fundamentals of Plant Physiology

PLANT GROWTH REGULATORS

- Who suggested the use of term "Phytohormone" in plants - **Thiamann**
- Organic substances which are naturally produced in plants are - **Phytohormone**
- Major Plant growth regulators are - auxins, Gibberellins, Cytokinins, ABA, Ethylene

AUXINS

- Growth hormone which become weakly acidic - **Auxins**
- Auxin was named by **- Kogl**
- Auxin (Greek word) is derived from - '**Auxein'** which means to grow
- Naturally occurring Auxin is **– IAA**
- Synthetically produced auxins are **– NAA, IBA, 2, 4 – D, MCPA**
- Example of Anti-Auxins are
  – Naphthythalamic acid (NTA) , Ethylene chlorohydrins
- Active sites of auxins
  – shoot tip region, coleoptiles and developing embryos etc.
- Auxin synthesis occurs rapidly in
  - Green leaves in presence of light than the in the dark
- Precursor of IAA - **Tryptophan**
- The site of Auxin transport is located on - **Plasma lemma**
- Test that are generally used for bioassays of auxins
  - Avena curvature test and split pea stem curvature
- **Role of auxins:**
  1. Promotes apical dominance
  2. Increases cell division in cambium
  3. Promote the elongation of cells
  4. Auxin increase in shoot and decrease in root
  5. Induces uniform flowering in pineapple
  6. IBA promotes rooting of cutting

GIBBERELLINS:

- Second important growth hormone found in plants **- Gibberellins**
- Gibberellins was discovered by - **Kurosawa (1926)**
- Gibberellins first isolated from - ***Gibberella fujikuroi***
- The causal organism of "foolish seedling of rice" - ***Gibberella fujikuroi***
- "foolish seedling of rice" are commonly called **- Bakanae disease of rice**
- Movement of gibberellins takes place in - **both xylem and phloem**
- Precursor of gibberellins **- N- Kaurene**
- Chemically gibberellins are related to - **Terpenoids**
- Examples of Anti- gibberellins
  - Phosphon D, Cycocel (CCC), Maleic hydrazide, paclobutrazol
- **Role of gibberellins:**
  1. Breaking of dormancy
  2. Induction of flowering in long day plants

3. Promotes male flowers production
4. Enhances seed germination
5. The most important effect of GA is the stem elongation i.e. GA induces internode elongation or sub apical elongation

CYTOKININS:

- Movement of cytokinin takes place through - **Xylem**
- Kinetin was identified by - **Miller and Skoog**
- Term cytokinin proposed by - **Letham (1963**)
- The first naturally occurring hormone identified – **Zeatin**
- Important site of cytokinin synthesis - **Root tip**
- Precursor of cytokinin - Either **adenine or adenosine** i.e. purine bases
- Mobility of cytokinin - Either **polar and basipetal**
- **Role of cytokinin:**
    1. Initiation of cell division
    2. Delay of senescence
    3. Induce flowering in short day plants
    4. Promotes stomatal opening
    5. Promote femaleness in male flowers

ABSCISSIC ACID (ABA):

- Naturally occurring growth regulator - **ABA**
- PGR acting as stress hormone - **ABA**
- ABA first identified by - **Wareing (1965)**
- Precursor for biosynthesis of ABA - **Violoxanthin**
- Biosynthesis of ABA also takes place through - **Mevalonic acid**
- ABA is a - Terpenoids
- Bioassays for ABA are
  - Rice seedling growth inhibition test and inhibition of α amylase in barley endosperm
- **Role of ABA:**
    1. Induces bud dormancy and enhances the process of abscission
    2. Senescence of leaf is promoted by ABA
    3. Stimulates the release of ethylene
    4. Brings the closure of stomata during water stress
    5. ABA is called Anti- Gibberellins.

ETHYLENE:

- Plant growth hormone known as ripening Hormone - **Ethylene**
- Ethylene level in plants increased by - **Auxin**
- Naturally occurring volatile hormone - **Ethylene**
- ----------established that ethylene is the only gaseous growth regulator - **Burg (1962)**
- Maximum ethylene is formed in - **Ripening fruits and senescing tissues**
- Biosynthesis of ethylene occurs from - **Methionine**(sulphur containing amino acid)
- Inhibitors of ethylene synthesis - **Amino-ethoxyvinylglcine**

- Bioassays for ethylene test - **Triple pea test and pea stem swelling test**
- **Role of ethylene**:
    1. Responsible for fruit ripening with increase in respiration
    2. Induces uniform flowering and ripening in pineapple
    3. Inhibits stem elongation and cause abscission of leaves
    4. Induces fruiting in ornamental plants
    5. Latex flow in rubber increase by **- Ethephon**

OTHERS:

- Hormone used for sugarcane ripening **- Glysophosine**
- Wound hormone found in injured portions of a plant **- Traumatic acid**
- destruction product of Violoxanthin and forms ABA **– Xanthoxin**
- Steroid isolated from pollen grains of Brassica is **– Brassins**
- Methyl ester in jasmine, inhibits growth and promote senescence **– Jasmonic acid**

ELEMENTARY KNOWLEDGE OF PHOTOSYNTHESIS

- Total carbon fixed by land per year **= 110×10^{12}**
- Total carbon fixed by ocean per year **=273×10^{11}**
- Law of limiting factors Explained by **- Blackmann**
- ----- traced the path of carbon in photosynthesis and gave the C_3 cycle– **Calvin (1954)**
- ------- reported C_3 pathway for carbon dioxide fixation in certain tropical grasses **- Hatch and Slack (1965)**
- The reduction of CO_2 to carbohydrate level needs assimilatory products such as **- ATP and NADPH + H^+**
- Reduction of CO_2 occurs in **- Dark**
- Production of assimilatory powers is **- Light dependent**
- Major photosynthetic pigments of higher plants are **- Chlorophyll a and Chlorophyll b**
- Important accessory pigments in plants are **- Carotenoids and xanthophylls**
- Light reaction of photosynthesis takes place in **- Thylakoids or Grana**
- Dark reaction of photosynthesis take place in **- Stroma**
- Photosynthesis is an **- Oxidation-Reduction process**

a) Calvin cycle (C_3 plants):

- The CO_2 acceptor is **- Ribulose 1, 5- diphosphate**
- The first stable product of photosynthesis is a **- 3 carbon compound Phosphoglyceric acid (PGA)**
- For synthesis of one glucose molecule .....ATP are required **- 18**
- The enzyme RUBP carboxylase or Rubisco is found in **- Chloroplast stroma**
- Most abundant protein on earth **- RUBP carboxylase or Rubisco**
- Examples of C_3 plants **– Wheat, Barley, Oat, Rye, Rice, Pea, Soybean**

b) Hatch and slack cycle (C_4 PLANTS):

- The CO_2 acceptor **- Phosphoenolpyruvic Acid (PEP)**

- First stable product **- Oxaloacetic acid (Oxaloacetate)**
- Photosynthetic rate is the highest in **- C_4 plants**
- ------ ATP are required for the synthesis of one glucose molecule **- 30**
- The most distinguishable anatomical feature of the leaves of C_4 plants is the presence of **- Two types of photosynthesis cells viz. bundle sheath cells containing chloroplasts**
- The bundle sheath cells lacking in ------ in their chloroplast **- Grana**
- Leaves of C_4 plants have **- Kranz type of anatomy**
- PEPCO enzymes are present in **- C_4 plants**
- C_4 cycle is found only in **- Certain tropical plants**
- C_4 plants are about ----- as efficient as C_3 plants in converting solar energy into the production of dry matter **- Twice**
- Example of C_4 plants
  – Sugarcane, maize, pearl millet, sorghum, *Cyperus rotundus* etc.

c) Crassulacean acid metabolism cycle (CAM cycle):

- CAM cycle occurs in **- Mesophyll cells**
- Most (not all) CAM plants possess the ----- habits **- Succulent**
- Examples of CAM plants **– Bryophyllum, Opuntia, Agave, Pineapple etc.**
- Photosynthesis active radiation (PAR) are having the wavelength **- 400 to 700 nm**
- Important accessory pigments in plants are **- (1) Carotenes, (2) Xanthophylls**
- CO_2 concentration in the atmosphere is **- 382 ppm**
- Photosynthesis reaction **- $6CO_2 + 12H_2O + light = C_6H_{12}O_6 + 6H_2O + 6O_2$**
- Light reaction or hill reaction takes place in **- Grana of chloroplast**
- dark reaction of Calvin Cycle takes place in **- Stroma of chloroplast**
- The products of the light reaction are **-ATP and $NADPH_2$**
- Water use efficiency are in the order of **- $CAM > C_4 > C_3$**
- In photosynthesis light energy is converted into **- Chemical energy**
- Chlorophyll molecule contains ----- in its structure **- Mg^{+3}**
- One $NADH_2$ will prpoduce **- 3 ATP [new concepts 3.5]**
- One $FADH_2$ will produce **- 2 ATP [new concepts 2.5]**

ELEMENTARY KNOWLEDGE OF RESPIRATION

- Respiration in plants consists of
  - Glycolysis & Krebs Cycle and ETC (Electron Transport Chain)
- Glycolysis occurs in the **- Cytoplasm**
- Krebs cycle and ETC occurs in the **- Mitochondria**
- Glycolysis occurs in **-Anaerobic condition**
- Total ATP synthesis from one molecule of glucose in respiration is
  - 36 ATP (Net gain) Gross production is 38 ATP
- Total ATP synthesis from one molecule of glucose in glycolysis
  - 4 ATP (Net gain – 2 ATP)

- Krebs cycle is also called as - **citric acid cycle or TCA (tricarboxylic acid cycle)**
- Final product of glycolysis is **- Pyruyate**
- Anaerobic respiration pathway products are **- Ethanol and lactic acid**
- During respiration CO_2 molecules are released in **- Mitochondria**
- Krebs cycle starts with **- Acetyl coA and oxaloacetate**
- Election transport chain is present in the
  - cristae of mitochondria (where ATP is synthesized in respiration)
- The high energy compound synthesized during respiration is by
  - oxidative phosphorylation of ADP with P (inorganic phosphate)
- Electron carriers involved in the respiratory election transport chain
  - Cytochromes
- Energy content of one molecule of glucose is **- 686 KCal or 2870 KJ**
- 1 molecule of ATP is equal to **- 7.6 KCal**
- 1 molecule of $NADH_2$ is equal to **- 52 KCal**
- The energy currency of the cell is **- ATP**
- During the breakdown of glucose molecule, ----- ATP are formed - **38 ATP**
- Ratio of CO_2 evolved to ratio of O_2 evolved in plant is called
  - Respiratory Quotient
- Normal range of Respiratory Quotient in plants **– 0.97-1.17**
- ------ molecules are formed on complete oxidation of a glucose molecule through hexose monophosphate shunt cycle **- 36 ATP**
- The net gain of energy by anaerobic respiration is **- 2 ATP**
- The no of CO_2 molecule released between anaerobic and aerobic respiration is - **Zero**
- The ratio of energy released between anaerobic and aerobic respiration is **- 1:18**

a) Glycolysis:

- Glycolysisis is also called as - **EMP pathway (Embden Meyerof Paranas pathway)**
- Glycolysis involves degradation of glucose to ---- pyruvic acid molecules - **2**
- Glycolysis occurs in **- Cytosol of cytoplasm**
- Glycolysis are common for ----- respiration **–Both aerobic and aerobic**
- End product of Glycolysis **- Pyruvic acid**

b) **Krebs cycle**:

- Also called as - **TCA cycle, citric acid cycle, organic acid cycle, mitochondrial respiration**
- Kreb's cycle occurs in **- matrix of mitochondria (in aerobic condition)**
- Krebs cycle starts with **- Acetyl CoA and oxaloacetate**
- In Krebs cycle, the mineral activator required for enzyme aconitase is - **Fe**
- The only 5 C compound in TCA cycle is **- α- Ketoglutaric acid**

c) Electron transport chain:

- Also called as - **respiratory chain or oxidative phosphorylation**
- ETC occurs - **inside the mitochondria** (in the inner membrane of cristae)

Photorespiration

- Refers to production of ---- in respiration from 2 C compounds in presence of light - **CO_2**
- Reported only in green cells such as in - ***Beta, Phaseolus, glycine, Oryzae, Pisum, Gossypium, Capsicum, Helianthus*** **etc.**
- Photorespiration is discovered by - **Decker in tobacco plants**
- Substrate for photorespiration is - **glycolic acid (2 C)** (so called as **C_2 cycle or glycolate metabolism**)
- Photorespiration occurs in between - **chloroplast, cytosol, peroxisome and mitochondria**
- Photorespiration occurs in - **C_3 plants and temperate plants**
- The presence of -------- decreases the photosynthetic efficiency of plants - **photorespiration process**
- Photorespiration is said to be highest in - **Rice**.
- Serine {amino acid} is produced in - **photorespiration [in mitochondria].**
- In photorespiration, NAD is reduced to - **$NADH_2$**

Mineral Nutrition

- Criteria of Essentiality proposed by - **Arnon and Stout (1939**)
- Criteria of Essentiality are –
  (1) In the absence of that element, plants is not able to complete its life cycle
  (2) The element should not be substituted by other element
  (3) Element should form a part of any molecule or constituent of the plant.
- The element that do not form the constituent of plant can grow without it but if present it is advantageous to the plant - **Beneficial element**
- Macronutrients - **C, H, O, N, S, Ca, Mg, K, P (>100 µg/g dry matter)**
- Micronutrients - **Cl, Fe, B, Mn, Zn, Cu, Mo (100 µg/ g dry mater**)
- Mobile elements - **N,P,K, Mg, Mn, Mo, Cl, Zn and Na**
- Immobile elements - **Bo, Fe, Ca, Cu, S [in plants]**
- Beneficial elements - **Co, Sl, Selenium, Na, Ni**
- Cobalt is essential element for - Legumes
- Silicon is essential element for - Rice, Maize
- Nickel is essential element for - Legumes
- Atleast 60 elements are present in plants out of which --- only are essential - **17**
- **Carbon:** (46% dry weight basis)
  - **Source**: CO_2 from the air
  - **Function**: Most of the compounds in the living cells are C-containing.
- **Oxygen:** (50%)
  - **Source**: O_2, CO_2, H_2O
  - **Function**: The most abundant elements by weight in plants Required for all compounds in plants.

- **Hydrogen:** (6%)
  - **Source**: H_2O
  - **Function**: Most abundant elements by number of atoms Present in all the compounds in the living cell component of H_2O
- **Nitrogen:** 1.5%
  - **Source**: NO_3, NH_4 in the soil solution, Legumes through N2 fixation.
  - **Function**: All the crops prefer NO_3^-(Nitrate) except Rice which prefers NH_4^+ (Ammonium)
  - **Components** of nucleic acid. Chlorophyll molecule, Proteins
  - **Deficiency**: Pale yellow leaves & reduced growth redleaves in cereals
  - Red colour develops in Apple due to the anthocyanin production
  - Root lengthening in wheat
  - Excess Nitrogen leads to vegetative growth, delay in flowering
- **Phosphorus:** (0.2-0.8%)
  - **Source** : H_3PO_4 & HPO_4 from the soil solution
  - **Function**: Component of nucleic acid, Phospholipids (Membranes), ATP
  - **Deficiency**: variable colour development in leaves (Dark green) reduced tillering & leaf fall. Anthocyanin produced give pink colour.
- **Potassium:**
  - Only present in plants as K^+ not bound to any components
  - **Function**: Stomatal closing & opening
  - Disease resistance
  - Osmotic adjustment, needed for cell elongation
  - **Deficiency**: rosette, die back in plants
- **Chlorosis:**
  - Stunted growth & Thin shoots
  - Tip burns & leaf scorch in older leaves
- **Magnesium**
  - Constitutent of chlorophyll
  - Activates many enzymes
  - **Deficiency**: Older leaves affected Cholorosis. Sand drown disease in tobacco
- **Sulphur:** 0.1%
  - **Source**: Soluble sulphates
  - **Functions**: Aminoacids (Cystein and Methonene)
  - Coenzyme A
  - Volatile Oils
  - **Deficiency**: Downward cupping of leaves e.g. tobacco, Torr, Tea,
  - Tea yellow disease
  - Chlorosis
- **Calcium:**
  - **Functions**: Calcium pectate is present in the middle lamella of the cell wall
  - ATPase activator

- Counteract metal toxicity
- **Deficiency**: Young leaves are mostly affected
- Hooked tips & distort leaves

- **Iron**
  - Component of cytochromes, Catalase, peroxidase
  - Deficiency- Intervienal Chlorosis (iron Chlorosis)
  - Leaf bleaching (S. Cane)

Deficiency symptoms of Elements:

- General starvation occurs due to - **N**
- Intervienal chlorosis in Sugarcane occurs due to - Fe
- Grey speck Disease of oats, Pahla blight of sugarcane, marsh spot of pea due to **- Mn**
- Die back disease of citrus or exanthema, Reclamation, white tip disease **- Cu**
- Mottled leaf of citrus, drenching of citrus - **Zn**
- Little leaf/ Rosette as in Apple, Pine, Peach walnut, citrus etc, white tip of maize- **Zn**
- Khaira disease of rice - **Zn**
- Whip tail of cauliflower and brassicae, scald of legumes - Mo
- Heart rot of sugar beet and marigold - B
- Canker of table beet - B
- Browning & Hallow stem of cauliflower - B
- Cracked stem of alfa-alfa - B
- Hard fruits of Citrus - B
- Top sickness of Tobacco - B
- Water core of turnip - B
- Sickle leaf disease - P
- Blossom End Rot (BER) in tomato and Tip hooking in cauliflower - Ca

Important points:

- ----- play an important role in the opening and closing of stomata - **Potassium ions (K^+)**
- Instrument used for measuring transpiration - **Porometer**
- The growth is maximum during - **exponential phase**
- Transpiration takes place through - **stomata, lenticels or cuticle**
- Exudation of water from plants in the form of liquids is called - **Guttation**
- Ex. of Short day plants – **soybean, potato, sugarcane, cosmos, chrysanthemum, tobacco, rice, onion, upland cotton, strawberry, datura etc**
- Ex. of Long day plants – **spinach, lettuce, radish, alfalfa, sugar beet, opium, poppy, oats, wheat etc.**
- Ex. of Day neutral plants –**tomato, cucumber, cotton, pea, sunflower, maize etc.**
- Method on inducing early flowering in plants by pre-treatment of their seeds at very low temperature is called -**Vernalisation**

- Hormone responsible for vernalisation - **Vernalin**
- To make one molecule of glucose --- turns of Calvin cycle are required- **6**
- The ratio of photosynthesis to respiration during day time is - **10:1**
- In most succulent plants, CO_2 is fixed by the activity of - **PEP carboxylase**
- The ratio of CO_2 reduced and oxygen released during photosynthesis is - **1:1**
- DCMU is an example of - **photosynthetic inhibitor**
- The products of light reaction are - **ATP and $NADPH_2$**
- Major form of carbon transfer in plants is by - **sucrose**
- For photosynthesis, the visible range of spectrum between ---- is essential - **250 to 750 nm**

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7. Fundamentals of Biochemistry

Structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins.

- Major group of compounds found in a cell are **carbohydrates, fats, nucleic acids and proteins and their derivatives.**

1. CARBOHYDRATES

- Organic compounds with a general formula $\mathbf{(CH_2O)_n}$
- Carbohydrates can be classified into 3 categories, based on degree of polymerization
  - **(a) Monosaccharides**
  - **(b) Oligosaccharides**
  - (c) **Polysaccharides**

(a) Monosaccharides

- These are simple sugars derived from hydrolysis of oligo and polysaccharides with 'C' atom ranging from 3-9.
- They are of two types (a) Aldoses, (b) Ketoses
- **Aldoses:** Sugars with terminal CHO-(aldehyde) group at C, - Glyceraldehyde (simplest)
  - Aldotriose- Aldoses
  - Aldoterose- Erythrose, thresose
  - Aldopentose – Arabiose ribose deoxyribose
  - Aldohexose – Glucose, galactose, mannose
- **Ketoses** : Having >C=O group
- **Ketotetroses** : Erythrulose
- **Ketotriose** : Dihydroxy acetone – simplest keto sugar, e.g.-Sorbose
- **Ketopentoses** : ribulose, xylolose
- **Ketohexose** : Fructose – It is the sweetest among all the sugars.

(b) Oligosaccharides

- All derived from combination of two or more monosaccharides units Depending upon the number of monosaccharides presence they can be classified as
  - (I) **Disaccharides** : eg. Sucrose, Maltose, Lactose, cellobiose
  - (II) **Trisaccharides** : eg. Raffinose
  - (III) **Tetrasaccharides** : eg. Stachyose
- Sucrose: Produced from α-D glucose and β-D fructose by α, 1-->2. glycosidic linkage. It is a non- reducing sugar.
- Maltose: Consists of 2 units of glucose {α-D glucose and β-D glucose} linked together by α, 1-->4. It is a linkage reducing sugar found in germinating seeds largely.
- **Cellobiose**: Consists of 2 units of glucose but the bond involved is β, 1--4 linkage. It is a reducing sugar.

- **Lactose:** Consists of one molecule of β-D glucose beta and one molecule of β-D galactose linked together by β 1--4 linkages.
- **Stachyose:** It is a tetra saccharide consists of one glucose and one fructose and 2 galactose.

(C) Polysaccharides

Molecular weight in **kilo Daltons (kd)**

(a) Storage polysaccharides:

- In plant consists of amylase, amylopectin. (It is polymer of glucose).
- **Amylose** is un-branched chains of glucose units joined by α– 1,4 linkages. The chain is linear, but it is helical one.
- **Amylopectin**: Highly branched, Bond types: α 1- 4 linkage but at the branching points α 1--6 linkage is present.
- **Glycogen:** It is present only in animal cells. It is just like starch, but heavily branched and compact and it contains both α 1- 4 and α 1- 6 linkages.

(b) Structural Polysaccharides

- **Cellulose:** Polymer of glucose joined together by β 1- 4 linkage
- **Hemicellulose:** Polymer consisting of L-arabinose. D-glucose, D-galactose, D-Xylose, along with uranic acid (galacturonic acids)
- **Pectin:** Polymer of galacturonic acid. Normally present in middle lamella and cell walls as calcium Pectate.

2. PROTEINS

- The name was suggested by - **Berzelius {1938}**
- This name is derived from Greek - **Proteios** means **'first rank'**
- Proteins are **polymer of** - **Amino acids**
- Each amino acid is linked with each another one by - **Peptide bond (-C=O-NH2)**

Different structural levels:

- **Primary structure**- it is the linear arrangement of amino acids.
- **Secondary structure**- It is the structure found by linear Polypeptide chain which folds in a regular fashion.
- This may be of two kinds (1) **alpha helix** (2) **beta pleated sheet**.
- These secondary structures are produced by interaction between neighboring amino acids of same chain via Hydrogen bonding.
- **Quaternary structure**-The structure produced by association of more than one polypeptide
- Examples for some commonly occurring proteins
- Structural proteins :
    - Collagen : Muscle protein
    - Keratin : In hair and wool and nail
    - Fibroin : In silk
    - Elastin : Found in insect wings
    - Regulatory proteins : Enzymes
    - Transport proteins: Myoglobin, Haemoglobins

- **Another classification of proteins:**
- **Simple proteins** – Contains only ordinary amino acids
- **Conjugated proteins** – Proteins that contain non amino acid components in addition to amino acids these additional factors are called **prosthetic groups**.
- **Examples:**
    - Nucleioproteins – Nucleic acid and protein – chromosomes
    - Glycoprotein – Protein and sugar units
    - Lipoproteins –Protein and lipids
    - Metalloproteins - metals and proteins haemoglobin

3. ENZYMES

- These are special classes of proteins. Enzymatic activity was first discovered by **Buchner** (**Zymase** was the first found initially from **Yeast**)
- The term enzyme was coined by **W. Kuhns [1898]**
- Terminology's **Holoenzymes = Apoenzyme + Prosthetic group**
- **Apo-enzyme** - Without **prosthetic group**
- **Legand** - Any substrate that binds with an enzyme
- **Active site** - The site responsible for substrate and catalysis.
- **Regulatory site** = the site other than catalytic site.
- **Characteristics of an enzyme:**
  * Specific, Protinacious, colloidal nature, sensitive to temperature & pH.
  * Enzymes do not change the equilibrium level, But quickens it.
  * They lowers down the energy of activation.
- **Mechanism of action of enzymes:**
    - The lock and key model was proposed by **Fisher** and introduced by **Koshland Some special classes of enzymes.**
- **Allosteric enzymes:** are regulatory enzymes which have more than one polypeptide
    - This type of enzymes have a well developed regulatory mechanism
    - They produce a sigmoidal curve (instead of classical parabolic curve)
- **Isozymes:** They are different enzymes which catalyze the same reaction in same or different tissues. They are different in molecular weight and synthesized from different genes.
- **Ribozymes:** They are catalytic RNA with enzymatic property (non protein)
- Factors affecting activity of enzymes are Temperature, PH, Ionic strength, Water content.

4. VITAMINS

- The term vitamins was introduced by **Funk**
- **Classification:**
    1. Water soluble: Vit. B complex (B_1, B_2, B_{12}), Niacin [nicotinic acid] & Vit. C
    2. Fat soluble : Vit. A, D, E and K.

Vitamins and their deficiency symptoms

Vitamins	Deficiency symptoms
A (Retinal)	:Xerophthalmia or dry Deonatosis (dry scaly skin) , Night blindness because of reduction in red cone cells
B1 (thiamine)	:Beri-Beri (Extreme weakness, pain in joints)
B2 (Riboflavin)	:Ariboflavinosis (Blurred vision, cracks on skin at angle of mouth)
B12 (Cyanocobalamin)	:Pernious anemia (Reduction in RBCs)
B_6 Niacin (Nicotinic acid (Peridoxin)	:Pellagra (Black Tongue)
C (Ascorbic acid)	:Scurvy
D (Calciferol)	:Rickets (Pigeon chest in children), Osteomalacia (adults)
E (Alpha Tocopherol)	:Sterility

- Vitamins mainly act as "**cofactors**" for enzymatic activity.

5. NUCLEIC ACIDS

- classes
- DNA – Deoxyribose
- RNA – Ribose
- Nucleoside = Sugar (Ribose/ Deoxyribose) + Nitrogenous base
- Nucleotide = Nucleoside + phosphate group
- **Types of Bases**
  - Adenine
  - Thymine
  - Uracil (RNA)
  - Guanine
  - Cytosine
- Nucleic acid : **Frederick Mischer** in puss cell
- B-DNA (right handed helix; double structure): **Watson & crick**
- Bacteriophages –DNA or RNA
- Non-genetic RNAS

  t-RNA- Transfers amino acids from cytoplasm to Ribosome

  m-RNA- 5% carries the message from genes (DNA)

  r- RNA – Ribosomal RNA- Part of Ribosome (work benches of protein synthesis).

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8. Crop protection

Major pests and diseases of rice, maize, pulses, oilseeds, vegetables, wheat, cotton, sugarcane and their management.

PESTS OF RICE

- **Yellow stem borer**: *Scirpophaga incertulas* (Pyraustidae)
  - Deed heart in young seedlings
  - White earhead in panicle stage. No grain formation.
  - Monophagous pest

  Control:
- **Parasitiods**: *Tetrastichus Schoenobii;* egg parasitiod *Trichogramma Japonicum*
  - Destruction of stubbles
  - Host plant resistance: TKM 6 resistant variety contains *Penta deconal* & silica.
  - Pheromone Oviposition deterants in rice for stem borer
- **Gall fly or gall midge**: *Orseoeoa oryzae* (Cecidomyiidae)
  - Silver shoot or onion leaf which is a modified leaf sheathcaused by maggot.
  - Bio control agent: Playigaster oryzae
- **Leaf folder**: *Cnapholocrocis medinalis* (Pyraustidae)
  - Longitadial folding of leaves & drying of leaves by larva.
  - Control: Avoid use of excess nitrogen
  - Parasitoids: *Trichogramma Japonicum*
- **Green leaf hopper:** *Nephotettix virescens* (Cicadellidae)
  - yellowing of leaves
  - Vector of rice Tungro, Yellow dwarf, Transitory yellowing
- **Brown plant hopper:** Nilaparvata lugens (Delphacidae)
  - Hopper burn drying burning symptom in young plants, Circular patches of drying, Vector of grassy stunt, Ragged stunt and wilted stunt.
  - Avoid use of excess nitrogen
  - Resistant varieties: Py3, CO42, Mudgo (low aspargine content)
  - Resurgence causing pesticides : Acephate, Fenthion, Phosphamidon, synthetic Pyrethriods, Methyl demeton
  - Predators: *Cyrtorhimus lividipennis Lycosa sp. Microvetia* sp.
- **Ear head bug**: *Leptocorisa acuta:* L. *oratorius* (Gundhi bug) (Alydidae): chaffy grains with black spot. Feeds on tender stem. Peduncle and milky grains leads to chaffy ear head.
  - **Control**: Fenthion 100 EC 200 ml
  - Malathion 5% dust @ 10 kg/ha.
  - Clean cultivation- removal of weeds & grasses.
- **Rice root nematode**: *Hirschmaiviella oryzae* (Montek disease)
- **White up nematode or spring dwarf nematode:** *Aphelexhcopdes besseyi* hot water treatment of seeds at 52^0C for to min.
- **Rice stem nematode**: *Ditylenchus angustus*

- Larva disease in rice.

- **Rice case worm**: *Nymphula depunctalis*
  - Larva with in tubular cases. Floating on water.

PESTS OF WHEAT

- The rabi crops which are seriously damaged by white grub beetle are - **wheat and potato.**
- **Wheat shootfly**: *Atherigona naquii*
- **Ghujia weevil**: *Taenymecus indicus* is a pest of wheat, barley gram and mustard. The adult weevils cut to germinating seedlings grub feed on soil humus.
- **Wheat aphid**: *Macrosiphum miscanthi*
- **Wheat gall nematode** or **ear cockle nematode:** *Anguina tritici* Bacterium associated: *Corynebacterium tritici*
- **Seed galls/ Thundu disease/ yellow ear rot** (Bacterium+Nematode)
  - Mgt. Hot water treatment of seeds at 50^0C for 2 hrs.
- **Wheat stems borer:** *Sesamia inferens* (Noctuidae).

PESTS OF SUGARCANE

1) Shoot borer: *Chilo infuscatellus* (crambidae) or early shoot borer

- Number of feeding punctures near the base of shoot. Rotten portion of straw colored dead heart emits offensive odour. It can be pulled out easily.
- **Control**: Earthing up during early stage.
  - Trash mulching
  - Trichogramma Chilonis
- Soil application of Gammas HCH emulsion @ 1 kg a.i./ha over the cane sets in famous at the time of planting
- Granulosis Virus can also be used

2) Top borer: Scirphophaga excerptalis (Pryalidae)

- Midrib tunnelling. Shot – holes on axial bud growth leaves, dead heart and can be pulled out easily and given bunchy top appearance, Acrial root formation.
- **Control:**
  i. Avoiding of frequent irrigation
  ii. Carbofuran @ 1 kg a.i./ha synchronizing with brood emergence
  iii. Trichogramma japonicum
  iv. Pre-pupal parasitoid Isotima Javensis
  v. Resistant var: COJ67, CO 1007

3) Internode borer: *Chilo sacchaviphagus indicus (crambidae)*

- Attack starts from 4th months onwards. Internodes constricted and shortened with many bore holes: fresh bore holes with wet frass, stunted growth. Major pests in peninsular India. Hardening of internodes.
- **Control:** Detrashing at 5.7 & 9th months

  -T- chilonis @ 3.5 cc/ha/fortnight from 4th month until a month before harvest.

4) Gurdaspur borer: (Crambidae) *Acigone steniellea*

- Two phases: Gegarious phase – feed on first internode from to & may larvae enter into the core through single hole.
- Solitary phase – dispersed to other came by silhen treads.

5) White grub: *Holotrichia consanguinea: H. Serrata. (Meloionthidae Anomula begglensis* (Rutelinae)

- Drying of crops: Yellowing & nibbling of leaves: roots eaten away.
- Control: *Netarhizium onisopliae*
  - Pudding & crop rotation
  - B. *Popillae* milky disease

6) Termites: *Odentotermes spp: Microtermes obesi*

- Older leaves dry up first & cane falls down if disturbed.
- Filled with moist soil inside the papery rind.

7) Sugarcane scale: *Melanaspis glomerate:* (diaspridiadae)

- Grayish block appearance of stem. Reduced yield, juice quality of Jaggery production
- Control: Detrashing & Trash burning.

8) Leaf hopper: *Pyrilla perpusilla* (Lophopidae)

- Yellowish white spots on leaves; sooty mould on later stages.
- Control: Externel parasitoid: *Epiricarlia melanoleuca* (Ephpyropidae)
- Green muscardine fungus: *Aceria sacchari (*Eriophyidae)
- Forming a circular Ereneum gall in the inner side of the leaf sheath

PESTS OF COTTON:

- Consuming 54% of total insecticide in India though the area under cotton is only 5%

1) Cotton jassid or leafhopper: *Amrasca devastans (A. biguttula cicadellidae)*

- Hopper burn yellowing, curling, bronzing & drying.

2) Whitefly: *Bemisia tabaci* (Aleyrodidae)

- Shedding of leaves, stunting of plants, bud boll opening and poor quality lint. Contamination of lint with honey dew and sooty mould appearance.
- Vector of cotton leaf curl virus disease in Punjab.
- Whitefly outbreak on cotton in AP during 1985-86.
- Outbreak was due to indiscriminate use of insecticides particularly synthetic pyrethroids against Heliothis.

3) Spotted bollworm: *Earias vitella*

- Spiny bollworm: *Earias insulana* (Noctuidae)
- Symptom: Boring of terminal shoots of young, plants "Flaring of squares" and boring of young bolls frass at the entrance hole.
- Moths are green in colour.

4) Pink bollworm: *Pectinophora gossypiella* (Gelichidae)

- Symptom: Rosetting of flowers
- Eating of seeds
- Double seed formation, Locular burrowing

- Diapause during winter

5) American bollworm: *Helicoverpa armigera* (Noctuidae)

- Large, circular bore holes with faecal pellets. Larvae feed by thrusting their heads alone inside.

6) Red cotton bug: *Dysdercus cingulatus* (Pyrrhocoridae)

- Rotting of bolls: water soaked spots
- Lay eggs in soil
- Bacterium associated: *Nematospora gossypii* – staining of hint.
- Control measures: All pests
- Crop rotation with cereal: i) okra should not be grown in rotation
    - ii) Yellow sticky trap for monitoring whitefly
    - iii) Whitefly tolerant var. LPS 141 and Supriya
    - iv) Pheromone trap for PBW (Gossyplure)
- Pheromone trap for Helicopiveria (Helilure)
- Biological control:
    - *Trichogramma chilonis* against bollworms
    - Spodoptera NPV 250-500 LE/ha (1 LE=$6x10^9$ POB= 3 larvae)
    - Helicoverpa NPV
    - B.t. Formulation against early instars of bollworms
    - Synthetic pyrethriods should be used only during peak flowering and boll formation stages.

7) Stem weevil: *Pempherulus affinis*

- Stem gall near the base of the plant
- MCU 3 – resistant variety
- Control – soil application of granular insecticide/Neem cake

PESTS OF CHICK PEA (BENGAL GRAM)

- ***Helicoverpa armigera*** – Gram pod borer or gram caterpillar consume foliage and developing pods.
- ***Greasy cutworm, Agrotis ypsilon*** (Noctuidae)
  Cut the stems at ground level

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TERMINOLOGY:

- *Regular pest:* Occur most frequently on cultivated crops
  Eg.: cotton bollworms, Brinjal fruit borer
- *Occasional pest:* Occurring less frequently
  Eg.: case worm on rice
- **Seasonal pests**: Occurs in a particular season of year
  Eg.: red hairy caterpillar on groundnut
- **Persistent pest**: Occurs throughout the year on crops
  Eg.: chilli thrips, Rose thrips
- **Sporadic pests**: Occurs in a few isolated localities
  Eg.: Gall midge on rice in Madurai area
- **Endemic pests**: Occurs in same Agril. Area year after year
  Eg.: nematode on potato in Nilgris
- **Migratory pests**: Moves from one area to others and causes damage
  Eg.: Locust
- **Epidemic pests**: Occur in particular area/season in severe form
- **Pandemic pests**: Occur in a large geographical area/entire country or continent
  Eg.: locust outbreak

Pesticide calculation:

1) Apply 0.75 kg a.i./ ha of 3% carbofuran granules

Formula: Rec. Dose of ai./ha
$$\frac{}{\text{\% al. of formulation}} \times 100$$

$$\frac{0.75 \times 100}{3} = 25\text{kg granules/ha}$$

2) Quantity of Malathion 50 EC required spraying 1 ha of field, o.5% strength

Pesticide V1 x N1 = V2 x N2 (Spray fluid)

$V1 = \frac{V2 \times N2}{N2}$ (500 lit of spray fluid in required/ha)

$$= \frac{500 \times 0.5}{50} = 5 \text{ liters}$$

MAJOR DISEASES OF RICE/ WHEAT/ COTTON/ SUGARCANE/ PIGEON PEA

Diseases of Rice:

1) Blast - *Pyricularia oryzae:* air borne: edifenphos/ Hisoses 0.05% *Magnaparthe grisea)*
2) Brown spot - *Helmininosporium oryzae;* Seed borne; common fungicide *Bipoloris oryzae (Cochlioboltus miyabeanus)*
3) Bacterial blight - *Xanthomonas campestris* pv.- *orzyae*
   Seed and any antibiotic infected debris streptomycin + tertacyclin
   Symptom : Kresek in seedling stage
4) Foot rot (or) - *Gibberella fujikorai;* seed lime; common fungicide
   Foolish seedling disease (or) *(Fusarium Moniliforme*)
   Bakanae disease
5) Sheath blight (or) - *Rhizoctonia solani;* Soil borne; Cultural practice + fungicides
   Leaf smut - *Enteloma oryzae*
6) Stem rot *Sarocladium oryzae (Leptosphaeria salrini)*
7) Udabatta disease - *Ephelis oryzae* (*Balansia oryzal)* Hot water
8) False smut or Green smut - *Ustilaginoidea virens*
9) Bunt - *Tilletia barcleyana* (*Neovosia horrida)*
10) Rice tungro virus - Vector *Nephotetti cinticeps: N. virescens (GLH)* reduced tillering and orange discoloration
11) Rice yellow dwarf Phytoplasma starting, leaves remains green in colour
12) Ufra disease - *Ditcylanchus angustus*
13) Pansukh (dry physiological leaf disease)
14) Khaira disease - Zinc deficiency.

Diseases of Wheat

1) Stem rust - *Puccinia graminis tritici*
2) Leaf rust (Brown, rust) - *P. graminis recondita*
3) Yellow rust - *P. graminis striiformis* (stripe rust) (air borne)

Control

i. Sulphur dust
ii. Plantavax (oxy corboxin)
iii. Loose smut *Ustilago tritici* - internally seed borne solar heat Treatment. Hot water treatment (vitavax, carboxin)

iv. Hill bunt *Tilletia foetiaa* - Externally seed brone
T. caroues
v. Kornal bunt - *Neovossia indica* Soil & air brone
vi. Flag smut - *Urouystis gramininis*-Seed & soil borne

Control for smut & bunts

~ Seed treatment with Agresan 2g/kg.
~ Benomyl spray for bunts

(1) Exerlite - *Angiuna tritici*
(2) Tundu (Yellow ear rot) *Corynebacterium tritici*
- *Anguna tritici*
(3) Molya (or) cereal root-eel worm *Heterodera avemae*

Diseases of cotton :

1) Wilt - *Fusarium oxysporum* f. sp. *vasinfectum*
2) Wilt - *Verticillium dahliae*
3) Root rot *Macrophomina phaseoline*
4) Blackarm - *Xanthomonas compesttris*
- Pv. *Maliacearum (x, axnopodis new name)*
- Spray 500 ppm streptomycin sulphate
5) Stenosis or smail leaf MLO (mycoplasma like organisms) vector-jassid
6) Anthrocanose - *Colletotrichum capsici*
- *Physalospora tucumanensis*
- Spread through setts 0.1% Carbendaym- sett treatment
7) Grey or Areolate mildew - *Ramularia areola*
Common control Acid delinting

Diseases of Sugarcane:

1) Red rot *Colletotrichum falcatum*
Physalospora tucumanensis
Spread through setts 0.1% carbendays sett treatment.
2) Smut - *Ustilago scitaminea* remove infected – clump & dip in hot water avoid ratooning
3) Sett rot (or) Pineapple - *Ceratocystis paradoxa*
4) Gummosis or gumming disease - *Xanthomonas campestris pv. Vascularum*
5) Red stripe - *Pseudomonas rubrilineans*
6) Mosaic Virus vector - *Rhopalosiphum maidis*
7) Grassy shoot - MLO (Myoplasma Like organisms) vector – *Proveista moesta* Hot water treatment 52% c 1/hr. Aerated steam therapy 54%C for 8/hr.
8) Root knot nematode - *Meloidogyne* sp.

Bengal gram:

(1) Wilt - *Fusarium Oxysperium j.* sp. *ciceri*
(2) Root rot - *Macrophamina phasolina*
(3) Blight - *Asehochyta rabei* seed borne

General Plant Pathology

- Father of Plant pathology - **Anton De Bary**
- Father of Indian Plant Pathology - **E. J. Butler**
- An Indian whose name is associated with wheat rust - **K. C. Mehta**
- Father of plant virology - **Beijerinck**
- Father of plant Bacteriology - **E. F. smith**
- Irish Famine(1845) is due to - **Late blight of potato** (*Phytophthora infestans)*
- Bengal Famine(1943) is due to - **Brown spot of rice** (*Helminthosporium oryzae*)
- Most important disease of rice- - **Blast** ***(Pyricularia oryzae)***
- Kresek phase of rice is due to - **Bacterial leaf blight** ***(Xanthomonas oryzae)***
- Bakanae disease of rice (also called Foot rot) is due - ***Gibberella fujikuroi***
- Bakanae disease of rice also called - **Foot rot and Foolish seedling disease**
- Disease due to which plant become very tall is - **Bakanae**
- Causal organism of Sheath rot of rice is - ***Sclerotium oryzae***
- Causal organism of Rice Tungro of rice is - A virus
- Rice Tungro of rice is transmitted by **-BPH (*Nephottetix virescens*)**
- Ufra disease of rice is causad by - By nematode ***(Ditylenchus angustus)***
- Most pathogenic bacteria are gram negative and rod shaped
- Gram positive plant pathogenic bacteria: **Corynebacterium / Clavibacter** (tundu disease of wheat)
- Tundu disease caused by- **Bacteria and nematode (*Anguina tritici)*** association, a complex disease
- Plant viruses are mostly - **Single stranded RNA**
- Virus contain only one type of nucleic acid, either DNA or RNA, never both
- Virus contain nucleic acid 5 % and protein (nucleoprotein)- **95 % (TMV)**
- Tobacco mosaic virus is single stranded RNA- Rod shaped transmitted by sap or mechanically
- Single stranded DNA plant virus - **Gemini virus**
- Double stranded RNA virus - **Reovirus**
- Double stranded DNA virus - **Caulimovirus**
- Total stem parasite - **Cascuta (Dodder)**
- Partial stem parasite - **Loranthus**
- Total root parasite - **Orobanche**
- Partial root parasite - **Striga**
- Bacterial cell wall is made up of – **Murein/peptidiglycan**
- Karnal bunt of wheat discovered by - **Mitra *et al*., in 1931**
- A disease affecting wheat export from India- **Karnal Bunt** ***(Neovossia indica / Tilletia indica)***
- Wheat: a.Stem Rust (Black) - ***Puccinia graminis tritici***- Alternate host: **Berberi (*Berberis vulgaris)***
  b. Leaf rust (Brown) - ***P. recondita***, Alternate host: - **Thalictrum sp.**
  c) Stripe rust (Yellow)- ***P. striiformis***

- Rust disease is controlled by - **Plantavax**- a systemic fungicide
- Smut disease is controlled by - **Vitavax** (a systemic fungicide)
- Wheat rust in India survive in the southern hill (Nilgiri) and in Northern hill (Himalaya) in the form of Uredospore
- Loose smut of wheat - ***Ustilago nuda tritici*** (Internally seed borne, controlled by Vitavax, solar Heat Treatment)
- Molya disease of wheat- Nematode- ***Heterodora avanae***
- Black arm of cotton- ***Xanthomonas campestris pv. malvacearum***
- Red rot of sugarcane- ***Collectrichum fulcatum***
- Grassy shoot - **Phytoplasma**
- Sporadic- Occurs irregularly in a place at low level
- Endemic- Occurs every year in a confined area at some level
- Pandemic- Occurs over a few countries or few continents
- Epidemic- Occurs over a large geographic area in short time at a devastative level
- Viroid- a plant pathogen made up of only RNA (single stranded). No protein is there
- Prions- Infectious protein molecule
- Potato- 1. Spindle tuber disease (1st discovered Viroid disease)
- Other Viroid disease- Coconut cadang, Citrus exocartis
- Disease caused by Phytoplasma (MLO)- a. sandal spike b. sugarcane grassy shoot c. Brinjal little leaf d. Sesamum Phyllody e. coconut root wilt
- Disease caused by Spiro plasma (Phyllody)- **Citrus stubborn**
- Viral disease- Bunchy top of banana- ***Pentalonia nigronervosa***
- Crown gall of stone fruit- ***Agrobacterium tumefaciens***
- Fire blight- First bacterial disease discovered- ***Erwinia amylovora***
- Ergot of Bajra- ***Claviceps microcephala (purpurea)***
- Green ear disease of Bajra**-** ***Sclerospora graminicola***
- Wart of potato and Golden nematode- Endemic pest, domestic quarantine
- Bunt- ***Tilletia foetida. T. caries***
- Fungicide- Bordeaux mixture discovered by **Millerdat**
- Systemic fungicide- **Van Schmelling & Marshal Kulka**
- Pomegranate blight- ***Xanthomonas campestris*** **pv.** ***punica***. Recently epidemic in Maharashtra
- Panama wilt of banana- fungal disease
- Moko disease of banana- Bacterial disease
- Soft rot of potato- ***Erwinia carotovora***
- Kalisena- Bio formulation of ***Aspergillus niger*** N27 to control soil borne disease, developed in IARI
- Gene deployment for control of Rust- by **Nagarajan**
- Seed gall wheat- Nematode, Molya disease, ***Anguina tritici***
- Destructive insect pest act- **1914**
- Cyanobacteria- BGA-prokaryotic

- Powdery mildew- controlled by **sulphur fungicide**
- Apple scab caused by- ***Venturia inequalis*** **(perfect)** ***Spilocaea pomi*** **(fungi**)
- Scab of potato caused by- ***Steptomyces scabies*** **(Actinomycetes)**
- Electron Microscope discovered by **– Knoll and Ruska (1932)**
- Crystallization of Virus **– Stanley (1935)**
- First book on plant pathology written by **– Julius Kuhn (1858)**
- Wart disease of Potato is endemic to **Darjeeling only**
- Plasmid – extra chromosomal fragments found in bacterial cells
- Gene to gene Hypothesis proposed by **– Flor (1955) in linseed rust**

PLANT PATHOLOGIST IN INDIA:

- **K. R. Kirtikar** was the first Indian scientist who collected many Fungi and identified them
- **E. J. Butler (1910**) did detailed studies of Fungi and diseases caused by them. He wrote a book **'Fungi and Diseases in Plants'**
- **E. J. Butler** is called the **'Father of Modern Plant Pathology'** in India
- **J. F. Dastur (1886-1971**) was the first Indian plant pathologist to study in detail on fungi and plant diseases
- **B. B. Mundkar** identified and classified the smut fungi found in India
- The **Indian Phytopathological society** is founded by **B. B. Mundkar in 1948**
- **Dr Karam chand Mehta (K. C. Mehta**) of Agra college discovered disease cycle of cereal rust in India
- **Prof. Jaichand Luthra** and **Sattar** developed solar heat treatment technique of seeds to control loose smut in wheat
- **M. J. Thirumalachar** performed extensive studies on rusts and smuts in India. Developed antibiotics like **Oreofungin** and **Streptocyclin**

INTRODUCED DISEASE INTO INDIA:

Name of disease	Introduced from	Year
Leaf rust of coffee (*Hemileia vastatrix*)	**Srilanka**	**1876**
Fire blight of apple (*Erwinia amylovora*)	**England**	**1940**
Flag smut of wheat **(***Urocystis tritici***)**	**Australia**	**-**
Bunchy Top of Banana (viral disease)	**Srilanka**	**1940**
Wart disease of Potato (*Synchytrium endobioticum*)	**Holland**	**1952**
Onion smut *(Urocystis cepulae)*	**-**	**-**
Golden nematode of potato	**Europe**	**1960s**
Groundnut rust	**U.S.A**	**1970s**
Citrus canker	**U.S.A**	**-**

MYCOPLASMA:

- Larger than viruses but smaller than Bacteria

- Devoid of cell wall and cytoplasm
- Enveloped by a lipo-protein plasma membrane
- Highly resistant against the antibiotic Penicillin but is sensitive to Tetracycline antibiotic
- Tetracycline used to control Mycoplasma
- First isolated from sheep infected by Pleuro pneumonia and therefore called PPLO (Pleuro Pneumonia Like Organisms)
- Most of the yellow diseases of plants are caused by Mycoplasma
- E.g. Witches broom of Potato, Mulberry dwarf and Aester yellows etc.

Miscellaneous:

- **Virus =** Nucleic acid (DNA or RNA) + Protein (outer cover)
- **Lipo-virus =** Nucleic acid + protein + lipid **e.g. Influenza virus**
- **Animal virus (Bacteriophage) =** DNA + Protein
- **Plant virus =** RNA + protein
- **Viroid** = nucleic acid only
- **Plant Viroid =** RNA only

BACTERIOPHAGES:

- Discovered by F. W. Twort (1915) and Felix de Herelle (1917)
- Contains nucleic acid (double stranded DNA)
- It has two parts viz tail and head
- The tail is composed of protein only. The head has outer coat of protein and inner core as DNA

VIRIOD:

- Term 'viriod' used by T.O Diener
- Naked nucleic acids without protein coat
- Consists of only RNA
- These 'miniviruses' are the smallest known agents of infectious disease
- Potato spindle was the first disease reported to have been caused by a viriod
- Infectious in plants only
- Examples – Citrus excortis viriod, chrysanthemum stunt and chlorotic mottle viriod

Virions:

- Individual, completed and infectious nucleoprotein particles of a virus
- In short, virus particles are called Virions
- Also called nucleocapsids

Prions or slow viruses:

- Smallest proteinaceous infectious
- Contains protein only
- Example – Mad cow disease, Alzheimer's disease
- Nanometre is the unit for measurement of viruses

9. Important principles of economics

Important economic concepts

- Expense to income ratio is **- efficiency ratio**
- Production function is physical relationship between **- inputs and outputs**
- A statement which gives complete list of purchase and sales of assets is **- Case flow statement**
- The point at which total cost and total revenue is equal is **- breakeven point**
- The statement which measures the credit worthiness of the farm business is **-balance sheet**
- The statement which provides repayment capacity of the farmer is **-fund flow statement**
- When MP = 0, TPP is at **- maximum**
- The stage which optimize the resources, maximize the production is **- II stage**
- Farm building can be valued by cost **-depreciation method**
- The word marginal in economics means **- additional**
- The type of relationship in which all other inputs are fixed except one to produce a product is known as **- factor product**
- Slope of iso-cost line is **- downward**
- Linkage of co-operative marketing societies with PACS was recommended by **- Commission on agriculture credit**
- Advisory of central government regarding agricultural commodity prices is **- CACP (Commission on Agriculture Cost and Prices)**
- Minimum support price and procurement price is announced **- CACP**
- National income in India is calculated by **- product method and income method**
- Inflation means **- persistence rise in general price level**
- Production possibility curve is **concave** downwards because **- Law of increasing opportunity cost**
- The theory of demand is explained by **- marginal product curves**
- Demand function of commodity is **- influenced by income**
- The firm is in equilibrium when **- MC= MR**
- The production function which is highly useful in fertilizer related studies is **- Quadratic production function**
- The line that connects the point of equal slope of successive product indifference curve is **- Isoclines**
- A technique which is used to evaluate profitability of a particular type of equipment is **- Partial budgeting/ enterprise budgeting**
- Theory of rent is based on **- law of diminishing marginal returns**

- Optimum factor combination is achieved at
  -the point of least cost combination
- Economic area of production can be located **- in stage II**
- After the inflation point, the TPP curve increases at **- decreasing rate**
- Markets are classified as forward and spot markets based on
  - Nature of transaction
- Debt- equity ratio is deferred **- liabilities/ net worth**
- A bankers to government of India is **- Reserve Bank of India**
- Disposal income is personal income- **- personal tax**
- All possible combination of two products with a given level of input is
  - Production possibility frontier
- The purpose of regulated market is to **- eliminate healthy malpractices**
- When a farm perform more than one activity, it is called **- vertical integration**
- Rejection of null hypothesis when it is false is known as **- no error**
- The present value of future return is calculated by the formula **- PV = R/ (1+ r)**
- New entry in the balance sheet is called **- net worth**
- The financial statement of a farm business can be provided by
  - Net worth statement
- The most limiting factor of production in Indian agriculture is **– capital**
- Farm machinery and equipments are an example of **- Working assets**

Important Economic Theories	**Given By**
Theory of profit	**- A. Walker**
Modern theories of interest	**- Hicks Hansen**
Wage fund theory	**- J.S. Mill**
Population theory	**- Malthus**
Theory of multiplier	**- Keynes**
Theory of disguised unemployment	**- Nurkses**
Theory of unlimited supplies of labour	**- Lewis**
Low level equilibrium trap	**- Nelson**
Theory of undeveloped countries	**- Keynes**
Theory of stage of economic growth and classical theory of economic development	**- W.W. Rostow**
Theory of das capital	**- Karl Marks**
Theory of economic growth	**- John Fei & Gustav Ranis**
Theory of push	**- N. Rosentein Rodan**
Theory of social dualism	**- J. K. Boeke**
Theory of circular causation	**- Myrdal**
Requirement of steady growth	**- Harrod Damar**

- The model of distribution - **Kaldor**
- The model of profit and growth - **Psinette**
- The model of capital accumulation - **Joan Robinson**
- The model of economic growth - **R. E. Meade**
- The model of growth - **Kaldor**
- The single sector model - **Mahalanobis**
- Theory of rent - **Recardo**
- Theory of time preference **-Fisher**
- Theory of employment - **Keynes**
- Monitory theory - **R.G. Howatrey**
- Theory of consumption - **Keynes**
- Modern theory of wages and employment - **Keynes**
- Support theory - **Stanley Jevon**
- Under consumption theory - **J.A. Hobbson**
- Quantity theory of money - **Milton Fridman**
- Theory of inflation - **A.P.Lerner**
- Theory of absolute advantage - **Adam Smith**
- Modern theory of international trade - **Bertil Ohlin**

Farm efficiency measure and economic ratio

- Production efficiency = Yield per acre/ Yield of locality x 100
- Intensity of cropping = Total cropped area / total cultivated area x 100
- Productive man work unit per man = Total PMWU / man equivalent
- Machinery cost per crop acre = Total machinery cost / total cropped area
- Operating cost ratio = Total operating cost / total profit
- Overhead charged ratio = Total operating cost / total profit
- Overhead charges ratio = Total fixed cost per year/ gross income
- Ratio of capital turnover = Gross income /total farm income x 100
- Net cash income = Total cost receipt – total operating cost
- Net farm income = Net cash income ± change in inventory
- Farm earnings = Net farm income = value of farm product
- The net capital ratio = Total assets / Total liabilities.

Important Economic formulae

Ratio Methods

A. Capital Ratios:

1. Net capital Ratio = Total assets/ Total liabilities

2. Working capital Ratio= $\frac{\text{Working assets + Current assets}}{\text{Intermediary liabilities + current liabilities}}$

3. Current ratio = Current assets/ Current liabilities

4. Debt equity ratio = Deferred liabilities/ Net Worth

B. Income Ration:
1. Rate of turn over = Gross income/ Total assets
2. Net income per acre= Total returns to fixed farm resources/ Total acres

C. Cost Ratios:
1. Gross ratio= Total expenses/ Gross income
2. Fixed ratio= Fixed expenses/ Gross income
3. Operating ratio= Operating expenses/ Gross income

D.

1. Adjusted crop yield = $\frac{\text{Crop yield index X cropping intensity on the farm}}{\text{Cropping intensity in the area}}$

2. System index = $\frac{\text{Potential net income per hectare on the farm}}{\text{Average net income per hectare in the area}} \times 100$

Cost concepts in farm Management

1. Cost A_1 = Wages of casual labour + attached labour + hired bullock labour + imputed value of owned bullock labour + hired machine labour + imputed value of owned machine labour + seed + manure and fertilizers + plant protection chemicals + irrigation charges + interest on working capital + depreciation + land revenue.

2. Cost A_2 = Cost A_1 + rent paid for leased in land, if any
3. Cost B_1 = Cost A_1 + interest on owned fixed capital/ exuding land
   Cost B_2 = Cost B_1 + rental value of owned land
4. Cost C = Cost B + imputed value of family labour
   Cost C is also called gross cost or total cost of cultivation. All cost that paid out for the factors of production.

A. Aggregate Measures
1. Net operation income = Gross income – (Operating expenses + depreciation on working assets)
2. Net farm income = Net operating income – (fixed expenses + depreciation on fixed assets).

B. Income measures in relation to different cost concepts
1. Farm business income = Gross income – Cost A_1
2. Owned farm business income = Gross income – Cost A_2
3. Family labour income = Gross income – Cost B
4. Net income = Gross income – Cost C
5. Farm investment income = Net income + rental value of owned land + interest on owned fixed capital.

Financial Test Ratios

A. Test Ratios:

1. Current ratio = Total current assets/ Total current liabilities
2. Intermediate ration = (Total current assets + intermediate assets)/ (Total current liabilities + intermediate liabilities)
3. Net capital ratio = Total assets/ Total liabilities
4. Acid ratio = $\frac{\text{Cash receipt accounts receivable + Securities in more than one year}}{\text{Total current liabilities}}$
5. Current liability ratio = Current liability/ Owner's equity
6. Debt equity ratio (or Leverage ratio) = Total debts/ Owner's equity
7. Equity to asset value ratio = Owner's equity/ Total asset value

Financial Test Ratios

A. Input-Output ratios:

1. Operating ratio = Operating expenses/ Gross income
2. Fixed ratio = Fixed expenses/ Gross income
3. Gross ratio = Total expenses/ Gross income

B. Investment to income ratio:

1. Capital turn-over ratio = Gross income/ Average capital investment
2. Rate of return on investment = Net return to capital/ Average capital investment

C.

1. Break-even point (BEP) = Annual fixed cost / (Selling cost per unit – variable cost per unit)
2. Margin of safety = Total output – output at breakeven point
   = Total revenue – revenue at breakeven point
3. Percentage of margin of safety = (Break even point out put/ Volume of output) ×100

10. Principles of extension education

- The word 'extension' is used first time by **- Land Grant College (UK)**
- An applied behavioral science and brings about behavioral changes in human beings is called **- Extension Education**
- The process through which a person attains changes in behavioural by his own activity is a called **- Learning**
- Process of arranging / providing situation in which solving the problem is called **- Teaching**
- Demonstration conducted by farmer under the direct supervision of extension worker is a**- Result Demonstration**
- Demonstration conducted to show the technique of doing things is **- Method Demonstration**
- Demonstration conducted by research worker farmers field is **-Front line demonstration**
- Extension teaching methods:
- **Individual** - Farm & Home visit or personal contact, Letters (Personal) Telephone Call and Result demonstration and Office call
- **Group** (20-30 persons) - Symposium (2-3 speakers), Panel (2-8 speakers), Discussion, Tour and field days and Lecture, meetings, slide, school, seminar, conferences
- Mass of Community (more than 30 persons)- Bulletins, Leaflet / booklet / folder , pamphlet, News paper, Magazine, Journals, radio, cinema, movie
- Stages of extension in India: -
- Stage I Pre-independence era (1866-1947)
- Stage II Post-independence era (1947-1953)
- Stage III Community development and extension service era (1953-1960)
- Stage IV Intensive agricultural development era 1960- till date
- Principle of extension education is **- Learning by doing**
- Goal of extension education is **- To promote income of farmers**
- Television broadcast for rural development in India, started in **-1957**
- Cooperative society is basic institution for**- Socio-economic growth of the villagers**
- The fundamental objective of extension education **- Development of the people**
- T & V system is a good example of **- Training approach**
- The main objectives of the community development programme are **- Area development , Self help programme, Development of the whole community**
- According to Balwantrai Mehta committee, Panchayati Raj should be……of local self government bodies from village to district - **Three tier structure**
- Panchayati Raj firstly started in 2nd October in **- Nagaur (Rajasthan)**
- Formula for the Intelligence Quotient (I.Q.) **- Mental age/Chronological age x 100**
- Sequence in extension teaching **- Attention -Interest - Desire - Conviction -Action -Satisfaction**
- Principle of learning

- Learning is growth like and continuous,
- Learning should be meaning full, and
- Learning should be challenging and satisfying

- Element for good learning situation- **Physical facilities, Extension worker and Subject matter**
- Radio mass medium is characterised by **-one way without instant audience response**
- Purpose of extension evaluation is to identify - **the weak points, the strong points and the gaps and errors**
- Methods of group communication are **- News paper, Demonstration, Symposium and Flannel graph**
- People's participation in an extension programme is significant when **- Majority of villagers participat**
- Extension evaluation begins at **- the mid step of the programme**
- Examples of Mass communication **-Television, Film and Tape recorder**
- Success in rural development project depends upon **-Participation of beneficiaries**
- National Academy of Agriculture Research Management is located at **- Hyderabad**
- For a study of farming system, the best PRA exercise is **-Resource mapping**
- Community development project was started in India in **-1952**
- The best Source of interview in a rural society **- Focused group**
- The process by which message transfer from source to receiver is called **- Communication**
- The correct sequence of innovation-decision process or adoption process **- Awareness -interest -evaluation -trial-adoption**
- Farmers which are first to adopt a new idea **- Innovators**
- Farmers which are Last to adopt a new idea **- Leggards**
- No of years required for normal adoption rate of introduction of the innovation throughout the community **- 6 – 10 years**
- Drama is example of ……method of extension teaching **- Audio-visual**
- Examples of projected aids are **- Cinema, Slide, and Over head projector**
- Methods of extension teaching to show the value of an improved practice to people
- **- Result demonstration**
- No. of flash cards should be used for one talk **- 10 - 12**
- Step included in the programme planning- **Collect facts-Analyse situation-Identify problems**
- Primary institution of society **- Family**
- The word Extension is derived from **- Latin**
- Rural development depends on **- Research, Research and Extension**
- Working with rural people through out of school education along with their current interest and needs for getting overall development of rural families is called **- Extension process**

- Extension involves **- education for all village people, teaching through learning by doing and seeing is believing**
- Education results in **- Change in knowledge, Change in attitude and change in skills**
- Extension approaches having the highest intensity of influence **- Individual approach**
- Scheme for self-employment for rural youths **- TRYSEM**
- Sources of communication credible for non progressive/remote village situation **- Radio**
- News paper articles are included in **- Mass method of extension**
- "Stay at home" type of people can be contacted by **-Individual method of extension**
- Mass method of extension is **- Less intensive and less effective**
- Puppet shows are included in **- Audio-visual aids**
- Flash cards, pull charts, slides and film strips are the type of **- Audio-visual aids**
- Model is……, whether workable or not **- replica of the original**
- A working model is known as **- Mock-up**
- Real objects taken out of their natural settings is called as - **Specimens**
- The disc recording is made by the **- Mechanical process**
- Tape and wire recording are made by **- Magnetic process**
- The movie film recording is made by **- Optical process**
- Visual teaching aid flannel graph is also known as**- Khadder graph**
- A, B, C of posters means **- Attractive, Brief and Clear**
- A chart which consist of a series of individual charts which are bound together and hung on a supporting stand is called **- Flip charts**
- The process by which two or more people exchange ideas, facts,feelings or impressions - **Communication**
- "The communication process in Rural development" is written by **- Leagans**
- Leagans model of communication process is
  - **Communication- Message-Channel - Treatment -Audience -Audience response**
- A statement of situation, objectives, problems and solutions is called- **Extension programme**
- A plan of work arranged chronologically is called **- A calendar of work**
- A sound extension programme building based on
  - **Analysis of the facts in the situation**
  - **Select problems based on needs**
  - **Determine objective and solutions**
- Expressions of the ends towards which our efforts are directed is **-Communication**
- Objectives is defined as .the distance in any given direction one expects to go during a given period of time **- Goal**
- The ultimate objective of extension work is the full development of **- Individual**
- The gap between the situation and objective is the area of **- Needs**
- Panchayat Raj came after **- Self determined programme**

- First step for making a programme planning includes- Evaluation, Analysis of the situation and determining problems, Deciding on objectives and Teaching
- The main objective of evaluation in extension is **- To facilitate effective decision making without jumping to conclusion**
- In good administration the offices of a are arranged in a pyramid of authority and responsibility **- Bureaucracy**
- Farm demonstration work began in 1903 USA by **- Dr. Seaman**
- Extension work in Japan was first started by **- Fanner's organization**
- Departmentof revenue, agriculture and commerce **- 1871**
- The famine commission **- 1880**
- The Royal commission's report came in **- 1928**
- "Grow more food campaign" was started in **- 1947**
- Intensive Agricultural Development Programme (IADP) popularly also known as package programme started originally in 7 districts in **- 1960-61**
- Intensive Agriculture Area Programme came into operation in **- March, 1964**
- for social justice government started new programme -
  - **Small farmers development Agency (SFDA)**
  - **Marginal Farmers and Agriculture Laborers Scheme (MFAL)**
  - **Drought Prone Area Programme**
- Dominant social institution permeating social and economic relations- Caste
- Rural community differ from urban community in relation to **-Population density, Culture and Environment**
- Leader one who has received specialized training in the field in which he work as full time and paid for his work **- Professional leader**
- Best method for selection of leader **- Sociometry**
- Things which person ought or ought not to do in society **- Mores**
- Information sources at adoption stage- **Self-experience gained at the trial stage**
- Adopter category which respect and regarded by many others in the social system as a role Model **- Early adopters**

IMPORTANT POINTS:

- Etawah pilot project (1950) is given by **- Albert Mayer**
- The first KVK was established in 1974 at **- Pondichery**
- Lab to Land programme was started by **-ICAR**
- A.T.M.A. stands for- **Agriculture Technology Management Agency**
- T and V systems of extension was started by **- Daniel Benor**
- Parts of communication module are - **Communicator, Message, Audience**
- High yielding variety programme was started in the year **- 1966**
- The periodical "Kisan Bharti " is published from **- Pant Nagar**
- Role of different agencies for village development is included in **- Chapati diagram**
- Gurgaon project (1920) was started by **- F.L. Bryne**
- Sevagarm attempt was started under the supervision of **- M.K. Gandhi**
- Shriniketan attempt was started by **- R.N. Tagore** in Bengal

- Marthandum attempt (1921) was started by **- Spancer Hatch**
- NREP started in **- 1977**
- Firka development scheme launched in - **Madras** in- 1966
- Village Panchayat Act came into existence in **- 1958**
- Lab to land programme was launched by - **ICAR** in 1979
- The University Education Commission headed by - **Dr. S. Radha Krishanan**
- The Rural Systems Research idea was motivated by **- M.S.Swaminathan (1988)**
- The Planning Commission was set up by **- Govt. of India in 1950**
- Chairman of Planning Commission **- Prime Minister**
- Operational Research Projects (ORP) were initiates in **- 1970-71**
- The basic unit of development under **IRD** program - **Village**
- National Extension Service (NES) in India started in **- October 2, 1952**
- First Agricultural University in India
  - **G.B. Pant University of Agriculture and technology,** Pant Nagar
- Three-tier system of the local self government
  - **Gram panchayat - khand samiti - Zila parishad**
- Elements of communication process - **Source - message -channel - receiver**
- Extension education is **-both discipline and profession**
- Mode of radio broadcast are **- Straight talks, Interviews, Songs etc**.
- Form of social interaction **-Competition, Cooperation and Conflict**
- Overt behaviour in diffusion of innovation **- Adoption or rejection**
- General meetings involves **- Heterogeneous participation**
- Campaign implies **- Extensive teaching**
- Programme planning is a procedure of **- Working with people**
- A series of still pictures on one roll is called **- Film strip**
- A bulletin should contains **- 24-48 pages**
- Unit of two or more people in reciprocal communication and interaction with each other **- Group**
- Bhoodan movement was initiated by **-Achary Vinoba Bhave**
- Young Farmers Association was formed in India under the guidance of
  - **Dr. P. S. Deshmukh** (in April, 1956)
- National commission on farmers was set up in India in **- February, 2004**
- first chairman of National Commission on Farmers **- M.S. Swaminathan**
- National Agricultural Science Museum is located at **- New Delhi**
- National food for work programme was launched on **- Nov. 14, 2004**
- National food for work programme implemented as a
  - **100% centrally sponsored scheme**
- Swaranjayanti Gram Swarozgar Yojana (SGSY) was launched in **- April, 1999**
  (a) Sampoorna Grameen Rozgar Yojana **- 2001**
  (b) Pradhan Mantri Gramodaya Yojana (PMGY) **- 2000-01**
  (c) Rural Employment Generation Programme (REGP) **- 1995**
- Firka development scheme was launched under the guidance of- **T. Prakasam**
- Total population in India in villages **- 3/4**
- National Agriculture Technology Project was started in **-1998-99**
- NATP was funded from **- World Bank**
- National Institute of Agriculture Marketing (NIAM) is located at **- Jaipur**

- 3/4 Indian villages have a human population less than **- 1000**
- State Agricultural Universities in India were in the pattern of
  - **Land Grant College (**U.S.A.)
- The term "community development" originated from
  - **Cambridge University of England** in 1946
- Voluntary agencies are characterized by **- Greater continuity**
- MSP is announced by **- CACP**
- Nonnative science decided the **- Objectives of education**
- Decentralization through democratic bodies stimulated by **- B.R.Mehta**
- The key village scheme for improving the Quality and productivity of buffaloes and cattle in India started in- August 1952
- Most people retain -----% of what they read- **10 - 15**
- Most people kept in mind -----%of what they seen- **30 - 35**
- Symposium is a short series of lectures; usually by speakers - **2-5**
- Phillips 66 format or hurdle system is related with- **Buzz sessions**
- Small group interaction designed to encourage the free introduction of ideas on an unrestricted basis without any limitations to feasibility is known as - **Brain storming**
- Seminar method having focus on any particular subject or problem is followed in- **Syndicate Studies**

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11. Important rural development programmes in India

- The evaluation of Agricultural and Rural Development can be grouped into five stages.

Stage I : Pre Independence era

1903 : Model villages by Daniel Hamilton
1908 : Tagore Started Youth organisation in the villages in the Kaligram Pargana
1921 : Rural Reconstruction Institute, shantiniketan
1921 : Marathandam Project by Spencer Hatch
1921 : Gurgaon Experiment by F. L. Brayne
1921 : Sevagram Project by Mahatma Gandhi.
Adarsh Seva Sangh, Pohri (Gwalior) by Col. Shitole
1932 : Rural reconstruction Movement by V. T. Krishnamachari in Barod
1945 : Indian Village service by A. T. Mosher and B. N. Gupta, D. Tharugad
1946 : Firka development Scheme by T. Prakasha, D. Tharugad
1947 : Mazdoor Manzil at Nilokheri by S. K. Dey

Stage II : Post Independence era

1948 : Grow more food campaign
1948 : Etawah Pilot Project by Albert mayer.
1952 : Grow more food campaign enquiry committee.

Stage III : Community Development era

1952 : Community Development Project was started in 55 blocks, under the dynamic leadership of S. K. Day.
1953 : National Extension service.
1954 : NES Programme
1957 : Balwantraj Mehta committee on community.
Development Project recommended Democratic decentralization (Panchayatiraj).
1958 : Rajasthan became first state to adopt Panchayati Raj followed by Andhra Pradesh.

Stage IV : Intensive Agriculture development era

1960 : IADP Intensive Agriculture district Programme also called as Package Program in seven districts, later extended to nine more districts.
1964 : IAAP Intensive Agricultural Area Programme.
1964 : ICDP Intensive Cattle Development Project
1966 : HYVP High Yielding Varieties Programme.
1966 : MCP Multiple Cropping Programme.
1971 : MKP Minikit Programme for Rice was started and later extended to wheat, maize and other millets etc.

Stage V : Developmental Programmes with social Justice

1970 : SFDA Small farmer's Development Agency
1970 : MFAL Marginal Farmers and Agricultural Iaborers Programme.
1970 : DPAP Drought Prone Area Programme.
1974 : FWP Food for Work Programme.
1974 : MNP Minimum Needs Programme.
1974 : T & V Training and Visit system formulated by Daniel bonor and Baxtor of Israel. Turkey was the first started in Rajasthan Canal area in

			Rajasthan and Chambal area in Madhya Pradesh.
1974	:	KVK	Krishi Vigyan Kendra, Mohan singh Mehta committee recommended KVKs. First KVK was established by TNAU at Pondichery.
1974	:	CAD	Command Area Development Programme.
1979	:	IRDP	Integrated rural Development Programme.
1979	:	TRYSEM	Training Rural youth for Self-Employment.
1980	:	NREP	National Rural Employment programme
1980	:	NARP	National Agricultural research Project.
1982	:	DWCRA	Development of Women and Children-in Rural Areas.
1982	:	CAPART	Council for Advancement of Peoples Action and rural Technology.
1983	:	NAEP	National Agricultural Extension Project.
1983	:	RLEGP	Rural Landless Employment Guarantee Programme.
1986	:	TMO	Technology Mission on Oilseeds.
1989	:	JRY	Jawahar Rozgar Yojana, formed after merger of (NREP and RLEGP).
1993	:	EAS	Employment Assurance scheme
1994	:	IVLP	Institute village Linkage programme.
1994	:	MSY	Mahila Samrudhi Yojana.
1994	:	PMRY	Prime Minister Rozgar Yojana.
1995	:	NSAS	National social assistance scheme.
1999	:	NATP	National Agricultural Technology Project
1999	:	JGSY	Jawahar Gram Samuridhi Yojana (JRY).
1999	:	SGSY	Swaran Jayanti Gram Swarozgar Yojana (IRDP, TRYSEM, DWCRA, SITRA – merged into SGSY).

12. Organizational set up of agricultural research, education and extension in India,

- Who is the ex-officio President of the ICAR Society
  - Union Minister of Agriculture (Present**- Sharad Pawar)**
- Who is the principal executive officer of the ICAR
  - **Secretary**, Department of Agricultural Research & Education, Ministry of Agriculture, Govt. of India & **Director-General**, ICAR (Present- **Dr. S. Ayyappan**)
- Present Chairman of Agricultural Scientists' Recruitment Board
  -Dr. C. D. Mayee (Plant Pathlosist)
- Deputy Directors General under the ICAR organization **- 8**
- Assistant Directors General **- 24**
- Directorate of Information and Publications of Agriculture located at
  - New Delhi
- Directorates/Project Directorates - **25 (with upgradation of 12 NRCs)**
- National Bureaux **– 6 (New-NBAII, Bengaluru and NBAIM, Mau, UP)**
- Deemed Universities status -**6 (New- NAARM, Hyderabad and NIASM, Malegaon, Maharashtra)**
- **National Bureau of Agriculturally Important Insects (NBAII)** [formerly Project Directorate of Biological Control (PDBC)] is a nodal Institute at national level for research and development on all aspects of work on harnessing resources of insects including biological control of crop pests and weeds, training, information repository, technology dissemination and national/international cooperation.(2009)
- National Bureau of Agriculturally Important Microorganism(**NBAIM), Mau, UP (2005)**
- There are **44** Agricultural Technology Information Centres (**ATIC**) established under ICAR institutes.
- ICAR Introduced revised curricula and syllabi for **95 disciplines in Master's** and **80 disciplines in Doctoral** programmes.
- The Handbook of Agriculture updated as **6th edition (2009).**
- **NIASM** (National Institute of Abiotic Stress Management), **Malegaon, Maharastra,2008**
- No of Krishi Vigyan Kendras (KVK) - **over 568.(upto Dec.2009)**
- Deputy Director General (Natural Resource Management): **Dr. A.K. Singh**
- Union Minister for Agriculture: **Shri. Sharad Pawar**
- Minister of State for Agriculture: **Prof. K.V. Thomas**.
- New Director-General of ICAR: **Dr. S. Ayyappan**
- Project Directorates-**25 (upgrated NRCs-12)**
- SAUs**-45**
- National Research Centres (NRCs)-**17**
- AICRPs-**61**
- National Institutes-**6 (very Imp.)**

- Central Institutes- **49**
- Directorate of Women in Agriculutre - **Bhuwneshwar, Orissa**
- Directorate of Floricultural Research- **New Delhi**
- Directorate of Information and Publication in Agriculture- **New Delhi**
- AICRP, NSP-crops - **New Delhi**
- AICRP, Arid Zone fruit-**Bikaner**
- AICRP, NSP-vegetable - **Varanasi**
- AICRP, Pestiside residue - **New Delhi**
- AICRP, Agro meteorology - **Hyderabad**

HISTORY OF AGRICULTURAL RESEARCH IN INDIA

1871 : Dept. of Revenue, Agriculture and Commerce (DRAC) (chief function: collection of statistics (revenue) and not agril. research) during the tenure of Lord Mayo.

1877-78 : India faced severe famine and GOI resolved to set up a Central Dept. of Agriculture controlled by imperial Secretariat.

1881 : Dept. of Agriculture were set up in provinces

1892 : Agriculture chemist and an Assistant Chemist were appointed to look after research and teaching.

1899-1900 : Famine

1901 : Inspector general of Agriculture and an imperial mycologist were appointed to advice to imperial and provincial Govt. On agricultural matters.

1903 : An Entomologist was employed.

1901-05 : Agricultural colleges were established at Pune, Kanpur, Sabour, Nagpur, Lyallapur and Coimbatore.

1905 : Agricultural Research institute was established at pusa, Bihar by Lord Curzon. The land was donated by Mr. Phipps of USA after whom the place was named as PUSA.

1919 : Constitutional reforms made agriculture as state subject.

1928 : Royal commission on Agriculture, headed by lord Linlithgow recommended setting up of imperial council of Agricultural research to promote, guide and coordinate agricultural research throughout India.

THE COMMODITY COMMITTEES:

- Ministry of Food and Agriculture started several committees concerned with research and development activities related to specific crops. Some had their own research stations and some are self financed.

Year	Committee	Research station/ Institute
1921	Cotton committee	Technological laboratory now CTRL Matunga)
1931	Lac cess committee	Indian lac Research institute, Namkum

		(1936), Bihar
1936	Jute Committee	Jute Agricultural; Research institute, Barrakpore Jute Technological Research Laboratory, Calcutta, West bengal (Continues at Page 41)

AGRICULTURAL UNIVERSITIES

- C.B. Pant University of Agriculture and Technology, Pantnagar, is the first Agricultural University established in the year 1960.
- Central agricultural University, Shillong, is the latest established Agricultural University
- There are 30 State Agricultural Universities.
- Maximum 4 Universities in Maharastra
- **Project Directorates:**

Name	**Place**
Rice	Hyderabad
Oilseeds	Hyderabad
Poultry	Hyderabad
Pulses	Kannpur
Wheat	Karnal
Biological Control	Bangalore
Water management	Rahuri
Cropping Systems Research	Modhipuram
Cattle	Meerut
Vegetable Research	Varanasi

National Research Centers (NRCs) :

Integrated Pest Management	New Delhi (IARI)
Groundnut	Junagarh
Sorghum	Hyderabad
Soybean	Indore
Cashew	Puttur
Citrus	Nagpur
Mushroom Research and Training	Solan
Spices	Calicut
Agro-forestry	Jhansi
Weed Science	Japalpur
Camel	Bikaner
Equines	Hisar
Meat	Izatnagar
Methuen	Jharnapani
Yak	Dirang
Cold Water Fisheries	Haldwani
Orchids	Gangtok

Mustard	Bharatpur
Plant Biotechnology	New Delhi (IARI)

- **National Bureaus (6):**

NBPGR : National bureau of Plant Genetic Resources, New Delhi, IARI
NBAGR : National Bureau of Animal Genetics Resources, Karnal, Haryana
NBAGR : National Bureau of Fish Genetic Resources, Allahabad (UP).
NBSSLUP : National Bureau of Soil Survey and Land Use Planning, Nagpur.
NBAIM : National Bureau of Agricultural Important Microorganism, Mau (UP)
NBAII : National Bureau of Agricultural Important Insects, Bangalore (Karnatka)

- **Other Institutes:**
  - ✓ Under Ministry of Rural Development:
    NIRD: National Institute for Rural Development. Hyderabad. Guahati.
  - ✓ Under Ministry of Foods and Agriculture and Cooperation :
    - o MANAGE: National institute for Agriculture Extension Management. Hyderabad.
    - o NAARM: National Academy for Agricultural Research Management.
- **Organization: Streams of Extension in India:**
  1. The ICAR extension system, comprising mainly Research Institutes and Agricultural Universities.
  2. Extension System of Ministry of Agriculture and the State Departments of Agricultural.
  3. Extension System of the Ministry of Rural Development and State Development Departments, and
  4. Development work by the Non-Governmental Organizations (NGOs). Business houses etc.
- **Front-line Transfer of Technology Programmes of ICAR:**

1964	National Demonstrations	
1974	Operational Research Project	
1974	Krishi Vigyan Kendra	
1979	Lab to Land Program	
1944	Sugarcane committee	Sugarcane Breeding Institute, Coimbatore Indian Institute of Sugarcane Research, Lucknow
1945	Coconut Committee	Central Coconut Research Stations. Kanyagulam and Kasargod
1945	Tobacco Committee	Central Tobacco Research institute, Rajahmundry
1947	Oil Seeds committee	Financed research Schemes, head quarters at Hyderabad.
1949	Arecanut Committee	Arecanut Research Station, Vittal
1958	Spices and Cashewnut Committee	Financed Research schemes

- The central commodity committees were later abolished (beginning in 1965) and the research institutes under their control were transferred to ICAR.
- 1965: Project for intensification of regional Research on cotton, Oilseeds and millets (PIRPCOM) First coordinated research work on regional basis was initiated in 1956 as a joint effort by ICAR and Indian Central Committees on oilseeds and Cotton. Seventeen centres were established throughout the country

	Place	**State**	**Research work on**
~	Coimbatore	Tamil Nadu	Cotton, Jowar, Groundnut
~	Bellary, Dhadesagur, Dharwad, Silakere	Karnataka	Cotton, Jowar, Kharif Jowar, Ragi, Groundnut
~	Rajendranagar	Andhra Pradesh	Castir, Groundnut, Cotton, Jowar
~	Amaravati, Mohol	Maharashtra	Rabi Jowar
~	Junagarh, Surat	Gujarat	Jowar, Groundnut cotton, Jowar
~	Gwalior, Hosangabad	Madhya Pradesh	Kharif Jowar, Linseed
~	Ajmer	Rajasthan	Jowar, Bajra
~	Kanpur	Uttar Pradesh	Indian Mustard, Bajra
~	Patiala	Punjab	Toria, taramaria
~	Sirsa	Haryana	Cotton
~	IARI	New Delhi	Cotton, Jowar, Bajra, linseed

- **AII India coordinated Research Project:**
- 1957: All India coordinated research project on maize was established with aid from Rockfellar foundation.
- 1965: ACRIPs were started on other crops as well as in other areas of Research.

Crops	**Place**
~ Maize	New Delhi
~ Jowar	Hyderabad
~ Barley	Karnal
~ Millets	Pune
~ Forage crops	Jhansi
~ National seeds project	New Delhi
~ Sugarcane	Lucknow
~ Sugar beet	Pantnagar
~ Cotton	Coimbatore
~ Jute and allied fibres	Barrackpore
~ Soybean	Indore
~ Tobacco	Anand

~ Cotton Project (WB assisted)	Nagpur
~ Fruits	Bangalore
~ Citrus	Bangalore
~ Tuber crops	Dholi (Bihar)
~ Potato	Simla
~ Vegetables	New Delhi
~ Medicinal and Aromatic plants	New Delhi
~ Spices and Cashewnut	Kasargod
~ Coconut and Arecanut	Kasargod
~ Under utilized and under exploited plants	New Delhi

INDIAN COUNCIL OF AGRICULTURAL RESEARCH:

- 1928: Royal commission on Agriculture, headed by lord linlithgow recommended setting up of imperial council of Agricultural research to promote, guide and coordinate agricultural research throughout India.
- 23rd May, 1929 : Imperial Council for Agricultural Research was established
- President : Mohammed Habibullah
- Vice-President : Vijaya Raghavacharya
- Secretary : Mr. S.A. Hydari
- Governing body has 16 members.
- March, 1946 : The name Imperial council of Agricultural Research Institute was changed to Indian council of agricultural research by then president Sir Jogendra Singh.
- **Reorganization or ICAR:**
- In 1963, the Agricultural review Team headed by Dr. Marion W. Parker of USDA was appointed. Based on its recommendations ICAR was made a fully automonous organization in 1966.
- IARI, New Delhi, NDRI, Karnal and IVRI, Izatnagar were made national Institutes.
- A policy was mad to appoint an agricultural scientist as the Chief Executive of ICAR, with the designation of Director General, Dr. B. P. Pal became first DG of ICAR in 1965.
- **Department of Agricultural Research and Education (DARE):**
  In June 1972 Gajendragadkar committee was established to review the recruitment and personal policies of ICAR and its institutes, which submitted its report in 1973. Department of Agricultural research and Education was created in 1973 in the Ministry of Food and Agriculture.
- An Agricultural research service was initiated in 1973 for the recruitment of Scientific personnel under Agricultural Scientists recruitment Board.
- Entire country was divided into 8 agroecological zones and 15 agro ecological zones and 15 agroclimatic zones.
- **Research Stations:**

CARI	:	Central Agricultural research institute	Port Blair
CARI	:	Central Avian Research Institute	Izatnagar

CARIANGI	:	Central Agricultural research Institute for Andaman and Nicobar Groups of Islands	Port Bihar
CAZRI	:	Central Aril Zone research Institute	Jodhpur
CLAE, IISS	:	Central Institute of Agricultural Engineering	Bhopal
CIBA	:	Central Institute for Barkishwater Aquaculture	Chennai
CICFRI	:	Central Inland capture Fisheries	Barrackpore
CIFA	:	Central Institute for Freshwater Aquaculture	Bhubaneshwar
CICR	:	Central Institute of Cotton Research	Nagpur
CIFT	:	Central Institute of Fisheries Technology	Cochin
CIHNP	:	Central Institute of Horticulture of Northern Plains	Lucknow
CIPET	:	Central Institute of Post-harvest Engineering and Technology	Ludhiana
CIRCOT	:	Central Research Institute for research on Cotton Technology	Bombay
CIRB	:	Central Research Institute for Research on Buffaloes	Hisar
CIRG	:	Central Institute for Research on Goats	Makhdoom
CMFRI	:	Central Marine Fisheries Research Institute	Cochin
CPCRI	:	Central Plantation Crops Research Institute	Kasargod
CPRI	:	Central Potato Research Institute	Kufri, Simla,
CRIAF	:	Central Research Institute for Arid Fruits	Bikaner
CRIDA	:	Central Research Institute for Dry land Agriculture	Hyderabad
CRIJAF	:	Central Research Institute for jute and Allied Fibres	Barrackpore
CRITF	:	Central Research Institute for Tropical Fruits	Srinagar
CRITF	:	Central Research Institute for Tropical Fruits	Lucknow
CRRI	:	Central Rice Research Institute	Cuttack
CSSRI	:	Central Soil Salinity Research Institute	Karnal
CSWCRTI	:	Central Soil and water Conservation Research and Training Institute	Dehradun
CSWRI	:	Central Sheep and Wool Research Institute	Avikanagar
CTCRI	:	Central Tuber Crops Research Institute	Trivandrum
CTRI	:	Central Tobacco Research Institute	Rajahmundry
CTRL	:	Central Technological Research Laboratory	Matunga
IASRI	:	Indian Agricultural Statistics Research Institute	New Delhi

ICARRCG	:	ICAR Research Complex for Goa	Goa
ICARRCNEHR	:	ICAR Research complex for North Eastern Hill Region	Barapani
ICARRCNER	:	ICAR Research complex for North Eastern Region	Shillong
IGFRI	:	Indian Grassland and fodder Research Institute	Jhansi
IIHR	:	Indian Institute of Horticultural Research	Hassergatta, Bangalore
IIPR	:	Indian Institute of Pulse Research	Kanpur
IISR	:	Indian Institute of Sugarcane Research	Lucknow
IISS	:	Indian Institute of Soil Science	Bhopal
ILRI	:	Indian Lac Research Institute	Namkum, Ranchi
JTRL	:	Jute Technological Research Laboratory	Calcutta
NAARM	:	National Academy of Agricultural Research and Management	Hyderabad
NCAEPR	:	National Centre for Agricultural Economics and Policy Research	New Delhi
NIAG	:	National Institute of Animal Genetics	Karnal
SBI	:	Sugarcane Breeding Institute	Coimbatore
VPKAS	:	Vivekananda Parvatiya Krishi Anusandan Shala	Almora
WTCER	:	Water Technology Centre for Eastern Region	Bhubaneswar

Deemed Universities

CIFE	:	Central Institute of Fisheries Education	Bombay
IARI	:	Indian Agricultural Research Institute	New Delhi
IVRI	:	Indian Veterinary Research Institute	Izatnagar
NDRI	:	National Dairy Research Institute	Karnal
NIASM	:	National Institute of Abiotic Stress Management	Maharastra
NAARM	:	National Academy of Agricultural Research and Management	Hyderabad

Indian Agricultural Research Institute:

1905 : Agricultural Research Institute was established at Pusa, Bihar by Lord Curzon. The land was donated by Mr. Phipps of USA after whom the place was named as PUSA. The Phipps laboratory in division of Soil Science and Agricultural Chemistry, IARI is named after him.
1911 : Renamed as Imperial Agricultural Research Institute.
1923 : Institute started offering Diploma of Associateship.
1934 : Major Earth quake damaged the buildings at pusa.
1936 : Shifted to New Delhi.
1936 : B. Vishwanath became the first Indian Director of the Institute.
1946 : The Diploma of Associate ship was Recognised equivalent to M. Sc.
1947 : Name has been changed from Imperial Agricultural Research Institute to Indian Agricultural Research Institute.
1958 : Recognized as "Deemed University" under UGC Act at 1956, PG School was established.

NON EDUCATIONAL INSTITUTES

- EEI, Anand, Gujarat
- EEI, Jorhat, Assam
- EEI, Hyderabad, AP
- EEI, Nilokhen, Haryana

International Institutes of crop Improvement:

CGIAR : Consultative Group for International Agricultural Research. Was established in 1971 by the joint efforts of Food and Agricultural Organisation world baulk and United Nations Development Programme.
CIAT : Centro International de Agriculture Tropical (International Centre for Tropical Agriculture), Palmira, columbia.
CIMMYT : Centro International de Majoramiento de Maizy Trigo (International Centre for Maize and Wheat Improvement) el Baton, Mexico.
CIP : Centro International de Papa (International Centre for Potato), Lima, Peru,

IBPGR	:	International Board for Plant Genetics Resources Rome, Italy.
ICARDA	:	International centre for Agricultural Research in Dry Areas, Alleppo, Syria.
ICGES	:	International Centre for Genetic Engineering and Biotechnology Triesta, Italy and New Delhi, India.
ICRISAT	:	International Centre for Research in Semi-Arid Tropies, Patancherru, Hyderabad, India.
IFRI	:	International Food Policy Research Institute, Washington, USA.
IIAS	:	International Institute for Applied System Analysis, Luxemburg, Vienna.
IITA	:	International Institute of Tropical Agriculture, Ibadan Nigeria.
INSFFER	:	International Network on Soil Fertility and Fertilizer Evaluation on Rice, New Delhi, India.
ILRAD	:	International Livestock Research Institute, Nairobi, Kenya.
ILCA	:	International Livestock Centre for Africa, Addis Ababa.
IRRI	:	International Rice Research Institute, Los Bonas, Philippines.
ISNAR	:	International Service for national Agricultural Research. The Hague, Netherlands.
WARDA	:	West African Rice Development Association, Monrovia, Liberia.

13. Elements of statistics

MEASURES OF CENTRAL TENDENCY:

- Measures of central tendency also know as **- Average**
- Different types of measures of central tendency - **Arithmetic Mean, Harmonic Mean, Geometric Mean, Median and Mode.**
- Arithmetic Mean is **- Sum of all observations/No. of observations**
- Arithmetic Mean is used **- To calculate average yield, SD, and correlation and regression coefficients.**
- AM is dependent on - **change of origin.** Eg.- if the observations (X) with AM (ϕ) change to (ϕ+a) then New AM will be - **ϕ+a**
- AM is dependent on - **change of scale**. Eg.- if the observations (X) with AM (ϕ) change to (aϕ) then New AM will be - **aϕ**
- If the observations (X) with AM (ϕ) change to (aϕ+b) then New AM will be - **aϕ+b**
- The algebraic sum of the deviations of the variate from the mean is - **zero** $\sum(X-\phi) = 0$
- AM of the first "n" natural numbers (1, 2, 3…….n) is (n+1)/2, i.e. AM of first 10 number is - **5.5**
- Sum of square of deviations of the variate from their mean is - **least**
- Harmonic Mean is used **- When deal with Rate, price and speed**
- Geometric Mean is used **- When deal with relative changes Ex. Bacterial growth, cell division**
- Median is **- a positional average**
- Median is **- Middle most item of all values**
- If the no. of observation (N) is odd then median will be …….when they are arranging in ascending or descending order of magnitude - **(N+1)/2 th item**
- Median is used for **- open ended class data's Intelligence, Ability and Efficiency**
- Mode is **- Most frequently occurred item**
- Mode is used for **- Typical soil type, cropping pattern in a locality, and shoe and shirt size in business**
- In Symmetrical distribution, there will be - **Mean = Median = Mode**
- In Moderately skewed distribution, there will be **Mean – Mode = 3 (Mean – Median)**

MEASURES OF DISPERSION:

- Measures of dispersion commonly known as **- distance measures**
- Measures of dispersion gives an idea about the extent of the observations or spread of the observations from **- a central value**
- Measures of dispersion is of two type: **Absolute MD** and **Relative MD**
- Measures of dispersion in which unit is same as that of observation - **Absolute MD**
- Measures of dispersion in which no unit - **Relative MD**
- Absolute MD includes **- Range, mean deviation, quartile deviation** and **standard deviation**
- Relative MD also known as the **- Coefficient of dispersion.**

- Relative MD is measure of dispersion divided - **by related measure of central tendency**
- Relative MD includes Coefficient of mean deviation about **- mean, mode, median and SD, QD**
- Range is the simplest MD. It is difference between higher value and lower value in the observations.
- Mean deviation is the arithmetic mean of the absolute deviation of the observations.
- Minimal property: Mean deviation is least calculated about median, then about mean and then about mode.
- Standard deviation is the positive square root of average of the square of deviation of all the observation from their AM.
- SD represents by $\sigma = \sqrt{\sum f (X-\phi)/ N}$ where, ϕ is mean
- Variance is square of the standard deviation.
- Variance of any consecutive number "n" is $(n^2-1/12)$, i.e. variance of number from 11 to 20 is $(10^2 -1)/12 = 99/12 = 33/4$
- There is no effect of change of origin on SD. Eg. If the observations (X) change
- Coefficient of variation = (SD/ mean) X 100

REGRESSION AND CORRELATION

- **S**tudy the association between two or more variables is called- **Correlation**
- The correlation coefficient lies between **- –1 to +1**
- If Correlation coefficient is 0, there is …….between variables **- No relationship**
- Correlation is independent of change of …… of the variables **-Scale and origin**
- Correlation is ……..of two regression coefficients **-Geometric mean**
- The degree of relationship between two variables is **- Symmetric** (i.e. $r_{xy} = r_{yx}$)
- Average relationship between two of more variables is measured by **–Regression**
- Regression gives the **- nature of relationship between two variables**
- Regression gives the **- cause and effect of relationship**
- Regression coefficients are **- not symmetric** (i.e. $b_{xy} \neq b_{yx}$)
- Regression is independent of change of **- Origin but not of scale**

PROBABILITY

- Probability = $\dfrac{\text{No of favorable cases}}{\text{Total no of equally likely cases}}$
- Probability ranges from -**0 to 1**
- Probability of an event uncertain to occur is - **0**
  Eg. Probability of 7 in throwing a die will be - 0
- Probability of sure or certain event is - **1**
- Different possible results of an experiments is - **Outcome**
- Outcome or set of outcomes associated with a certain condition is -**Event**
- Event which occur only once or will exclude the occurrence of other is called **- Mutually exclusive event**
- Mutually exclusive events does - **not have any common element**
- The occurrence of one event does not affect the occurrence of others is called **- Independent event**
- If A and B are independent, then P (AB) = P (A).P (B),

so P(A+B) **= P (A)+P (B)**

- Probability of happening of event A is given as P ($\bar{A}$) and P ($\bar{A}$) = 1-P(A) or P(A) + P ($\bar{A}$)= 1
- P(A+B), Probability of occurrence of at least one of the event A or B (i.e. either A, B or both) or (PUB)
- P(A+B), probability of occurance of both the events A and B or P(AΩB)
- P(B/A) probability of occurrence of B when A has already occurred, it is called - **The conditional probability**
- The conditional probability is given as **- P(B/A) = P(AB)/ P(B)**
- P(A+B) = P(A) + P(B) – (AB)
- If A and B are independent, then P(AB)= P(A).P(B), so P(A+B) = P(A) + (B)
- Probability of not happening of event A is given as
- **Additive theorem**
  - (I) Mutually exclusive events
    P (A or B) =P (A) +P (B), where P(AB)=0
  - *(II)* Not mutually exclusive events
    P (A or B) =P (A) +P (B)-P (AB)
- **Multiplication theorem**
  (I) P (A and B) =P (A) X P(B)

DISTRIBUTION

a) Binomial Distribution (BD)

- Random variable of BD is a discrete one
- BD has Bernoulli trials containing two outcomes (i.e. success, failure)
- The BD is

  $P(X) = {}_nC_x p^x q^{n-x}$

  Where
  - n = no of trials
  - p = probability of success
  - q = probability of failure
  - x = no of successes in 'n' trials
- Mean (np) ≠ variance (npq)
- If n is large and if neither p of q is too close to 0, then BD approaches normal distribution.
- When n> 20; p<0.05, BD approaches Poisson distribution.

b) Poisson Distribution (PD) (the law of improbable events)

- PD – discrete probability distribution

  $$P(x) = \frac{e^{-\lambda}\lambda^x}{X!}$$

  Where
  - x = 0, 1, 2, 3, 4, 5……
  - e = 2.7
  - λ = mean (np)
- Mean (np) = variance (npq) p → 0; q → 1
- Uses of PD
  - ~ Printing errors in a book
  - ~ No of deaths in a district in a given period

~ Arrivals of trucks aero planes at terminals
~ Telephone calls

c) Normal Distribution (ND)

- ND – continuous probability distribution
- Standard deviation of a sample = σ Tv
  Where,
  s = SD of population
  n = sample size
- The normal curve is bell shaped and symmetrical
- Mean = median = mode
- Area under standard normal curve = 1; mean = 0; SD = 1

EXPERIMENTAL DESIGNS

- The variation due to uncontrolled factors is called - **Experimental error**
- The objects of comparison is called - **Treatment**
- Allocation of treatments to the different experimental units by a random process- **Replication**
- The principle of making use of greater homogeneity in groups of experimental units for reducing experimental error - **Local control**
- **Critical difference** (standard error) diff. X t value for error df at 5% or 1% level
- **Summary of different experimental degign:**

S N	Type of Design	Type of experimental material	Error degrees of freedom
1	CRD	Homogeneous	N-n
2	RBD	Variation in one direction	(n-1) x (r-1)
3	LSD	Variation in two directions	(n-1) x (n-2)

Where, N = total no. of observations
n = no of treatments
r = no. of replications

- Design used to study effects of 2 or more factors requiring different plot sizes - **Split Plot Design**
- Design used to study agronomic practices with fertilizer treatments - **Split Plot Design**
- Design used to study the effects of two or more factors and their inter relationships - **Factorial experiments**

TEST OF SIGNIFICANCE

- The statistical procedure for deciding the difference under study is significant or not is called - **Test of significance**
- The assumption (assumption) about population parameters is - **Hypotheses**
- A hypothesis which is under test for possible rejection is called- **Null hypothesis (H_o)**
- Null hypothesis (H_o) is the applied for ……..between two parameters.
  - **- No significant difference**

- A hypothesis which is under test for possible rejection is called - **Alternative hypothesis (H_a)**
- Alternative hypothesis (H_a) is the applied for ……between two parameters. - **- Significant difference**
- **There are two types of Errors:**
- The error occurs due to rejection of Null hypothesis while H_o is true - **Type I error (Rejection error):**
- The error occurs due to Acceptance Null hypothesis while H_o is false - **Type II error (Acceptance error)**
- Probability of type-I error is denoted by **-α** and known as- **Level of significance.**
- Probability of type-II error is denoted by **-β** and is related with -**Power of test.**
- Power of test is denoted by - **1-β**
- Type-II error is ……than Type-I error - **more serious**
- Critical region is the - **Region of rejection**
- Whether the test is one sided (tailed) or two sided (tailed) based on - **Alternative hypothesis**
- Level of significance/ type-I error lies between **– 0 to 1**
- A null hypothesis is ……..if the value of the test statistic lies in the Critical region - **Rejected**
- The number of independent values in a set of values is known as - **Degree of freedom**
- Degree of freedom in a test takes care of - **sample size**
- Student T test was given by - **W.S. Gosset**
- Student T test is applicable in case of - small samples
- Standard normal variate Z is given by - ----------
- Z test assumes that **all the observation in sample are independent**, **Sample size is small (<30)** and **random variable X follows the normal distribution.**
- t statistic ranges from **-α to + α**

TESTS OF SIGNEFICANCE (Small sample < 30)

SN	Type of Test	Uses
1.	Students t test	Small samples
2.	Z test	Large samples
3.	F test	To test the proportions and variances
4.	Chi square	Test of independence, test of goodness of fit, test homogeneity